A PRACTICAL TREATISE

ON

Materia Medica and Therapeutics

WITH ESPECIAL REFERENCE TO THE CLINICAL APPLICATION OF DRUGS.

BY

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SECOND EDITION. THOROUGHLY REVISED.

IN TWO VOLUMES.

VOLUME I.

DEVOTED TO PHARMACY, GENERAL PHARMACOLOGY AND THERAPEUTICS, AND REMEDIAL AGENTS NOT PROPERLY CLASSED WITH DRUGS.

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TO

THE MANY PUPILS

WHO HAVE ATTENDED HIS LECTURES DURING THE PAST
EIGHTEEN YEARS AND ARE NOW PURSUING THEIR
PROFESSION IN THE UNITED STATES OF AMERICA
AND IN MANY FOREIGN COUNTRIES,

THESE VOLUMES,

ILLUSTRATING AN ALL-IMPORTANT AND PRACTICAL
DEPARTMENT OF MEDICINE, PHARMACY,
AND DENTISTRY,

ARE

RESPECTFULLY INSCRIBED BY THEIR TEACHER,

THE AUTHOR.

PREFACE TO THE SECOND EDITION OF VOLUME I.

This volume has been carefully and thoroughly rewritten and remodeled. In preparing a second edition of the work the author has earnestly desired to emphasize his profound conviction of the value of the natural forces and of mechanical and physiological agencies in the treatment of disease. The great aim of practical medicine is the cure or relief of disease. In the effort to accomplish this object the physician should strive to make use of every means by which the system of the patient may be benefited in its struggle with the malady. Enlightened therapeutics must be preceded by a correct diagnosis, and diagnosis, in its turn, should lead us to a diligent study of etiology. It is only after the nature of an ailment has been recognized and its origin ascertained that we can be in a position to intelligently apply methods of relief. Pathology is but modified physiology, and if we are able, at an early period, to remove or neutralize the action of a malific cause we aid Nature in the re-establishment of normal function. The origin of specific infection comes from without, the genesis of toxic processes is to be sought within, the organism. In each of these two great morbid types the tissues and organs are injuriously affected by the presence of abnormal chemical products. The grand object of modern therapeutics is, therefore, to prevent, as far as possible, the formation of these deleterious substances; or, when this effort has failed, to promote their speedy and thorough elimination. We have learned to appreciate more justly the resistant as well as the reparative power of the economy. The germicidal properties of the blood-serum and the white cells and the increased activity of the eliminating organs protect us from the dangers by which we are every day and every hour surrounded. Exact experimentation has recently shown us the comparative facility with which hungering and thirsting animals succumb to infection. In these facts, thus briefly stated, we have the foundation of the rules which should govern the medical profession. Preventive medicine and sanitary science should be the first objects of study. In the emergency of dangerous epidemics the profession has the active assistance of the public. The laity can perceive the advantage of free ventilation and efficient drainage, but the regulation of personal habits, in accordance with the laws of hygiene, is, for most, a task too difficult to accomplish. This fertile cause of disease is always in operation. The practitioner, therefore, is constantly confronted with preventable but firmly-established disease. The correction of unhealthy physical habits must be the first step in the course of successful treatment. The physician should be competent to regulate his patients' mode of life as regards exercise, work, diet, amusement, and sleep. The physiology of digestion must be thoroughly studied; the chemical composition, the nutritive value, and the methods of preparation of foods should be understood. Much good is accomplished simply by the relief of the organs of digestion, assimilation, and excretion. The spirits and tone of mind and the circulation and processes of oxygenation improve in proportion to the benefit to digestion. Sleep becomes more sound and refreshing. Drugs can accomplish but a similar result, and will altogether fail unless their efficiency is promoted by the observance of physiological rules. Exhausted energy is re-established by the proper application of electrical force and the manipulations of massage. External heat compensates, in a measure, for weakness of the heat-forming apparatus, and is of advantage in conditions characterized by debility. It affords relief, also, in certain phases or periods of inflammatory disorders. The influence of cold, light, and music may, with great propriety and benefit, be utilized by the physician.

It is not essential that the physician should be a skilled pharmacist, but he should possess an intelligent conception of the methods of pharmacy and a familiar acquaintance with the physical and chemical properties of drugs. These subjects and the art of prescription-writing are, consequently, discussed, in the preliminary section of the book, from the stand-point of the general practitioner. The different modes of application or introduction of remedies, the Latin terms and phrases employed in prescriptions, the metric system, poisons and antidotes are also considered in this section.

In the chapter on "Electro-Therapeutics" one object has been held steadily in view—lucidity. The physical properties of this force, its modes of generation, the laws which regulate its manifestation and the mechanical means by which it is applied are described as briefly as is consistent with utility. The importance of electricity in the diagnosis of nervous affections and its value and indications in therapeutics are fully discussed. The physiological effects and the therapeutic applications of massage, so often synergistic with electricity, form the subject of a succeeding section. The paragraph upon the method of prescribing massage will, it is believed, be useful in securing the fullest benefit of this valuable procedure. The importance of pneumotherapy is pointed out, and the usefulness and the mode of administration of oxygen is described. The chapters on "Hydrotherapy," "Climate," "Diet," "Heat," "Cold," and other physiological agencies have all been rewritten.

The author hopes that his care and labor have succeeded in bringing within moderate compass information valuable alike to the physician and patient. He trusts, likewise, that this volume may be of service in demonstrating how much can be accomplished in the practice of medicine without the use of drugs, and how much the activity of drugs is enhanced by the judicious combination with physiological remedies.

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PHARMACOLOGY AND GENERAL THERAPEUTICS.

PART I.

Pharmaceutical Remedies, or Drugs.

GENERAL CONSIDERATIONS.—In the treatment of disease, recourse is generally had to certain agents which are known collectively as **remedies.** In point of fact, every preventive, reparative, or restorative means, which is, or can be made, available for the relief of the sick, or which is in repute for counteracting the effects of bodily disorder from any cause, is a remedy, or remedial agent, in a comprehensive sense of the term. It follows from this that remedies are of many kinds and of varying importance; indeed, they are almost as numerous and diverse as the causes of disease themselves. The principal classes of remedies, however, are comparatively few, and these may now be taken up systematically for consideration. A prominent form of remedial measure is that which seeks to remove the patient from the influence of unsanitary influences and to place him under more favorable conditions for recovery than those under which the sickness originated; such are known as **prophylactic** or **hygienic remedies.** They presuppose, on the part of the medical attendant, an acquaintance with the physiological laws of the human body, and of the effects of food, clothing, climate, occupation, habits, etc., upon its functions. Among prominent hygienic remedies are dieting, bathing, ventilation, change of residence or of occupation, due regulation of habits, and especially regulated exercises, including gymnastics and massage. These are **sanitary** or **hygienic agents** when employed to preserve health and prevent disease; they become **sanatory measures** when utilized in conjunction with the proper medical remedies, as they constantly are, in the treatment of the sick, with a view of hastening and facilitating their recovery. In the latter case, they are also included under the comprehensive term **regimen.** It is now considered of as great or even greater importance to properly regulate the ventilation and temperature of the sick-room, to direct the bathing and food of the patient, and to decide whether he shall have rest or exercise, in most instances, than it is to frame a prescription nicely adjusted to the state of the case; although the latter is by no means to be slighted. Light, heat and cold, magnetism and electricity are also remedial agents capable of powerfully influencing the bodily functions, and, when wisely directed, may produce positive sanatory or curative effects. These **imponderable remedies** or **forces,** as they have been called, are receiving much attention at the present day; and, as a result of the profound and painstaking investigations of many scientists and the careful observations of expert clinicians, the medical practitioner is now, for the first time, in a position to satisfactorily apply these agents and to record the results of his studies in exact and scientific terms. **Mechanical remedies** include various surgical measures, such as acupressure, acupuncture, aspiration, bandaging, blood-letting, etc.; also the various forms of gymnastics known under the name of Swedish movements, the movement cure, passive motion, etc.; and last, but by no means the least important among remedies which, at least, are partly mechanical, is massage, to which attention has been already called as a hygienic agent, and to which due consideration will be given hereafter in a special section, under **Kinesitherapy.** Finally, there is a class of remedies which are considered of such importance, and are so commonly used in the treatment of every condition of disease, that they are popularly termed "medicines"; these properly are **drugs** or **pharmaceutical remedies.** Formerly they were divided into chemical agents and drugs proper, or Galenicals; but this distinction has lost its force, since it has been shown that herbs, or "simples," owe their medicinal effects to "active principles," which are chemical in their nature, and which may be, and commonly are, administered separately, to produce the proper physiological and therapeutical effects of the drugs.

Pharmacology is the science of drugs; it is made up by contributions from all sources of knowledge bearing upon the natural history of remedies, their botanical and chemical relations, their effects upon the body both in health and in diseased conditions, and, in short, everything with regard to such an agent, viewed from a medical stand-point. For convenience, subdivisions of this comprehensive subject have been generally employed. **Materia Medica** is devoted particularly to the study of the source of drugs, their physical and chemical properties and constituents, and includes medical botany and pharmacodynamics, or the physiological action of remedies upon the lower animals and upon man; understanding by the term physiological action of a remedy the sum total of the effects produced upon different organs and tissues, with the resulting disturbance of function, in an animal otherwise in health. **Pharmacy** analyzes and identifies drugs, provides useful and attractive preparations, and teaches the best methods of administering them.

Toxicology studies the actions of poisons or toxic doses of drugs, with their antidotes, chemical and physiological, as well as other measures to be pursued to minimize or antagonize their deleterious effects.

Therapeutics is especially concerned with the application of remedies to the treatment of disease and the proper care of the sick. Other medical studies are only the foundation, therapeutics is the superstructure; as Fothergill well said, "the ultimate aim of all medical research is the treatment and prevention of disease." For convenience it is divided into surgical and medical therapeutics. Many systems of therapeutics have been promulgated in times long past before the era of science, or the application of exact scientific methods to the study of the action of drugs and the investigation of pathological and clinical problems. Having at length a sound foundation of accumulated knowledge and experience upon which to rest our practice, we are prepared to base a system of **rational therapeutics** upon the demonstrated and established effects of drugs and our knowledge of the nature of morbid processes in the human body. The only scientific system possible is one which (1) endeavors to remove morbific causes or render them inoperative; (2) seeks to repair the ravages of disease or to correct abnormal physiological action; (3) aims to ameliorate the condition of the patient by relieving prominent symptoms, such as pain, fever, sleeplessness, loss of appetite, etc., and (4) to place him under circumstances most favorable to recovery. **Symptomatic treatment** which seeks merely to remove symptoms, without investigating their causes, is obviously unsatisfactory and unscientific, but occasionally is resorted to in an emergency when such symptoms are urgent. **Empirical treatment** was the only kind of treatment possible before the mode of action and the effects of medicines were understood; it merely directed that certain medicines should be taken for the reason that in apparently similar conditions their administration had been followed by good results. Owing to the fallacious character of the teachings of experience, as pointed out by Hippocrates in his celebrated aphorism, it results that pure, blind empiricism abounds in error, and, as a rule of practice, is the poorest system of treatment to follow. On the other hand, where the knowledge obtained at the bedside is aided by sufficient acquaintance with the physiological action of drugs, already referred to as rational therapeutics, we have an **enlightened empiricism,** which should, on the contrary, be the best practice possible, since it affords to the patient all the assistance which science and experience combined can provide toward hastening and completing his recovery. It is not based on fixed law, but is progressively improving in proportion with advances in other departments of science. Any school of medicine assuming to rest upon a foundation less broad than this, or on a system which is fixed and stationary, by its own terms separates itself from the scientific study and practice of medicine, and makes its followers a medical sect or "school." In the course of centuries many such schools have been brought to light, and, after a brief period, have been outgrown and forgotten. Such a fate is the natural destiny of any restricted system, based upon dogma and not upon observation. The system of medicine which is studied as a department of natural science, and which is unrestricted by any hypothesis or supposed law of cure, in its application of remedies to the treatment of disease, will undoubtedly vary somewhat in its results, according to the individual skill of its practitioners, the scientific attainments of the time, and the peculiarities of patients; but when statistics are correctly compiled from sufficiently large groups of cases it is easily demonstrated to be more successful than any restricted system which has been or can ever be brought in competition with it. In order to avoid misapprehension, it may be proper at the outset to explain that in the present treatise the system of scientific or so-called "regular" medicine, as just described, will be followed. This is quite distinct from any school or sect in medicine, and also equally separate from allopathy or allopathic practice. Although many persons ignorantly confound them, a radical difference exists, as every educated physician knows, between a "regular practitioner" and an "allopathic doctor," inasmuch as the latter is sectarian and the former non-sectarian.

At the same time that we discard restrictions as to therapeutics and employ whatever remedial means experiment and observations lead us to believe will benefit our patients, it should not be forgotten that the knowledge at our command is derived from various sources, and if we are willing to acknowledge the indebtedness of modern medicine even to native tribes for many useful remedies, we should not be above admitting that useful lessons may also be occasionally learned from followers of exclusive schools of medicine, or so-called irregular physicians. "Every judicious physician," says Dunglison, "must be an eclectic," in the sense that he selects from every source the best means of controlling disease. In the ordinary restricted sense, an eclectic is one who confines himself to vegetable drugs, or, in other words, is a botanic physician, and in this sense it has been appropriated by a sect of physicians who were formerly known as Thomsonians, from the name of the founder. In the ranks of regular medicine, also, there are specialties in therapeutics, some confining their practice to massage or gymnastics, others to electricity, others again to bathing, or hydropathy. The qualified physician or general practitioner appreciates the value of all the various agencies that are used in treating the sick, and assigns to each its proper place in his therapeutics, directing his treatment not against disease, but to the improvement of patients temporarily in a diseased or abnormal condition.

A complete cyclopædia of therapeutic agents should include in its consideration every remedial measure which the best educated and most skillful physicians employ in treating the sick, giving to each its proper place and value. As there are separate treatises upon hygiene, dietetics, massage, balneology, and electro-therapeutics, and the importance of these subjects warrants their separate treatment, modern text-books of therapeutics are usually restricted to treatment solely by pharmaceutical remedies, or drugs. Nevertheless, in the present work due consideration is given to other forms of remedial agencies, and electro-therapeutics, hydro-therapeutics, masso-therapeutics, metallo-therapy, balneology, climatology, and hypnotism will be found discussed hereafter under their own titles.

PHARMACOLOGY, PHARMACOGNOSY, AND THE PHARMACOPŒIA.

Pharmacology (*φαρμακον*, a medicament, and *λογος*, a treatise) is, properly speaking, the science of drugs, and is limited, first, to **Pharmacognosy**, or the study of their natural history, their physical and chemical characters, tests for purity, etc.; secondly, to **Pharmacy**, which comprises the various methods of compounding and dispensing them in their several combinations for use in the treatment of disease. Some authors have restricted the term "pharmacology" to the results obtained from the study of the physiological action of drugs, but this is more appropriately named "pharmacodynamics." Good usage and etymology support the definition given above. Both pharmacodynamics and therapeutics, however, in so far as they relate to drugs, may be considered as departments of pharmacology, in a broad sense of the term.

The **Materia Medica**, or pharmacological remedies, may be divided into crude drugs and preparations. The latter may be made according to established formulæ, both non-officinal and officinal, or they may be extemporaneously compounded and dispensed according to the directions furnished by a physician. The latter are known as "magistral" preparations; they are compounded according to the formula contained in the prescription, of which more will be said presently. Officinal preparations are those recognized by authority of the pharmacopœia and directed to be kept in the shops (*officina*, a shop) ready for dispensing. They are also known by some as "official" preparations, because they are issued by the authority of the pharmacopœia. Since this authority does not extend beyond the geographical limits of the country to which it belongs, it follows that England, France, Germany, Sweden, and other countries, as well as the United States, have pharmacopœias of their own. Remedies belonging to each usually have after them initials indicating their source; thus, U. S. P. means United States Pharmacopœia; Ph. Br., British Pharmacopœia; Ph. F., French Pharmacopœia, or Codex Medicamentarius; Ph. G., German Pharmacopœia; Ph. Sw., Swedish Pharmacopœia. In the usual and modern acceptation of the term, a **pharmacopœia** is a medical book, issued by authority, containing a list of recognized drugs, with descriptions and physical characters, tests for purity and medicinal activity, and formulæ for accepted preparations. Drugs and preparations authorized by the pharmacopœia become in this way officinal. The necessity of having some standard to define the character, establish the purity, and regulate the strength of medicinal preparations is universally conceded. Those countries which do not possess a pharmacopœia of their own usually adopt the French Codex or the British and United States Pharmacopœias. Unfortunately, it may happen that a preparation will have the same title but differ considerably in strength in different pharmacopœias, such as the tincture of belladonna and the tincture and extract of aconite, which might lead to error in copying formulæ from English, French, or German sources, since these preparations in the United States Pharmacopœia are considerably stronger than the corresponding English preparations.

The Pharmacopœia of the United States is not issued directly by authority of the government, as in most other countries, although it is adopted by the government in the medical departments of the army, navy, and marine-hospital service. It is compiled as a voluntary undertaking by the physicians and pharmacists, in accordance with a peculiar arrangement. Every ten years representatives from medical societies and colleges, pharmaceutical societies and colleges, and delegates from the Army, Navy, and United States Marine-Hospital Service, meet in Washington, forming the National Convention for the Revision of the Pharmacopœia. After organization and the disposal of business which may come before it, a standing committee on revision is appointed, which, having received instructions from the convention, proceeds to prepare and publish an edition of the United States Pharmacopœia. The first issue was in 1820, and the seventh revision will shortly appear, the last convention having met in 1890. Many new remedies have been brought to the notice of the profession since the last revision, some of which have come extensively into use and possess decided merit, others are ephemeral and will soon sink into well-deserved neglect. Owing to the present degree of activity in therapeutics, it is impossible that the pharmacopœia should include all the medicinal agents used by physicians in the treatment of disease, especially those only recently introduced. Therefore, a considerable number of **unofficinal drugs** are in use, some of which will eventually prove their right to be recognized and become officinal, while many others will never be able to make good their claim. Proprietary remedies, patent medicines, and preparations made by secret formulæ are sold very largely to the public, and are sometimes prescribed by physicians, who appear to be unmindful of the fact that the Code of Ethics denounces this as a reprehensible practice, calculated to injure both the patient and the medical profession. The prescribing of preparations of unknown composition is opposed to the best interests of scientific medicine and the public.

MATERIA MEDICA.

The **Materia Medica** consists of officinal and non-officinal drugs and their preparations. It has several branches. Pharmacognosy investigates the physical characters of drugs in order to establish their identity. Medical botany establishes their place in the vegetable kingdom and their botanical grouping or relationship. Chemistry determines the constituents of the drug and isolates the so-called active principles; it also teaches the chemical antidotes. In the United States Pharmacopœia all remedies are arranged under their Latin titles alphabetically, and, owing to its convenience, the same plan has been adopted in Part III of the present work. It is possible to adopt either a natural method of classification of drugs, or an artificial arrangement into classes according to the physiological or therapeutical effects. A scheme of the latter kind appears at the conclusion of this section. The following list contains most of the drugs in use, arranged according to their natural affinities and chemical characters. It is similar to that adopted by Brunton in his well-known work on "Pharmacology, Materia Medica, and Therapeutics."

Inorganic Materia Medica.

Group I—*Non-Metals.*

Hydrogen.
Oxygen (Ozone, Peroxide of hydrogen).
Sulphur (Hydrogen sulphide).
Carbon (Charcoal).
Bromine (Acid hydrobromic).
Chlorine (Lime chlorinated, Soda chlorinated).
Iodine (Acid hydriodic).
Nitrogen (Acid nitric, etc.).
Phosphorus (Acid phosphoric).

GROUP II—*Metals* (a) *of the Alkalies and Alkaline Earths.*

Monad Metals.—Potassium, Sodium, Lithium, Ammonium.

Dyad Metals.—Calcium, Strontium, Barium, Aluminium, Magnesium, Zinc, Copper, Cadmium, Silver, Mercury.

(b) *The Heavy Metals.*

Triad Metals.—Thallium, Iridium, Gallium.

Tetrad Metals.—Lead, Tin.

Pentad Metals.—Nitrogen, Phosphorus, Arsenic, Bismuth, Antimony.

Hexad Metals.—Chromium, Tungsten Molybdenum.

Heptad Metal.—Manganese.

Unclassified Metals.—Iron, Nickel, Cobalt, Platinum, Gold.

ORGANIC MATERIA MEDICA.

GROUP I—*Carbon Compounds.*

(*a*) FATTY SERIES.

Hydrocarbons.
Benzinum.
Petrolatum.
Alcohol (Ethylic, Methylic, Amylic).
Aldehydes (Ethylaldehyde, Paraldehyde).
Ether.
Ethereal oil.
Acetic ether.
Ethyl and Amyl nitrite.
Nitro-glycerin.
Ethyl bromide and iodide.
Chloral hydrate.
Bromal hydrate.
Butyl-chloral hydrate.
Methylene bichloride.
Chloroform.
Iodoform.
Iodol.
Europhen.

(*b*) AROMATIC SERIES.

Carbolic acid.
Creasote.
Resorcin.
Hydroquinone.
Pyrocatechin.
Salicylic acid.
Naphthalin.
Naphthol (Alpha and Beta).
Chinoline.
Kairin.
Antipyrin.
Acetanilid.
Sulphonal.
Exalgin.
Phenacetin.

GROUP II—*Vegetable Materia Medica.*

SUB-KINGDOM I—PHANEROGAMÆ.

CLASS I—EXOGENS.

DIVISION I—ANGIOSPERMÆ.

SUB-CLASS I—THALAMIFLORÆ.

Natural Order.	*Officinal Name.*	*Synonym.*
Ranunculaceæ.	Ranunculus,	Crow-foot, Butter-cup.
	Aconitum,	Monkshood.
	Staphisagria,	Stavesacre.
	Delphinium,	Larkspur.
	Pulsatilla,	Meadow anemone.
	Adonis vernalis,	False hellebore.
	Helleborus,	Hellebore.
	Cimicifuga,	Actæa.
	Podophyllum,	May apple.
	Hydrastis,	Golden seal.
Magnoliaceæ.	Magnolia.	
	Illicium,	Star anise.

Natural Order.		*Officinal Name.*	*Synonym.*
Menispermaceæ.		Menispermum,	Canadian moonseed.
		Calumba,	Calomba.
		Pareira,	Pareira.
		Picrotoxinum,	Picrotoxin.
Berberidaceæ.		Caulophyllum,	Blue cohosh.
Papaveraceæ.		Opium.	
		Sanguinaria,	Blood-root.
		Chelidonium,	Celandine.
Cruciferæ.		Sinapis,	Mustard.
		Armoracia,	Horse-radish.
Violaceæ.		Viola,	Pansy.
Linaceæ.		Linum,	Flaxseed.
Geraniaceæ.		Geranium,	Cranesbill.
Polygalaceæ.		Senega,	Polygala.
		Krameria,	Rhatany.
Sapindaceæ.		Guarana,	Paullinia.
Erythroxylaceæ.		Erythroxylon,	Coca.
Malvaceæ.		Gossypium,	Cotton.
		Althea,	Marsh-mallow.
Aurantiaceæ.		Aurantium,	Orange.
		Limones,	Lemons.
		Bergamum,	Bergamot.
Sterculaceæ.		Theobroma,	Cacao.
Ternstromiaceæ.		Camellia,	Tea.
		Caffea,	Coffee.
Guttiferæ.		Cambogia,	Gamboge.
Canellaceæ.		Canella.	
Vitaceæ.		Uvæ passæ,	Raisins.
		Vina,	Wines.
Zygophyllaceæ.		Guaiacum.	
Meliaceæ.		Azedarach.	
Rutaceæ.	Ruteæ.	Ruta,	Rue.
		Cusparia,	Angostura bark.
	Diosmeæ.	Buchu.	
	Xanthoxyleæ.	Xanthoxylum,	Prickly ash.
		Pilocarpus,	Jaborandi.
Simarubaceæ.		Quassia.	

SUB-CLASS II—CALYCIFLORÆ.

Natural Order.	*Officinal Name.*	*Synonym.*
Rhamnaceæ.	Rhamnus purshiana,	Cascara.
	Rhamnus frangula,	Buckthorn.
Celastraceæ.	Euonymus,	Wahoo.
Aquifoliaceæ.	Prinos,	Alder.
Terebinthaceæ, Anacardiæ.	Mastiche.	
	Rhus glabra,	Sumach.
	Rhus toxicodendron,	Poison ivy.
Burseraceæ.	Myrrha,	Myrrh.

Natural Order.		*Officinal Name.*	*Synonym.*
Leguminosæ.	Papilionaceæ.	Glycyrrhiza,	Liquorice.
		Scoparius,	Broom.
		Tragacanth.	
		Santalum,	Saunders.
		Kino.	
		Balsamum Peruvianum.	
		Balsamum Tolutanum.	
		Abrus,	Jequirity.
		Physostigma,	Calabar bean.
		Hæmatoxylon,	Logwood.
		Chrysarobinum,	Goa powder.
	Cæsalpinæ.	Senna.	
		Cassia.	
		Tamarindus,	Tamarind.
		Copaiba.	
		Piscidia,	Jamaica dogwood.
	Mimoseæ.	Acacia,	Gum arabic.
		Catechu.	
		Erythrophlæum,	Sassy bark.
		Indigo.	
Rosaceæ.	Pomeæ.	Cydonium,	Quince.
	Dryadeæ.	Rubus,	Blackberry.
		Rubus idæus,	Raspberry.
	Roseæ.	Rosa,	Rose.
		Brayera,	Koosso.
		Quillaia,	Soap-bark.
	Amygdaleæ.	Amygdala dulcis,	Sweet almond.
		Amygdala amara,	Bitter almond.
		Prunus,	Prune.
		Prunus Virginiana,	Wild cherry.
		Laurocerasus,	Cherry-laurel.
Papayaceæ, Passifloræ.		Papayotin,	Papain, papoid.
Myrtaceæ.		Caryophyllus,	Cloves.
		Pimenta,	Allspice.
		Cheken.	
		Myrtus,	Myrtle.
		Cajuput.	
		Eucalyptus,	Blue gum.
		Granatum,	Pomegranate.
Cucurbitaceæ.		Colocynth,	Bitter cucumber.
		Elaterium,	Squirting cucumber.
		Pepo,	Pumpkin.
		Bryonia,	Bryony.
Umbelliferæ.	Campylospermæ.	Conium,	Hemlock.
	Orthospermæ.	Asafœtida.	
		Galbanum.	
		Ammoniacum.	
		Fœniculum,	Fennel.
		Anisum,	Anise.
		Anethum,	Dill.
		Carum,	Caraway.
		Sumbul.	
	Cœlospermæ.	Coriandrum.	

SUB-CLASS III—COROLLIFLORÆ.

Natural Order.	*Officinal Name.*	*Synonym.*
Caprifoliaceæ.	Sambucus,	Elder.
Cornaceæ.	Cornus,	Dogwood.
Rubiaceæ. Cinchoneæ.	Cinchona.	
Coffeæ.	Ipecacuanha,	Ipecac.
	Caffea.	
	Catechu.	
Valerianaceæ.	Valerian.	
Caprifoliaceæ.	Viburnum,	Black haw.
Compositæ.	Pyrethrum,	Pellitory.
	Absinthium,	Wormwood.
	Tanacetum,	Tansy.
	Santonica,	Santonin.
	Anthemis,	Chamomile.
	Matricaria,	German chamomile.
	Eupatorium,	Thoroughwort.
	Taraxacum,	Dandelion.
	Lactuca,	Lettuce.
	Arnica.	
	Calendula,	Marigold.
	Grindelia.	
	Inula,	Elecampane.
	Lappa,	Burdock.
Lobeliaceæ.	Lobelia.	
Ericaceæ.	Uva ursi,	Bearberry.
	Chimaphila,	Pipsissewa.
	Gaultheria,	Wintergreen.
Sapotaceæ.	Gutta-percha.	
Styraceæ.	Benzoin.	
Verbenaceæ.	Lippia Mexicana.	
Oleaceæ.	Olivæ oleum,	Olive-oil.
	Manna.	
Loganiaceæ.	Nux vomica.	
	Ignatia.	
	Gelsemium,	Yellow jasmine.
	Spigelia,	Pink root.
Apocynaceæ.	Apocynum,	Canadian hemp.
	Quebracho.	
Asclepiadaceæ.	Asclepias,	Pleurisy root.
	Asclepias incarnata,	White Indian hemp.
	Hemidesmus.	
	Condurango.	
Gentianaceæ.	Gentian.	
	Chiretta.	
Convolvulaceæ.	Scammony.	
	Jalap.	
Solanaceæ.	Dulcamara.	
	Capsicum.	
Atropaceæ.	Belladonna.	
	Hyoscyamus.	
	Stramonium.	
	Tobacco.	

Natural Order.	*Officinal Name.*	*Synonym.*
Scrophulariaceæ.	Digitalis,	Foxglove.
	Leptandra.	
Labiatæ.	Rosmarinus,	Rosemary.
	Lavandula,	Lavender.
	Mentha piperita,	Peppermint.
	Mentha viride,	Spearmint.
	Thymol.	
	Hedeoma,	Pennyroyal.
	Marrubium,	Horehound.
	Melissa,	Balm.
	Origanum,	Wild marjoram.
	Salvia,	Sage.
	Scutellaria,	Skull-cap.
Pedalaceæ.	Sesami oleum.	

SUB-CLASS IV—APETALÆ.

Natural Order.		*Officinal Name.*	*Synonym.*
Polygonaceæ.		Rheum,	Rhubarb.
		Rumex,	Yellow dock.
Phytolacceæ.		Phytolacca,	Poke.
Chenopodiaceæ.		Chenopodium,	American wormseed.
Myristicaceæ.		Myristica,	Nutmeg.
		Macis,	Mace.
Lauraceæ.		Cinnamomum.	
		Camphora.	
		Sassafras.	
		Coto.	
Aristolochiaceæ.		Serpentaria.	
		Asarabacca.	
Santalaceæ.		Santali oleum.	
Thymelaceæ.		Mezereon.	
Euphorbiaceæ.		Cascarilla.	
		Stillingia.	
		Crotonis oleum.	
		Ricinus.	
		Kamala.	
Piperaceæ.		Piper.	
		Cubeba.	
		Matico.	
Salicaceæ.		Salix,	Willow.
Juglandaceæ.		Juglans,	Butternut.
Hamamelaceæ.		Hamamelis,	Witch-hazel.
Balsamifluæ.		Styrax,	Storax.
Cupuliferæ.		Quercus,	Oak.
		Castanea,	Chestnut.
Urticaceæ.	Ulmeæ.	Ulmus,	Elm.
	Moreæ.	Morus,	Mulberry
	Artocarpeæ.	Ficus,	Fig.
	Cannabineæ.	Cannabis Indica,	Indian hemp.
		Cannabis Americana,	American hemp.
		Humulus,	Hops.

DIVISION II—GYMNOSPERMÆ.

Natural Order.	*Officinal Name.*	*Synonym.*
Coniferæ.	Pinus sylvestris.	
	Abies balsameæ,	Canada turpentine.
	Abies excelsa,	Burgundy pitch.
	Terebinthina Canadensis,	Balsam of fir.
	Pinus palustris,	Tar and pitch.
	Pinus Australis,	Turpentine.
	Pinus larix,	Larch.
	Thuja occidentalis,	Arbor vitæ.
	Juniperus,	Juniper.
	Succini oleum,	Oil of amber.
	Sabina,	Savin.

CLASS II—ENDOGENS.

Natural Order.	*Officinal Name.*	*Synonym.*
Smilaceæ.	Sarsaparilla.	
Liliaceæ.	Allium,	Garlic.
	Scilla,	Squill.
	Aloe,	Aloes.
	Veratrum viride.	
	Sabadilla.	
	Colchicum.	
Orchidaceæ.	Vanilla.	
	Cypripedium,	Ladies' slipper.
Zingiberaceæ.	Zingiber,	Ginger.
	Turmeric.	
	Cardamomum.	
Iridaceæ.	Iris,	Flag.
	Crocus.	
Palmaceæ.	Areca.	
Araceæ.	Calamus,	Sweet flag.
Graminaceæ.	Farina tritici,	Wheat-flour.
	Avenæ farina,	Oatmeal.
	Amylum,	Starch.
	Triticum,	Couch-grass.
	Hordeum,	Barley.
	Maltum,	Barley-malt.

SUB-KINGDOM II—CRYPTOGAMS.

Natural Order.	*Officinal Name.*	*Synonym.*
Filices.	Aspidium,	Male fern.
Lichenes	Cetraria,	Iceland moss.
	Litmus.	
Fungi.	Ergota,	Ergot of rye.
	Ustilago,	Corn-smut.
Algæ.	Chondrus,	Irish moss.

GROUP III—ANIMAL KINGDOM.

Class.	*Order.*	*Officinal Name.*	*Synonym.*
Mammalia.	Rodentia.	Castoreum,	Castor.
	Ruminantia.	Moschus,	Musk.
		Sevum,	Suet. Tallow.
		Lanolinum,	Lanolin.
		Lac,	Milk. [or calf).
		Pepsinum,	Pepsin (from the sheep
		Fel bovis,	Ox-gall.
	Pachydermata.	Adeps,	Lard.
		Pepsinum,	Pepsin (from the hog).
	Cetacea.	Spermaceti,	Spermaceti.
Aves.	Gallinæ.	Ovi vitellus,	Egg-yelk.
Pisces.	Sturiones. [idæ).	Ichthyocolla,	Isinglass.
	Teleosteæ (*fam.* gad-	Morrhuæ oleum,	Codliver-oil.
Insecta.	Hymenoptera.	Mel,	Honey.
		Cera,	Wax.
	Hemiptera.	Coccus,	Cochineal.
	Coleoptera.	Cantharides,	Spanish flies.
Helminthes.	Anelatæ.	Sanguisuga, or Hirudo,	Leech.

In the above comprehensive scheme, which is essentially that of Lauder Brunton, as previously stated, remedies are arranged with reference to their origin, and in this classification many natural relationships are manifested which ordinarily might be unnoticed by the student. It will be observed that drugs are derived from various sources, and vary greatly in their properties, physical and chemical. They all agree in one attribute, however, which is of influencing bodily functions in such a manner as to make them useful in the treatment of diseased conditions. The nature of these effects, and the manner of their manifestations, it will be the purpose of the following pages to show, especially in Part III, where drugs are discussed individually and in detail.

PHARMACY.

Pharmaceutical Nomenclature and Classification.—In every science it is necessary to follow some system of naming the objects under consideration, and if this be done carefully it is a great assistance to its study and avoids much confusion. Common names, being used by persons who possess but slight knowledge of the subject, are likely to be frequently misapplied and are not sufficiently distinctive. For instance, nitre may mean carbonate of sodium or nitrate of sodium, as well as nitrate of potassium or potassium nitrate, which is the proper chemical title. Milk-weed designates any common plant having a milky juice, whereas the name Asclepias tuberosa always serves to identify a species of asclepias, without confusion or error. Scientific names are therefore not adopted with the object of making the study of a subject more difficult to the beginner, but really with the view of making its comprehension more easy after he has mastered the details of its technique and nomenclature. It is absolutely necessary for the student of materia medica to have a knowledge of botanical and chemical terms. In the consideration of drugs in the present work, following the United States Pharmacopœia, every officinal drug appears under the title of its Latin chemical or botanical name, with the letters U. S. P. appended; and the English name or synonym is also given. In the case of plants the full botanical name and natural order are usually stated. The scientific, or botanical, title is given in Latin so as to avoid mistakes, as this is the name by which it would be recognized all over the world, and by which it may easily be identified; whereas, the same common name may be applied to plants of different species having very different physiological actions and medicinal effects. In common language the English name of the remedy is to be used, but in prescriptions the Latin pharmacopœial name should always be employed. Further remarks upon prescription-writing will be found at the end of this section. It is to be understood that throughout these pages the words U. S. P. after the name of a drug, preparation, or formula indicates the fact that it is recognized by the United States Pharmacopœia, and is officinal wherever this authority is acknowledged.

The nomenclature of the United States Pharmacopœia is based upon the following rules adopted by the Convention of 1880 through its Committee on Revision:—

"1. The officinal Latin title of a vegetable drug is to be the botanical genus-name. A few titles were excepted from this rule, being those of old and well-known drugs, as: Belladonna, Frangula, Ipecacuanha, Pulsatilla, Senna, Stramonium." In addition to this, certain familiar titles of former editions were retained, although the botanical names had been changed, thus: Asafœtida for Ferula narthex or Scorodosma, Ergota from Claviceps purpurea, Mastiche from Pistacia lentiscus, Pix Burgundica from Abies excelsa, Prunus Virginiana for Prunus (or Cerasus) serotina. A few foreign titles have likewise been introduced in exception to the rule, such as: Guarana for Paullinia sorbilis, Matico for Artanthe elongata, Jalapa for Exogonium purga, Cambogia for Garcinia Hanburii, Kino for Pterocarpus marsupium, Pareira for Chondodendron tomentosum, Santonica for Artemisia maritima, Sarsaparilla for Smilax officinalis, Senna for Cassia acutifolia and elongata, Styrax for Liquidambar Orientalis, Tragacantha for Astragalus gummifer and other species.

"2. The officinal Latin title, selected according to the previous rule, is to denote or stand for the part of the plant directed to be used, provided only one part of the plant is officinal. Examples: **Aconitum** to stand for Aconite-root; **Conium** for Conium-seed; **Hyoscyamus** for Hyoscyamus-leaves, etc. But if more than one part is in use the part is to be specially mentioned in the title. Examples: Belladonnæ folia; Belladonnæ radix; Stramonii folia; Stramonii semen."

Careful prescribers sometimes add to the officinal title a word indicating a particular preparation where some unofficinal article of different strength may be mistaken for it, thus: Tinctura aconiti **radicis**, Tincturæ colchici **seminis**, Tinctura conii **seminis**, Tinctura stramonii **seminis**; or, if the preparation made by some particular manufacturer is desired, the name or initials may be placed in parentheses, as: Syrupus hypophosphitum (Gardner), Extractum ergotæ fluidum (Squibb), Extractum rhamni purshianæ fluidum (P. D. & Co.—for Parke, Davis & Co.), Bismuth subnitras (Stevenson & Jester). This, however, is liable to abuse, and physicians, as the rule, should content themselves by directing the patient to a reputable pharmacist, who will fill the prescription correctly and conscientiously.

"3. The officinal English titles are to be the scientific, botanical (genus or species) names, rather than the vernacular names, except in the case of those drugs where the vernacular names are derived from, and still almost identical with, the scientific names, or where long custom has sanctioned some other name.

"4. The titles of compound medicines are to express their composition or indicate their constituents, rather than their properties. In a few instances this rule is departed from, as it was deemed unwise to alter the title of several well-known compounds, *e.g.*, Collodium flexile, Pilulæ catharticæ compositæ.

"5. The Latin names of alkaloids have been made to terminate in **-ina**, and the corresponding English names in **-ine**; the latter termination being at present preferred, in modern chemical language, to the termination **-ia**. The so-called neutral principles have received the termination **-inum**, English **-in**. Examples: (**Alkaloids**) Morphina, Morphine; Quinina, Quinine. (**Neutral principles**) Picrotoxinum, Picrotoxin; Santoninum, Santonin.

"6. The gender of the Latin nouns of salts in **-as** and **-is** has been changed back to the masculine gender, it having been shown that the alteration to the feminine gender, made in the Revision for 1860, was based on error.

"7. A number of special alterations in nomenclature (from that of the preceding revision) are made, for reasons carefully considered in every case. Examples: **Alumen,** to denote the Sulphate of Aluminium and Potassium, instead of the Sulphate of Aluminium and Ammonium; **Chirata, Asafœtida, Cambogia,** for Chiretta, Assafetida, Gambogia; **Lupulinum, Glycerinum, Pyroxylinum,** for Lupulina, Glycerina, Pyroxylon; **Massa,** for Pilula (in the sense of pill-mass); **Sulphidum,** for Sulphuretum; **Manganum,** for Manganesium; **Bromum, Chlorum,** and **Iodum,** for Brominium, Chlorinium, and Iodinium.

"8. In the typographical arrangement and spelling of systematic, botanical terms, the rules of the International Botanical Congress (Paris, 1867) are adopted, so far as they can be applied. Accordingly, the species names are printed with a small initial letter (even if derived from geographical names), *except* when the species name had, at any previous time, itself been a genus name, *e.g.*, **Datura Stramonium, Rhamnus Frangula, Solanum Dulcamara**; or when the species name is derived from the name of a person, as **Strychnos Ignatii,** or **Artemisia,** etc., var. **Stechmanniana** (under **Santonica**); or when it is an indeclinable word, as **Exogonium Purga, Acacia Verek, Erythroxylon Coca.**"*

With reference to chemical substances, their names, according to modern scientific nomenclature, are taken as the basis for the pharmacopœial titles. The following peculiarities, however, are to be noted. As the rule, the Latin name expressive of composition is used; thus, **Potassii iodidum,** in English, Iodide of potassium and not Potassium iodide. In the case of normal and acid salts, the old names are retained for the higher compounds, to distinguish them; thus, Sodium carbonate is Carbonate of sodium (**Sodii carbonas**); Sodium acid carbonate is Bicarbonate of sodium (**Sodii carbonas**). In metals having more than one grade of combination with the same radical, such as iron and mercury, the chemical method of indicating this by the termination **-ic** or **-ous** is not adopted. If but one of the two grades is used in medicine, the salt is named in the usual manner, the existence of the other being ignored. Ferric chloride is simply called chloride of iron (**Ferri chloridum**), this being the only chloride of iron used in medicine. In other cases where two or more grades are officinal, an arbitrary designation is adopted for one or more; thus, ferrous and ferric sulphates are known respectively as the sulphate of iron (**Ferri sulphas**) and tersulphate of iron (**Ferri tersulphas**).

In the case of the compounds of mercury with iodine and chlorine, the importance of distinguishing between them and reducing the danger of mistake to the minimum has led to special designations, of red iodide of mercury, **Hydrargyrum iodidum rubrum**; green iodide of mercury,

*United States Pharmacopœia, Sixth Decennial Revision, page xxviii. New York: Wm. Wood & Co., 1882.

Hydrargyrum iodidum viride; mild chloride of mercury, **Hydrargyrum chloridum mite**; and corrosive chloride of mercury, **Hydrargyrum chloridum corrosivum.** Some few compounds are known by their popular names for the sake of brevity and distinction,—as alcohol, alum, benzin, ether, chloroform, carbolic acid, creasote; others have special designations,—as chloral, petrolatum, salicylic acid. As the rule the pharmacopœia, under each chemical compound, mentions its symbol, combining weight and symbolic formula indicative of its composition, using both the new and old chemical nomenclature, the latter being in italics. It also indicates the physical characteristics, solubilities, and tests of identity and purity. Under each drug-heading is likewise found a concise statement of physical characteristics, tests of identity, and the manner of detecting adulterants. In the formulæ, parts by weight are used expressed in percentage so that calculations may be made for any desired quantity. A commentary upon and amplification of the pharmacopœia has been published under the title of a **Dispensatory**; in this country the leading works of this kind are the United States Dispensatory, by Profs. Wood, Remington and Sadtler, and the National Dispensatory, by Profs. Stille and Maisch, both published in Philadelphia. Dispensatories contain a large amount of information about drugs and their uses which would be out of place in a pharmacopœia.

Pharmaceutical Classes of Remedies.

ACIDS.

Two degrees of relative concentration are usually recognized, and in one case (acetic acid) there are three. The dilute acids are all of uniform strength,—one-tenth acid and nine-tenths water,—except dilute nitrohydrochloric, which contains only 7 per cent., and dilute acetic, 6 per cent., while aromatic sulphuric acid contains 20 per cent. of the officinal acid; dilute hydrocyanic acid contains only 2 per cent. of absolute hydrocyanic acid. The officinal **Acids** are:—

1. Inorganic.

(a) *Liquid Acids:—*

Acidum hydrobromicum dilutum,	Dose, ♏x–fʒiv.
Acidum hydrochloricum,	" ♏iii–x.
Acidum hydrochloricum dilutum,	" ♏x–xxx.
Acidum nitricum,	" ♏ii–v.
Acidum nitricum dilutum,	" ♏v–xxx.
Acidum nitrohydrochloricum,	" ♏i–iij.
Acidum nitrohydrochloricum dilutum,	" ♏v–xx.
Acidum phosphoricum,	" ♏iii–v.
Acidum phosphoricum dilutum,	" ♏ii–xx.
Acidum sulphuricum,	" ♏i–iij.
Acidum sulphuricum dilutum,	" ♏v–xv.

Acidum sulphuricum aromaticum,	Dose, ♏x–xx.
Acidum sulphurosum,	" ♏v–fʒj.

(b) *Solid Acids:—*

Acidum arseniosum,	" gr. $\frac{1}{30}$–$\frac{1}{12}$.
Acidum boricum,	" gr. v–xxx.
Acidum chromicum,	" gr. $\frac{1}{30}$–$\frac{1}{4}$.

2. ORGANIC.

(a) *Liquid Acids:—*

Acidum aceticum glaciale,	External use.
Acidum aceticum,	Dose, ♏v–x.
Acidum aceticum dilutum,	" fʒi–ij.
Acidum carbolicum crudum,	External use.
Acidum hydrocyanicum dilutum,	Dose, ♏i–v.
Acidum lacticum,	" ♏xx–fʒj.
Acidum oleicum,	External use.

(b) *Solid Acids:—*

Acidum benzoicum,	Dose, gr. x–xxx.
Acidum carbolicum,*	" gr. ss–ij.
Acidum salicylicum,	" gr. x–ʒj.
Acidum tartaricum,	" gr. v–xx.
Acidum citricum,	" gr. x–xxx.
Acidum tannicum,	" gr. i–xx.
Acidum gallicum,	" gr. ii–x.

The officinal **Alkaloids** are:—

Apomorphinæ hydrochloras,	Dose, gr. $\frac{1}{16}$–$\frac{1}{4}$.
Atropina,	" gr. $\frac{1}{200}$–$\frac{1}{60}$.
Atropinæ sulphas,	" gr. $\frac{1}{200}$–$\frac{1}{60}$.
Caffeina,	" gr. ii–x.
Cinchonidinæ sulphas,	" gr. v–xl.
Cinchonina,	" gr. v–xxx.
Cinchoninæ sulphas,	" gr. v–xxx.
Codeina,	" gr. $\frac{1}{6}$–ij.
Hyoscyaminæ sulphas,	" gr. $\frac{1}{60}$–$\frac{1}{32}$.
Morphina,	" gr. $\frac{1}{10}$–$\frac{1}{2}$.
Morphinæ acetas,	" gr. $\frac{1}{6}$–$\frac{1}{2}$.
Morphinæ hydrochloras,	" gr. $\frac{1}{6}$–$\frac{1}{2}$.
Morphinæ sulphas,	" gr. $\frac{1}{6}$–$\frac{1}{2}$.
Physostigminæ salicylas,	" gr. $\frac{1}{64}$–$\frac{1}{20}$.
Pilocarpinæ hydrochloras,	" gr. $\frac{1}{12}$–$\frac{1}{3}$.
Piperina,	" gr. ss–x.
Quinidinæ sulphas,	" gr. v–xxx.
Quinina,	" gr. i–ʒj.
Quininæ bisulphas,	" gr. i–xv.
Quininæ hydrobromas,	" gr. i–xx.
Quininæ hydrochloras,	" gr. i–xv.
Quininæ sulphas,	" gr. i–ʒj.
Quininæ valerianas,	" gr. i–xx.
Strychnina,	" gr. $\frac{1}{60}$–$\frac{1}{20}$.
Strychninæ sulphas,	" gr. $\frac{1}{60}$–$\frac{1}{12}$.
Veratrina,	" gr. $\frac{1}{50}$–$\frac{1}{12}$.
Chinoidinum,	" gr. x.

* As carbolic acid melts at the temperature of the human body, it may be prescribed in minims or drops as well as in grains.

Under the appropriate headings, mention will be made of many other alkaloids which are not officinal in the United States Pharmacopœia.

Neutral Principles.

Chrysarobinum,	Dose, gr. $\frac{1}{8}$–xx.
Elaterinum,	" gr. $\frac{1}{20}$–$\frac{1}{12}$.
Glycyrrhizinum ammoniatum,	" gr. v.
Picrotoxinum,	" gr. $\frac{1}{120}$–$\frac{1}{60}$.
Salicinum,	" gr. x–ʒij.
Santoninum,	" gr. i–iv.

OILS.

1. Expressed or Fixed Oils.

Oleum adipis,	External use.
Oleum amygdalæ expressum,	Dose, fʒii–iv.
Oleum gossypii seminis,	External use.
Oleum lini,	External use.
Oleum morrhuæ,	Dose, fʒi–iv.
Oleum olivæ,	" f℥ij.
Oleum phosphoratum,	" ♏i–v.
Oleum ricini,	" fʒi–f℥j.
Oleum sesami,	External use.
Oleum theobromæ,	External use.
Oleum tiglii,	Dose, ♏$\frac{1}{4}$–ij.

2. Distilled or Volatile Oils.

Oleum æthereum,	Dose, ♏ij.
Oleum amygdalæ amaræ,	" ♏$\frac{1}{4}$–j.
Oleum anisi,	" ♏v–x.
Oleum aurantii corticis,	In pharmacy.
Oleum aurantii florum,	In pharmacy.
Oleum bergamii,	In pharmacy.
Oleum cajuputi,	Dose, ♏i–v.
Oleum cari,	" ♏i–v.
Oleum caryophylli,	" ♏i–vj.
Oleum chenopodii,	" ♏v–xx.
Oleum cinnamomi,	" ♏i–iij.
Oleum copaibæ,	" ♏v–x.
Oleum coriandri,	" ♏i–v.
Oleum cubebæ,	" ♏v–xij.
Oleum erigerontis,	" ♏xx–xxx.
Oleum eucalypti,	" ♏iii–xx.
Oleum fœniculi,	" ♏v–xv.
Oleum gaultheriæ,	" ♏ii–xx.
Oleum hedeomæ,	" ♏ii–x.
Oleum juniperi,	" ♏v–xx.
Oleum lavandulæ,	" ♏iii–v.
Oleum lavandulæ florum,	In pharmacy.
Oleum limonis,	In pharmacy.
Oleum menthæ piperitæ,	Dose, ♏i–v.
Oleum menthæ viridis,	" ♏ii–v.
Oleum myrciæ,	" ♏ij.
Oleum myristicæ,	" ♏i–v.
Oleum picis liquidæ,	" ♏ij.

Oleum pimentæ,	Dose, ♏iii–v.
Oleum rosæ,	In pharmacy.
Oleum rosmarini,	Dose, ♏i–v.
Oleum rutæ,	" ♏ii–v.
Oleum sabinæ,	" ♏ii–v.
Oleum santali,	" ♏v–x.
Oleum sassafras,	" ♏i–iv.
Oleum sinapis volatile,	In liniment.
Oleum succini,	Dose, ♏v–xx.
Oleum terebinthinæ,	" ♏v–xv.
Oleum thymi,	" ♏i–ij.
Oleum valerianæ,	" ♏ii–v.

Preparations.

The pharmacopœia presents thirty-four classes of officinal preparations :—

Latin.			*English.*
1. Abstractum.	(Gen. sing., *i*	Gen. pl., *a*)	Abstract.
2. Acetum.	(" " *i*	" " *a*)	Vinegar.
3. Aqua.	(" " *æ*	" " *æ*)	Water (aromatic).
4. Ceratum.	(" " *i*	" " *a*)	Cerate.
5. Charta.	(" " *æ*	" " *æ*)	Paper.
6. Collodium.	(" " *i*	" " *a*)	Collodion.
7. Confectio.	(" " *onis*	" " *ones*)	Confection.
8. Decoctum.	(" " *i*	" " *a*)	Decoction.
9. Elixir.	(not declinable	)	Elixir (cordial).
10. Emplastrum.	(Gen. sing., *i*	Gen. pl., *a*)	Plaster.
11. Extractum.	(" " *i*	" " *a*)	Extract.
12. Extractum fluidum.	(" " *i*	" " *a*)	Fluid extract.
13. Glyceritum.	(" " *i*	" " *a*)	Glycerite.
14. Infusum.	(" " *i*	" " *a*)	Infusion.
15. Linimentum.	(" " *i*	" " *a*)	Liniment.
16. Liquor.	(" " *oris*	" " *ores*)	Solution.
17. Massa.	(" " *æ*	" " *æ*)	(Pill) Mass.
18. Mel.	(" " *lis*	" " *lita*)	Honey.
19. Mistura.	(" " *æ*	" " *æ*)	Mixture.
20. Mucilago.	(" " *inis*	" " *ines*)	Mucilage.
21. Oleatum.	(" " *i*	" " *a*)	Oleate.
22. Oleoresina.	(" " *æ*	" " *æ*)	Oleoresin.
23. Pilula.	(" " *æ*	" " *æ*)	Pill.
24. Pulvis.	(" " *eris*	" " *eres*)	Powder.
25. Resina.	(" " *æ*	" " *æ*)	Resin.
26. Spiritus.	(" " *us*	" " *us*)	Spirit.
27. Suppositorium.	(" " *i*	" " *a*)	Suppository.
28. Syrupus.	(" " *i*	" " *i*)	Syrup.
29. Tinctura.	(" " *æ*	" " *æ*)	Tincture.
30. Tinctura herbarum recentium.*	(" " *æ*	" " *æ*)	Tincture of fresh herbs.
31. Trituratio.	(" " *onis*	" " *ones*)	Trituration.
32. Trochiscus.	(" " *i*	" " *i*)	Troche (lozenge).
33. Unguentum.	(" " *i*	" " *a*)	Ointment.
34. Vinum.	(" " *i*	" " *a*)	Wine.

* The last two words are not changed.

Abstracta, or Abstracts (11).—Solid preparations, consisting of dry, powdered extracts, combined with sufficient milk-sugar to make the strength represent one-half that of the crude drug. The usual dose is about 1 grain; abstractum jalapæ, podophylli, senegæ, and valerianæ are given in larger doses. The officinal abstracts are:—

Abstractum aconiti.
Abstractum belladonnæ.
Abstractum conii.
Abstractum digitalis.
Abstractum hyoscyami.
Abstractum ignatiæ.
Abstractum jalapæ.
Abstractum nucis vomicæ.
Abstractum podophylli.
Abstractum senegæ.
Abstractum valerianæ.

Aceta, or Vinegars (4).—Liquid preparations made with vinegar or dilute acetic acid. Strength, 10 per cent. Usual dose, $\frac{1}{2}$ fluidrachm; except acetum opii, of which the dose is 10 minims.

Acetum lobeliæ. Acetum opii. Acetum sanguinaria. Acetum scillæ.

Aquæ, or (Aromatic) Waters (13).—Watery solutions of volatile substances, formerly prepared by distillation, now commonly made by adding the volatile or essential oil to distilled water, with magnesia and filtering. They are generally used as flavoring agents, and the dose is indefinite, except aqua ammoniæ, chlori and creasoti. Aquæ destillata is pure, recently distilled water.

Aqua destillata.
Aqua ammoniæ.
Aqua ammoniæ fortior.
Aqua amygdalæ amaræ.
Aqua anisi.
Aqua aurantii florum.
Aqua camphoræ.
Aqua chlori.
Aqua cinnamomi.
Aqua creasoti.
Aqua fœniculi.
Aqua menthæ piperitæ.
Aqua menthæ viridis.
Aqua menthæ rosæ.

Cerata, or Cerates (8).—Fatty mixtures, containing wax, so as to make them firmer than ordinary ointments.

Ceratum.
Ceratum camphoræ.
Ceratum cantharidis.
Ceratum cetaceæ.
Ceratum extracti cantharidis.
Ceratum plumbi subacetatis.
Ceratum resinæ.
Ceratum sabinæ.

Chartæ, or (Medicated) Papers (3).—Papers of definite size treated with drugs.

Chartæ cantharadis. Chartæ potassii nitratis. Chartæ sinapis.

Collodia, or Collodions (4).—Liquid preparations of collodion:—

Collodium. Collodium cum cantharide. Collodium flexile. Collodium stypticum.

Confectiones, or Confections (2).—Soft, solid preparations made into a paste with sugar.

Confectio rosæ. Confectio sennæ.

Decocta, or Decoctions (2).—Liquid preparations of vegetable drugs obtained by boiling with water. A decoction is directed to be made, as a rule, by placing the drug in a suitable vessel, with a cover, and adding 100 parts of cold water for each 10 of substance used, covering it well, and boiling for fifteen minutes. When cool, it is passed through the strainer, adding enough cold water to bring up the product to 100 parts, The strength of decoctions of energetic or powerful drugs should be specially prescribed by the physician. The decoctum cetrariæ is only 5 per cent.

Decoctum cetrariæ.
Decoctum sarsaparillæ compositum.

Elixir, or Elixirs (1).—The popularity of this class of remedies is due to their comparatively pleasant taste and to the fact that they contain alcohol and sugar. One has been introduced into the pharmacopœia as a vehicle:—

Elixir aurantii.

Emplastra, or Plasters (17).—Solid substances rendered soft and adhesive by heat, so as to be spread upon leather or muslin, of any desired size or shape, for application to the surface of the body to which the plaster is intended to adhere. One is an exception to the general rule that plasters are to be applied with heat; the emplastrum ichthyocollæ, or isinglass-plaster (court-plaster), is rendered adhesive by moisture.

Emplastrum ammoniaci.
Emplastrum ammoniaci cum hydrargyro.
Emplastrum arnicæ.
Emplastrum asafœtidæ.
Emplastrum belladonnæ.
Emplastrum capsici.
Emplastrum ferri.
Emplastrum galbani.
Emplastrum hydrargyri.
Emplastrum ichthyocollæ.
Emplastrum opii.
Emplastrum picis Burgundicæ.
Emplastrum picis Canadensis.
Emplastrum picis cum cantharide.
Emplastrum plumbi.
Emplastrum resinæ.
Emplastrum saponis.

Extracta, or Extracts (32).—Preparations of a solid or semi-solid consistency, containing the active principles or constituents of drugs, obtained usually by evaporation of alcoholic or watery solutions, the strength being from twice to four times that of the officinal agent from which they are made. They often contain glycerin, to keep them in a condition to readily make into pills. **Assayed extracts** contain a definite proportion of the active ingredient, determined by chemical analysis. Alcoholic extracts, aqueous extracts, acetic extracts, and ethereal extracts are made with the aid of dilute alcohol, water, acetic acid, or ether. Many so-called active principles, such as leptandrin, macrotin, hydrastin, etc., of botanic physicians, are simply alcoholic extracts, or impure resins, precipitated by the addition of water.

Extractum aconiti.
Extractum aloës aquosum.
Extractum arnicæ radicis.
Extractum belladonnæ alcoholicum.
Extractum cannabis Indicæ.
Extractum cinchonæ.
Extractum colchici radicis.
Extractum colocynthidis.
Extractum colocynthidis compositum.
Extractum conii alcoholicum.
Extractum digitalis.
Extractum ergotæ.
Extractum euonymi.
Extractum gentianæ.
Extractum glycyrrhizæ.
Extractum glycyrrhizæ purum.
Extractum hæmatoxyli.
Extractum hyoscyami alcoholicum.
Extractum iridis.
Extractum juglandis.
Extractum krameriæ.
Extractum leptandræ.
Extractum malti.
Extractum mezerei.
Extractum nucis vomicæ.
Extractum opii.
Extractum physostigmatis.
Extractum podophylli.
Extractum quassiæ.
Extractum rhei.
Extractum stramonii.
Extractum taraxaci.

Extracta Fluida, or Fluid Extracts (79).—Liquid preparations of active principles, usually alcoholic and, consequently, equivalent to strong tinctures. The rule was adopted at the last revision (1880) of having these preparations of definite strength, as related to the crude drug, so that one cubic centimetre of the fluid extract represents the active principles of one gramme of the drug.* The dose, therefore, is the same in minims as that of the dry, powdered drug in grains

Extractum aconiti fluidum.
Extractum arnicæ radicis fluidum.
Extractum aromaticum fluidum.
Extractum aurantii amari fluidum.
Extractum belladonnæ fluidum.
Extractum brayeræ fluidum.
Extractum buchu fluidum.
Extractum calami fluidum.
Extractum calumbæ fluidum.
Extractum cannabis Indicæ fluidum.
Extractum capsici fluidum.
Extractum castaneæ fluidum.
Extractum chimaphillæ fluidum.
Extractum chiratæ fluidum.
Extractum cimicifugæ fluidum.
Extractum cinchonæ fluidum.
Extractum colchici radicis fluidum.
Extractum colchici seminis fluidum.
Extractum conii fluidum.
Extractum cornus fluidum.
Extractum cubebæ fluidum.
Extractum cypipedii fluidum.
Extractum digitalis fluidum.
Extractum dulcamaræ fluidum.
Extractum ergotæ fluidum.
Extractum erythroxyli fluidum.
Extractum eucalypti fluidum.
Extractum eupatorii fluidum.
Extractum frangulæ fluidum.
Extractum gelsemii fluidum.
Extractum gentianæ fluidum.
Extractum geranii fluidum.
Extractum glycyrrhizæ fluidum.
Extractum gossypii radicis fluidum.
Extractum grindelia fluidum.
Extractum guaranæ fluidum.
Extractum hamamelidis fluidum.
Extractum hydrastis fluidum.
Extractum hyoscyami fluidum.
Extractum ipecacuanhæ fluidum.
Extractum iridis fluidum.
Extractum krameriæ fluidum.
Extractum lactucarii fluidum.
Extractum leptandræ fluidum.
Extractum lobeliæ fluidum.
Extractum lupulini fluidum.
Extractum matico fluidum.
Extractum mezerei fluidum.
Extractum nucis vomicæ fluidum.
Extractum pareiræ fluidum.

* In order to insure absolute uniformity of strength in the product, it is evident that the crude drug must be assayed and standardized before making the extract. This is accomplished in a series of fluid extracts prepared on account of their standard strength, which have been named Normal Liquids. These are made from selected drugs, and are ideal fluid extracts.

Extractum pilocarpi fluidum.
Extractum podophylli fluidum.
Extractum pruni Virginianæ fluidum.
Extractum quassiæ fluidum.
Extractum rhei fluidum.
Extractum rhois glabræ fluidum.
Extractum rosæ fluidum.
Extractum rubi fluidum.
Extractum rumicis fluidum.
Extractum sabinæ fluidum.
Extractum sanguinariæ fluidum.
Extractum sarsaparillæ fluidum.
Extractum sarsaparillæ compositum fluidum.
Extractum scillæ fluidum.
Extractum scutellariæ fluidum.
Extractum senegæ fluidum.
Extractum sennæ fluidum.
Extractum serpentariæ fluidum.
Extractum spigeliæ fluidum.
Extractum stillingiæ fluidum.
Extractum stramonii fluidum.
Extractum taraxaci fluidum.
Extractum tritici fluidum.
Extractum uvæ ursi fluidum.
Extractum valerianæ fluidum.
Extractum veratri viridis fluidum.
Extractum viburni fluidum.
Extractum xanthoxyli fluidum.
Extractum zingiberis fluidum.

Glycerita, Glycerites (2).—In these preparations glycerin is the vehicle for medicinal substances. The U. S. Pharmacopœia only recognizes two of this class of preparations, both without much efficacy by themselves, which may be used as excipients or vehicles for powders or other remedies. Glycerin is also a good solvent for some agents, such as pepsin, and preparations of this kind are sold as glycerites, glyceroles, or glycerins.

Glyceritum amyli.
Glyceritum vitelli.

Infusa, or Infusions (5).—These are preparations usually made by pouring boiling water upon vegetable drugs and allowing them to stand for two hours in a warm place, then separating the infusion from the dregs by straining. When the strength is not otherwise directed by the pharmacopœia or by the prescription of a physician, they are to be made 10-per-cent. strength. The infusions of cinchona and of prunus Virginianæ are made with cold water, by percolation. The officinal ones are :—

Infusum brayeræ.
Infusum cinchonæ.
Infusum digitalis.
Infusum pruni Virginianæ.
Infusum sennæ compositum.

Linimenta, or Liniments (10).—Preparations oily or alcoholic, or both, containing medicinal substances, and intended for external application to the surface of the body, with friction.

Linimentum ammoniæ.
Linimentum belladonnæ.
Linimentum calcis.
Linimentum camphoræ.
Linimentum cantharidis.
Linimentum chloroformi.
Linimentum plumbi subacetatis.
Linimentum saponis.
Linimentum sinapis compositum.
Linimentum terebinthinæ.

Liquores, or Solutions (26).—Liquid preparations of non-volatile drugs, generally chemicals, which are wholly soluble in the menstruum employed, which is water, except in the case of liquor guttæ perchæ, where chloroform is the menstruum.

Liquor acidi arseniosi.
Liquor ammonii acetatis.
Liquor arsenii et hydrargyri iodidi.
Liquor calcis.
Liquor ferri acetatis.
Liquor ferri chloridi.
Liquor ferri citratis.
Liquor ferri et quininæ citratis.
Liquor ferri nitratis.
Liquor ferri subsulphatis.
Liquor ferri tersulphatis.
Liquor guttæ perchæ.
Liquor hydrargyri nitratis.
Liquor iodi compositus.
Liquor magnesii citratis.
Liquor pepsini.
Liquor plumbi subacetatis.
Liquor plumbi subacetatis dilutus.
Liquor potassæ.
Liquor potassii arsenitis.
Liquor potassii citratis.
Liquor sodæ.
Liquor sodæ chloratæ.
Liquor sodii arseniatis.
Liquor sodii silicatis.
Liquor zinci chloridi.

Massæ, or Masses (3).—These are soft, solid mixtures of proper consistency to be made into pills.

Massa copaibæ. Massa ferri carbonatis. Massa hydrargyri.

Mellita, or Honeys (3).—Liquid preparations consisting of honey, or honey as a basis.

Mel. Mel despumatum. Mel rosæ.

Misturæ, or Mixtures (11).—Preparations consisting of a liquid used as a vehicle, and containing an agent not soluble in the menstruum employed. There are three pharmacopœial mixtures which should be placed in the list of solutions, as their active constituents are entirely dissolved in water.

Mistura ammoniaci.
Mistura amygdalæ.
Mistura asafœtidæ.
Mistura chloroformi.
Mistura cretæ.
Mistura ferri compositæ.
Mistura ferri et ammonii acetatis.
Mistura glycyrrhizæ compositæ.
Mistura magnesiæ et asafœtidæ.
Mistura potassii citratis.
Mistura rhei et sodæ.

Mucilagines, or Mucilages (5).—These are rather dense, viscid preparations of gum or mucilaginous substances, dissolved in water. They are used for suspending insoluble powders or emulsifying oily substances.

Mucilago acaciæ.
Mucilago cydonii.
Mucilago sassafras medullæ.
Mucilago tragacanthæ.
Mucilago ulmi.

Oleata, or Oleates (2).—The officinal oleates are made by dissolving medicinal bases in oleic acid, and are in the form of a soft solid or ointment. Some of the non-officinal oleates—*i.e.*, zinc oleate—are in the form of dry powder. The officinal oleates are :—

Oleatum hydrargyri (nearly 10 per cent.). Oleatum veratrinæ (2 per ceut.).

Oleoresinæ, or Oleoresins (6).—These are liquid preparations obtained by dissolving oily and resinous matters out of vegetable drugs by means of stronger ether, and afterward evaporating the ether. Benzin is sometimes substituted for the solvent required by the pharmacopœia. Oleoresins differ from fluid extracts in composition and in strength, being the most concentrated liquid preparations of drugs that are produced. The yield of oleoresin naturally varies, according to the quality of the crude drug, this class of remedies not bearing a uniform relation (of gramme to cubic centimetre), as fluid extracts are required to do. Fluid extracts often contain matters insoluble in ether.

Oleoresina aspidii.
Oleoresina capsici.
Oleoresina cubebæ.
Oleoresina lupulini.
Oleoresina piperis.
Oleoresina zingiberis.

Pilulæ, or Pills (15).—Small, spherical masses of medicinal substances, intended to be swallowed whole; two of the officinal forms are coated with tolu (pilulæ ferri iodidi and pilulæ phosphori); the rest are simply treated with dusting-powder. It is the rule among manufactures also to supply a full line of pills coated with gelatin or with sugar, in order to preserve and render them more pleasant to swallow. Sometimes a coating of keratin is used where it is desired that pills should not be dissolved until reaching the intestinal tract.

Pilulæ aloës.
Pilulæ aloës et asafœtidæ.
Pilulæ aloës et ferri.
Pilulæ aloës et mastiches.
Pilulæ aloës et myrrhæ.
Pilulæ antimonii compositæ.
Pilulæ asafœtidæ.
Pilulæ catharticæ compositæ.
Pilulæ ferri compositæ.
Pilulæ ferri iodidi.
Pilulæ galbani compositæ.
Pilulæ opii.
Pilulæ phosphori.
Pilulæ rhei.
Pilulæ rhei compositæ.

Pulveres, or Powders (9).—Drugs in a dry, finely-divided form, generally compounded or mixed.

Pulvis antimonialis.
Pulvis aromaticus.
Pulvis cretæ compositus.
Pulvis effervescens compositus.
Pulvis glycyrrhizæ compositus.
Pulvis ipecacuanhæ et opii.
Pulvis jalapæ compositus.
Pulvis morphinæ compositus.
Pulvis rhei compositus.

Resinæ, or Resins (6).—Solid preparations of vegetable origin, obtained by extracting with alcohol and precipitating with water, or by distilling the volatile oil from an oleoresin. One (resina guaiaci) is obtained directly by spontaneous exudation and drying upon the wood.

Resina (from turpentine).
Resina copaibæ.
Resina guaiaci.
Resina jalapæ.
Resina podophylli.
Resina scammonii.

Spiritus, or Spirits (22).—These are solutions of volatile or aromatic substances, in which alcohol is the menstruum.

Spiritus ætheris.
Spiritus ætheris compositus.
Spiritus ætheris nitrosi.
Spiritus ammoniæ.
Spiritus ammoniæ aromaticus.
Spiritus anisi.
Spiritus aurantii.
Spiritus camphoræ.
Spiritus chloroformi.
Spiritus cinnamomi.
Spiritus frumenti.
Spiritus gaultheriæ.
Spiritus juniperi.
Spiritus juniperi compositus.
Spiritus lavandulæ.
Spiritus limonis.
Spiritus menthæ piperitæ.
Spiritus menthæ viridis.
Spiritus myrciæ.
Spiritus myristicæ.
Spiritus odoratus.
Spiritus vini gallici.

Suppositoria, or Suppositories.—No formulæ for suppositories are now officinal, but they are directed to be made extemporaneously by incorporating the medicinal substance with cacao-butter (oleum theobromæ) and shaping them with a mold into small, conical masses, weighing 15 grains each, unless otherwise directed. They are intended to be inserted into the rectum and other cavities of the body, where they melt and allow the medicament to come in contact with an absorbing surface. Suppositories of soap and glycerin are largely used as laxatives to empty the lower bowel. Similar preparations of cacao-butter or gelatin for the urethra or nose are called bougiæ, or buginaria.

Syrupi, or Syrups (**34**).—These popular preparations are strong solutions of sugar in water, containing flavoring and medicinal substances. They are usually made with the aid of heat, for convenience, but, where heat would be injurious, they are directed to be made by stirring and filtering, or by percolation.

Syrupus acaciæ.
Syrupus acidi citrici.
Syrupus acidi hydriodici.
Syrupus allii.
Syrupus altheæ.
Syrupus amygdalæ.
Syrupus aurantii.
Syrupus aurantii florum.
Syrupus calcii lactophosphatis.
Syrupus calcis.
Syrupus ferri bromidi.
Syrupus ferri iodidi.
Syrupus ferri quininæ et strychninæ phosphatum.
Syrupus hypophosphitum.
Syrupus hypophosphitum cum ferro.
Syrupus ipecacuanhæ.
Syrupus krameriæ.
Syrupus lactucarii.
Syrupus limonis.
Syrupus picis liquidæ.
Syrupus pruni Virginianæ.
Syrupus rhei.
Syrupus rhei aromaticus.
Syrupus rosæ.
Syrupus rubi.
Syrupus rubi idæi.
Syrupus sarsaparillæ compositus.
Syrupus scillæ.
Syrupus scillæ compositus.
Syrupus senegæ.
Syrupus sennæ.
Syrupus tolutanus.
Syrupus zingiberis.

Tincturæ, or Tinctures (**72**).—Liquid preparations of vegetable drugs differing from spirits in not containing volatile substances. (To this, tinctura iodi, lavandulæ compositæ, and moschi are exceptions.)

Tinctura aconiti.
Tinctura aloës.
Tinctura aloës et myrrhæ.
Tinctura arnicæ florum.
Tinctura arnicæ radicis.
Tinctura asafœtidæ.
Tinctura aurantii amari.
Tinctura aurantii dulcis.
Tinctura belladonnæ.
Tinctura benzoini.
Tinctura benzoini composita.
Tinctura bryoniæ.
Tinctura calendulæ.
Tinctura calumbæ.
Tinctura cannabis Indicæ.
Tinctura cantharidis.
Tinctura capsici.
Tinctura cardamomi.
Tinctura cardamomi composita.
Tinctura catechu composita.
Tinctura chiratæ.
Tinctura cimicifugæ.
Tinctura cinchonæ.
Tinctura cinchonæ composita.
Tinctura cinnamomi.
Tinctura colchici.
Tinctura conii.
Tinctura croci.
Tinctura cubebæ.
Tinctura digitalis.
Tinctura ferri acetatis.
Tinctura ferri chloridi.
Tinctura gallæ.
Tinctura gelsemii.
Tinctura gentianæ composita.
Tinctura guaiaci.
Tinctura guaiaci ammoniata.
Tinctura humuli.
Tinctura hydrastis.
Tinctura hyoscyami.
Tinctura ignatiæ.
Tinctura iodi.
Tinctura ipecacuanhæ et opii.
Tinctura kino.

Tinctura krameriæ.
Tinctura lavandulæ composita.
Tinctura lobelia.
Tinctura matico.
Tinctura moschi.
Tinctura myrrhæ.
Tinctura nucis vomicæ.
Tinctura opii.
Tinctura opii camphorata.
Tinctura opii deodorata.
Tinctura physostigmatis.
Tinctura pyrethri.
Tinctura quassiæ.
Tinctura rhei.
Tinctura rhei aromatica.
Tinctura rhei dulcis.
Tinctura sanguinariæ.
Tinctura saponis viridis.
Tinctura scillæ.
Tinctura serpentariæ.
Tinctura stramonii.
Tinctura sumbul.
Tinctura tolutana.
Tinctura valerianæ.
Tinctura valerianæ ammoniata.
Tinctura vanillæ.
Tinctura veratri viridis.
Tinctura zingiberis.

Tinctura Herbarum Recentium, or Tinctures of Fresh Herbs, are directed by the pharmacopœia to be made of 50 parts of the fresh herb, macerated in 100 parts of alcohol for two weeks, and then filtering the product. No special formulæ are given.

Triturationes, or Triturations (1).—This is a newly recognized class of preparations, which represent one-tenth the strength of the crude drug, to every 10 parts of which 90 of sugar of milk are added, and the mixture thoroughly incorporated by trituration. The only officinal representative is

Trituratio elaterini.

Trochisci, or Troches (16).—Small, flattened, disk-like, solid masses, usually called lozenges. The basis is generally gum and sugar, making a mass which can be slowly dissolved in the mouth, thus medicating the mucous membrane of the mouth and throat.

Trochisci acidi tannici.
Trochisci ammonii chloridi.
Trochisci catechu.
Trochisci cretæ.
Trochisci cubebæ.
Trochisci ferri.
Trochisci glycyrrhizæ et opii.
Trochisci ipecacuanhæ.
Trochisci krameriæ.
Trochisci magnesiæ.
Trochisci menthæ piperitæ.
Trochisci morphinæ et ipecacuanhæ.
Trochisci potassii chloratis.
Trochisci sodii bicarbonatis.
Trochisci sodii santoninatis.
Trochisci zingiberis.

Unguenta, or Unguents (26).—Soft, fatty preparations, melting at the temperature of the body, and suitable for inunction and the administration of remedies by external application and friction.

Unguentum.
Unguentum acidi carbolici.
Unguentum acidi gallici.
Unguentum acidi tannici.
Unguentum aquæ rosæ.
Unguentum belladonnæ.
Unguentum chrysarobini.
Unguentum diachylon.
Unguentum gallæ.
Unguentum hydrargyri.
Unguentum hydrargyri ammoniati.
Unguentum hydrargyri nitratis.
Unguentum hydrargyri oxidi flavi.
Unguentum hydrargyri oxidi rubri.
Unguentum iodi.
Unguentum iodoformi.
Unguentum mezerei.
Unguentum picis liquidæ.
Unguentum plumbi carbonatis.
Unguentum plumbi iodidi.
Unguentum potassii iodidi.
Unguentum stramonii.
Unguentum sulphuris.
Unguentum sulphuris alkalinum.
Unguentum veratrinæ.
Unguentum zinci oxidi.

Vina, or Wines (14).—Alcoholic preparations in which stronger white wine is the menstruum generally employed.

Vinum album.	Vinum colchici radicis.	Vinum ipecacuanhæ.
Vinum album fortis.	Vinum colchici seminis.	Vinum opii.
Vinum aloës.	Vinum ergotæ.	Vinum rhei.
Vinum antimonii.	Vinum ferri amarum.	Vinum rubrum.
Vinum aromaticum.	Vinum ferri citratis.	

The doses of the preceding preparations are to be found under their respective headings, and also in a list contained in the second volume of this work. An introductory section will also be found to Part III, in which Classification of Remedies is considered, with definitions and descriptions of the various classes of medicinal agents employed in modern therapeutics.

Pharmaceutical Processes, or Pharmacy Proper.

Pharmacy is that department of medical science which is devoted to the collection, identification, manipulation, compounding and dispensing of drugs. It comprises the various articles and preparations composing the Materia Medica, officinal and non-officinal, guards against adulteration and substitution, analyzes the composition and determines the standard proportion of active constituents, besides providing eligible and efficient preparations, and indicating the proper procedures in filling prescriptions *secundum artem.* A knowledge of at least the rudiments of pharmacy is absolutely necessary to the practicing physician. It is a great misfortune that so many students are permitted to graduate from our medical schools with such an imperfect acquaintance with practical pharmacy as they ordinarily possess. Owing to ignorance on the part of the prescriber serious mistakes may be made, to the detriment of the patient and discredit of the physician.

In practical pharmacy a number of preparations known as favorite prescriptions or popular remedies, like Squibb's Cholera Mixture, Lafayette Mixture, etc., being in frequent demand, are usually kept on hand in the shops. Some of these, like Brown Mixture, Compound Licorice Lozenges, and Basham's Mixture, have been admitted to the pharmacopœia. Others are less often prescribed, but the pharmacist is expected to have the formula at hand so as to prepare the remedy extemporaneously. Such a collection of formulæ is known as the "Extra Pharmacopœia," or simply as a Formulary. Several such formularies exist, the best known being Griffith's. Some years ago the American Pharmaceutical Association appointed a committee to collect the formulæ for such unofficinal preparations and to select the best of each class, so as to form a National Formulary. This was done, and the result of the committee's work was fully approved by the American Pharmaceutical Association. The work was issued for the purpose of obtaining uniformity in unofficinal compounds, and to publish formulæ which represent some proprietary preparations. A Physicians' Manual of the National Formulary is published in Chicago, by C. S. Hallberg, at a trifling cost. Every physician should have at hand for reference the United States Pharmacopœia and the National Formulary.

The principal operations of pharmacy will now be systematically, though briefly, considered.* They are :—

1. Weighing and Measuring.
2. Determination of Specific Gravity and Temperature.
3. Operations Requiring the Use of Heat.
4. Operations Chiefly Mechanical.
5. Pharmaceutical Testing and Analysis.
6. Extemporaneous Preparations.

I. Weighing and Measuring.—Solids are usually weighed and liquids measured; the denser liquids, however, are often, for the sake of accuracy, dispensed by weight, and all liquids might be. Owing, however, to the variation in bulk of liquids, and the necessity of making corrections for specific gravity and temperature, this plan is not employed in prescribing, although parts by weight have been adopted in our pharmacopœia, except in the fluid extracts, which are made after the metric system. Scales, or balances, of various kinds and varying degrees of accuracy, are employed in weighing, and care should be used that scales used in compounding prescriptions are reliable and sufficiently sensitive for the purpose for which they are used.

Weight is the measure or expression of the attraction of gravitation for a given mass of matter at the earth's surface, being dependent principally upon its bulk, density, and physical condition. The comparative bulk of bodies is expressed in terms of dimension or measurement. Standards of weight and measure are established by law in all civilized countries. Those in use in the United States have been adopted by Act of Congress of June 14, 1836, when the Secretary of the Treasury was directed to furnish each State in the Union with a complete set of revised standards based upon those of Great Britain. In 1864 the use of what is known as the metric system was legalized in Great Britain, but was not made compulsory; and in 1866 the United States pursued the same course. It was partially introduced into the pharmacopœia in the revision of 1880. The measures in use in buying or selling drugs and

* For fuller details our readers are referred to the excellent treatise on the Practice of Pharmacy by Professor Remington, of Philadelphia. J. B. Lippincott & Co., 1885.

compounding prescriptions are as follow: Troy and Avoirdupois weights for ascertaining the relative ponderosity of bodies; Wine, or Imperial measure for quantity of liquids, and the metric system.

Troy, or Apothecaries', weight is used for compounding or dispensing drugs; avoirdupois is the standard for commercial purposes, and is used in buying and selling drugs in quantity.

Troy, or Apothecaries', Weight.

20 grains (symbol gr.)	equal 1 scruple (symbol ℈).
60 grains, or 3 scruples, ...	equal 1 drachm (symbol ʒ).
480 grains, or 8 drachms, ...	equal 1 ounce (symbol ℥).
5760 grains, or 12 ounces, ...	equal 1 pound (symbol ℔ Troy).

Avoirdupois Weight.

437½ grains, ...	equal 1 ounce (symbol oz).
7000 grains, or 16 ounces,.	equal 1 pound (symbol ℔ Av.)

The British Pharmacopœia is peculiar in using in its formulæ Avoirdupois weight; the United States Pharmacopœia adhering to Troy weight. Symbols are employed to designate the different denominations; thus, in Apothecaries' weight, gr. (Lat. *granum*) stands for grain or grains; ℈ (Lat. *scrupulum*) stands for scruple or scruples; ʒ (Lat. *drachma*) for drachm or drachms, and ℥ (Lat. *uncia*) for ounce or ounces. In prescriptions, as well as in dispensing, these symbols are commonly employed; they will be referred to again under the section on Prescription-Writing.

Fluids, as already stated, may be dispensed by weight; but they are usually measured and sold by quantity.

Apothecaries' Measure.

60 minims (symbol ♏)	equal 1 fluidrachm (symbol fʒ).
480 minims, or 8 fluidrachms, . . .	equal 1 fluidounce (symbol f℥).
7680 minims, or 16 fluidounces, . . .	equal 1 pint (symbol O).
61440 minims, or 8 pints, ...	equal 1 gallon (symbol C).

An Imperial pint contains twenty fluidounces, of which there are eight in the Imperial gallon. The latter will contain ten pounds of distilled water (at 60° F.). The Imperial fluidounce weighs 437.5 grains, which is less by 18.2 grains than the United States Pharmacopœia ounce of water. This should be remembered in copying prescriptions from English medical publications.

The metric system of weights and measures is growing in favor, and is employed by nearly all European pharmacopœias, and partly by that of the United States.* The unit of this system is the metre, which is the

* In the forthcoming revision of 1890, the committee has adopted the metric system throughout the U. S. Pharmacopœia.

ten-millionth part of one-fourth of a meridian, or one forty-millionth of the polar circumference of the earth. This has been found to be a little more than the English yard (3 feet 3 inches and $\frac{3}{8}$), or 39.37 inches. From this unit of length the unit of capacity is derived; a thousandth part of a cubic metre is a litre, which contains a little more than two pints ($2\frac{1}{10}$ pints); it is represented by a cube whose height is one-tenth of a metre. The unit of weight is obtained by taking the weight of distilled water which will fill a cube whose sides measure one one-hundredth of a metre; this is called a gramme, and it is equivalent to 15.432 grains. By a system of prefixes the quantities are readily expressed by multiplication or division; thus, *myria* = 10.000 times, *kilo* = 1000 times, *hecto* = 100 times, *deka* = 10 times; whereas *deci* means $\frac{1}{10}$, *centi* $\frac{1}{100}$, and *milli* $\frac{1}{1000}$. This will be readily understood by referring to the following table, in which the relative value of different denominations in the metric and English systems are approximately given.

Measures of Length.

$\frac{1}{1000}$ metre . .	= 1 millimetre (mm.),	or	$\frac{1}{25}$ inch.
$\frac{1}{100}$ metre . .	= 1 centimetre (cm.),	"	$\frac{1}{10}$ inch.
$\frac{1}{10}$ metre . .	= 1 decimetre (dm.),	"	$3\frac{15}{16}$ inches.
1 metre . .	= 1 METRE (M.),	"	39.37 inches.
10 metres . .	= 1 Dekametre (Dm.),	"	32.81 feet.
100 metres . .	= 1 Hectometre (Hm.),	"	328.09 feet.
1000 metres . .	= 1 Kilometre (Km.),	"	3280.9 feet.
10000 metres . .	= 1 Myriametre (Mm.)	" 32,809 feet, or	$6\frac{1}{4}$ miles.

Measures of Capacity.

$\frac{1}{1000}$ litre . .	= 1	cubic centimetre (c.cm.), or millilitre (ml.) =	16.0 minims.
$\frac{1}{100}$ litre . .	= 1	centilitre (cl.) =	2.705 f℥.
$\frac{1}{10}$ litre . .	= 1	decilitre (dl.) =	3.381 f℥.
1 LITRE (L.)	= $2\frac{1}{10}$	pints (O) =	33.815 f℥.
10 litres . .	= 1	Dekalitre (Dl.) =	2.641 gallons.
100 litres . .	= 1	Hectolitre (Hl.) =	26.419 gallons.
1000 litres . .	= 1	Kilolitre (Kl.) =	264.19 gallons.
10000 litres . .	= 1	Myrialitre (Ml.) =	2641.9 gallons.

Measures of Weight.

$\frac{1}{1000}$ gramme, or 1 milligramme	(mg.)	. . . . equal to	$\frac{1}{64}$ grain.
$\frac{1}{100}$ gramme, or 1 centigramme	(cg.)	. . . . equal to	$\frac{1}{6}$ grain.
$\frac{1}{10}$ gramme, or 1 decigramme	(dg.)	. . . . equal to	1.5 grains.
1 gramme	(G.)	. . . . equal to	15.432 grains.
10 grammes, or 1 Dekagramme	(Dg.)	. . . . equal to	154.32 grains.
100 grammes, or 1 Hectogramme	(Hg.)	. . . . equal to	3.52 oz. Av.
1000 grammes, or 1 Kilogramme	(Kg.)	. . . . equal to	2.2 lbs. Av.

Relation of Metric Weights and Measures to Apothecaries' Weights and Measures.

1 grain	equals	0.0647895	gramme.
1 scruple	"	1.295	grammes.
1 drachm	"	3.887	grammes.
1 ounce	"	31.103	grammes.
1 minim	"	0.061613	cubic centimetre or millilitre (weighing
		.0616	gramme, or 0.95 grain).
1 drachm	"	3.697	millilitres, or cubic centimetres.
1 ounce	"	2.957	centilitres.
1 pint	"	4.273	decilitres.
1 gallon	"	3.785	litres.

In ordinary use, in prescription-writing, the following table will be found to be nearly correct, and can be easily memorized.

♏j or gr. j	equals	.06	gramme.
fʒj or ʒj	"	4.0	grammes.
f℥j or ℥j	"	32.0	grammes.

The use of a decimal line greatly reduces the possibility of mistakes in reading such prescriptions. As .06 (drug) is less than 1 grain, while 4. and 32. (vehicle) are more than the fluidrachm or ounce, there is no danger of giving a stronger dose than was intended by using this system. C.cm. (cubic centimetres), used for G. (grammes), causes an error of about 5-per-cent. excess.

A teaspoonful is usually 5 gm. or c.cm.; a tablespoonful, 20 gm. or c.cm. Since domestic measurements of this kind are so irregular and unreliable, it is best to have the patient take his medicine from a properly graduated glass or a standard spoon.

Ordinary expressions of weight or measure, therefore, may be reduced to metric terms by the following rule: Multiply grains by 6, and the result will be centigrammes; multiply drachms by 4, or ounces by 32, and the result will be grammes. In the same manner, by dividing centigrammes by 6, we obtain grains; or grammes by 4 or 32, and the result will be the number of drachms or ounces, as the case may be.

Liquids are usually measured, when compounding prescriptions, in convenient glass vessels, which, on account of having their capacity graduated by marks blown or engraved upon them, are known as graduates. They are usually smaller at the bottom, having a conical shape, or they may be cylindrical. The indications of capacity may be according to the ordinary apothecaries' liquid measure or to the metric system. Larger quantities are measured in tinned-iron or copper measures, where the liquid is not corrosive; for liquids which cannot be measured in metallic vessels glass or porcelain can be used. Small quantities are measured by minims or by drops. The only accurate method of regulating the dosage of small quantities is by using a small instrument known as a minim-pipette. This is simply a glass tube, with a slightly contracted extremity, so that it will deliver its contents not too rapidly. Upon the side the tube has graduations engraved upon it. A rubber cap may be applied to the upper extremity, by which fluid may be drawn into the tube when its point is placed under the surface. The desired amount may then be expelled by compressing the cap or bulb, and the amount is indicated by the graduations. If the pipette is long enough the rubber bulb can be dispensed with and the mouth applied to produce suction, the liquid afterward being retained by placing the forefinger over its upper end, by which also the flow may be regulated. A little experience with this instrument will enable the operator to transfer small quantities of liquid from one receptacle to another with considerable accuracy and rapidity. A good way to keep the pipette ready for use and clean is to use a perforated cork, passing the pipette through it into a bottle containing alcohol or water. When water or any fluid capable of wetting the glass is used the fluid will creep up the sides of the tube by capillary attraction, and the outer edge of the fluid will therefore be higher than the remainder of the surface. In reading the measure it is customary to take the level of the centre of the liquid, or a plane slightly above it, in order to be accurate.

In spite of the fact that every one knows that a drop is not a unit of measure, and that the size and weight of drops of liquid vary according to temperature, specific gravity, and even the shape of the bottle from which they come, and that the drops of some liquids are much larger than others,—for instance, the drop of deodorized tincture of opium being nearly twice as large as that of the ordinary tincture,—physicians constantly prescribe active medicines by drops when they mean minims, if they mean anything at all definite. This uncertainty with regard to drops is shown by the following table,* where every attempt to maintain uniformity was observed :—

Acetum opii,	90 drops in 60 minims.
Acetum scillæ,	68 " "
Acidum aceticum,	108 " "
Acidum carbolicum,	111 " "
Acidum hydrocyanicum,	60 " "
Acidum lacticum,	111 " "
Acidum phosphoricum dil.,	59 " "
Acidum sulphuricum aromat.,	146 " "
Acidum sulphuricum dilut.,	60 " "
Æther fortior,	176 " "
Alcohol,	146 " "

* From a table prepared by the late Mr. Stephen L. Talbot. The preparations referred to are of the revision of 1870.

Aqua destillata,	60 drops in 60 minims.		
Bromum,	250	"	"
Chloroformum purif.,	250	"	"
Creasotum,	122	"	"
Ext. belladonnæ fld.,	156	"	"
Ext. colchici rad. fld.,	160	"	"
Glycerinum,	67	"	"
Liquor acidi arseniosi,	57	"	"
Liquor arsenii et hydrarg. iodidi,	58	"	"
Liquor hydrargyri nitratis,	131	"	"
Liquor iodi comp.,	63	"	"
Liquor potassæ,	62	"	"
Liquor potassii arsenitis,	57	"	"
Oleoresina aspidii,	130	"	"
Oleum caryophylli,	130	"	"
Oleum ricini,	77	"	"
Oleum tiglii,	104	"	"
Spiritus chloroformi,	150	"	"
Syrupus,	65	"	"
Syrupus scillæ,	75	"	"
Syrupus scillæ comp.,	102	"	"
Syrupus senegæ,	106	"	"
Tinctura aconiti,	146	"	"
Tinctura belladonnæ,	137	"	"
Tinctura digitalis,	128	"	"
Tinctura ferri chloridi,	150	"	"
Tinctura iodi,	148	"	"
Tinctura nucis vomicæ,	140	"	"
Tinctura opii,	130	"	"
Tinctura opii camph.,	130	"	"
Tinctura opii deodorat.,	110	"	"
Tinctura veratri viridis,	145	"	"
Vini colchici radicis,	107	"	"
Vini colchici seminis,	111	"	"
Vini opii,	100	"	"

Scientific accuracy in prescribing and in dispensing medicines can only be obtained by carefully measuring or weighing the agent in graduates or scales of standard accuracy. Where a fraction of a grain, drop, or minim of some powerful remedy is ordered the division can be made more evenly by diffusing the remedy in a larger quantity of some menstruum in which it is soluble, like alcohol, ether, or water, or some inert powder, like gum arabic. Thus, the one one-hundred-and-twentieth of a grain of atropine may be obtained by dissolving one grain in an ounce of water, of which four minims would represent the desired quantity. Croton-oil and similar agents can be dissolved in alcohol or diffused through some inert powder, like milk-sugar, and thus be accurately divided into parts smaller than the minim or drop.

Most pharmacists are supplied with a full set of metric weights and measures, and can compound prescriptions in accordance therewith; but there are practical objections and difficulties that stand in the way of the general adoption of the French system which will prevent its general use in prescription-writing for many years, or until they are overcome, as pointed out by Professor Oscar Oldberg. At the same time those physycians who have been trained according to the metric system may find it easier for themselves to continue to employ it in prescription-writing; they owe it to their patients, however, to see that the prescriptions are sent to a pharmacist sufficiently versed in the system not only to avoid making mistakes himself, but also to qualify him to detect any errors that may have been accidentally made by the physician. The maximum dosage of drugs, according to the usual metrology, is usually known to a drug-clerk, but he is not often found familiar with the doses according to the metric system, and therefore the chances of mistakes in compounding are greatly increased. Bottles are now provided by the manufacturers, which contain definite quantities, according to decimal system, in cubic centimetres or millilitres; and pipettes and graduates, marked in metric equivalents, are for sale in all establishments for the sale of scientific apparatus. Until measures are taken for the general adoption of the new system, both by physician and pharmacist, prescriptions should be written and compounded according to the weights and measures in general use in other departments of applied science and social life.

Determination of Temperature and Specific Gravity.—In some pharmaceutical operations it is necessary to take into consideration the temperature or relative degree of heat, both of the room in which the work is going on and of the object manipulated. For instance, the laboratory or room may be below zero or above 90 degrees; it usually is about 65 degrees, or between this and 70 degrees, and, where no temperature is specified, it is supposed to be at this point. When it differs much, either above or below, it should be noted, especially when taking the specific gravity of fluids.

The instruments employed in measuring degrees of heat are called thermometers; they do not indicate absolute heat, but only its relative intensity. Thus, more heat would be required to raise a gallon than an ounce of water 1 degree, and yet the thermometer would register the same in each case. The quantity of heat is calculated in another way,—according to the laws of physics. Thermometers used to indicate the degree of heat are usually made of glass, pure mercury being preferred as the index because it expands uniformly between the boiling-point of water and its freezing-point. On account of the contraction of the glass, old thermometers generally read too high. Where the temperature is important, the thermometer may be compared with a standard, and its variations noted and allowed for. Thermometers should be three years old before being used, in order to allow for the shrinkage of the glass, which usually reaches its limit in this time.

Thermometers in this country are usually marked according to Fahrenheit's scale, which commences at 32 degrees below the melting-point of ice and divides the intervening space between this and the boiling-point of water into 212 equal gradations, making 180 degrees between the point at which ice melts and water boils; the degrees above and below these extremes are established by experiment. This form of thermometer is generally employed in this country for laboratory work, and is given the second place by the U. S. Pharmacopœia. In Reaumur's thermometer, which is in use to some extent on the continent of Europe, the freezing-point is 0 degrees and the boiling-point 80 degrees. The Centigrade, or the thermometer of Celsius, is principally used for scientific work all over the world, and has the first place in the U. S. Pharmacopœia (1880). The melting-point of ice is zero and the boiling-point of water is 100 degrees, the intervening space being equally divided into degrees Centigrade. The reading in Fahrenheit degrees may be converted into Centigrade by a simple rule. Bearing in mind that the former begins 32 degrees below freezing, which is the zero of the other, and that the space in the former occupying 180 degrees only covers 100 degrees of the latter, we have the following:—

To convert Fahrenheit degrees into Centigrade, subtract 32, multiply by 100, and divide by 180,—the result will be degrees Centigrade.

To convert Centigrade degrees into those of Fahrenheit, multiply by 180, divide by 100, and add 32.

As both scales are in use in clinical medicine, it is necessary for the student to familiarize himself with this calculation and remember the rules.

All thermometers are not equally sensitive; while some reach their maximum reading in one minute, others require three or four to get up to the proper degree. In pharmacy, this is of less consequence than in practice of medicine in taking the temperature of the body, where the rule is to permit the thermometer to remain in place at least five minutes before reading off the temperature.

The specific gravity of any substance is an expression of the relative weight of any quantity of the substance as compared with an equal bulk of distilled water at a temperature of 60 degrees and under ordinary conditions of atmospheric pressure as indicated by the barometer. It may be ascertained directly in the case of a liquid by placing it in a bottle which, when filled to the same point with distilled water, would contain just 1000 grains of the latter, and weighing it accurately; in this way, by subtracting the weight of the bottle, we get the weight of a quantity of liquid which exactly fills the space that 1000 grains of water would. The result is the specific gravity of the liquid. An easier, though less direct, method is to use specific-gravity beads, which are small, balloon-shaped, glass globes, of different sizes and weights, so adjusted that they have different degrees of buoyancy. Figures are scratched upon each one, showing the specific gravity of the medium in which it swims indifferently, neither floating nor sinking. These are known as Levi's beads, and are used in cases where a liquid is to be evaporated until it attains a given specific gravity. They are hydrometers having only one specific gravity. An improvement on this, which is in general use, is the mercurial hydrometer, of which two are used,—one for liquids heavier than water and one for liquids lighter than water. The form in general use is that of Baumé, which consists of a closed glass tube, loaded at the lower end with mercury or shot, and having an expansion, just above the weight, containing air, which causes it to float in an upright position. The original scale of Baumé has been superseded by the specific-gravity scale, which is engraved upon the stem of the instrument. Hydrometers are usually floated in cylindrical glass jars, the instrument sinking to a certain depth in liquids to be tested; the degree marked upon the scale cut by the surface of the fluid indicates the specific gravity at the ordinary temperarure (60 degrees). Alcoholmeters, elæometers, and lactometers are used for alcohol, oils, and milk, respectively. The urinometer, used in testing urine, is a specific-gravity hydrometer. The best form for this purpose is that manufactured by Dr. E. R. Squibb, of New York, which is remarkably accurate.

Heat is indispensable in pharmaceutical operations. Any of the ordinary sources of heat may be utilized, but it is found more convenient to use alcohol or illuminating-gas for the majority of the purposes to which heat is essential. The ingenuity of inventors has supplied us with small lamps or stoves, burning alcohol or petroleum, which are most convenient and cleanly. A Bunsen gas-burner, or one of its many modifications, is now an indispensable adjunct to the pharmaceutical laboratory.

The following are the principal procedures requiring heat:—

1. **High Temperatures.**—Ignition, or burning. Fusion, or melting. Calcination, or driving off volatile substances by heat. Deflagration, or burning with the aid of oxygen or some substance, like nitre or potassium chlorate, capable of yielding oxygen. Carbonization, or heating organic substances without exposure to air; the volatile substances escape, and the residue is of a dark color, like charcoal. Torrefaction, or roasting. Incineration, or reduction to cinders by consuming all the carbon. Sublimation, or separation of a volatile solid substance from another not volatile by heat.

2. **Temperatures Less High.**—Among these are the water bath; steam bath; glycerin, oil, or sand bath. In the water bath it is not possible to raise the temperature higher than 212° F., but the addition of salt increases the density and raises the boiling-point to 227.1. By using steam under pressure the temperature may be still further increased 100 degrees. Vaporization and evaporation are employed to separate volatile substances from fixed bodies. "When vaporization is used to separate a volatile liquid from a less volatile liquid it is called **evaporation.** When the object sought is the volatile liquid it is called **distillation.** When it is used to separate a volatile liquid from a solid it is called **desiccation, exsiccation,** or **granulation.** When it is used to separate a volatile solid from another body it is called **sublimation.**"

Many of the most useful classes of preparations are made with the aid of heat of moderate degree of intensity. Infusions are liquid preparations made by treating vegetable substances with either hot or cold water, but usually the former. The preparation must not be boiled. Cold water is selected as a menstruum when the drug contains some volatile substance which may be dissipated by heat, such as the prunus Virginiana. The general directions given by the pharmacopœia are to take 10 parts of the substance and boiling water q. s. to make 100 parts. "Put the substance into a suitable vessel provided with a cover, pour upon it the boiling water, cover the vessel lightly, and let it stand two hours. Then strain, and pass enough water through the strainer to make the infusion weigh 100 parts." The strength of energetic or powerful substances should be specially prescribed by the physician. In the five officinal solutions the decimal system is not followed. The infusions of brayera and of cinchona are each 6 per cent., digitalis $1\frac{1}{2}$, wild cherry is 4, and the compound infusion of sennæ contains 6 per cent. of senna and 12 each of manna and sulphate of magnesium.

Decoctions require not only boiling water, but boiling vegetable substances with water. The general officinal formula for an ordinary decoction, the strength of which is not directed by the physician nor specified by the pharmacopœia, is prepared in the same decimal proportion of ingredients as the infusion, but the process differs. "Put the substance into a suitable vessel provided with a cover, pour upon it 100 parts of cold water, cover it well, and boil for fifteen minutes; then let it cool to 45° C. (113° F.), strain the liquid, and pass through enough cold water to make the product weigh 100 parts." Of the two officinal decoctions, that of cetraria contains only 5 per cent.; that of sarsaparilla comp. contains 10 of sarsaparilla, with 2 each of sassafras, guaiac, and licorice-root, with 1 of mezereon.

In making extracts, the heat of the water bath is utilized in evaporating the extract to a pilular consistency. Heat is also employed in making ointments, cerates, suppositories, solutions, in spreading plasters, and a variety of other pharmaceutical manipulations.

Other operations are chiefly mechanical,—among these are comminution, solution, separation of fluids and solids, filtration, clarification, decoloration, precipitation, crystallization, granulation, dialysis, extraction, expression, percolation, maceration, separation of immiscible fluids, decantation and siphonage.

Comminution is the process of breaking a solid into small pieces. In the case of herbs, the agent may be broken up by cutting, slicing or chopping, or, if it be sufficiently dry, it may be ground in a mill or mortar, or it may be rasped or grated. When it is reduced to fragments by being subjected to a succession of blows, the process is called **contusion.** Drugs are frequently cut or sliced and then contused, preparatory to making pharmacopœial preparations, such as infusions, decoctions, or tinctures. For small quantities the mortar and pestle are generally used, but larger quantities are ground in a drug-mill. Different degrees of fineness of powder may be attained, being regulated by the fineness of the meshes of sieves through which it is to be passed to separate it from the coarser particles and make it uniform. When reduced to a very minute subdivision it is said to be impalpable, because the substance has lost its character of hardness, and is soft and light to the touch. **Very fine** powder passes through a sieve having eighty or more meshes to the linear inch, and is known as No. 80 powder; **fine** powder passes through a sieve of sixty meshes to the inch and is called No. 60; **moderately fine** powder passes through one having fifty meshes to the inch, No. 50 powder; **moderately coarse** powder passes through a sieve of forty meshes to the inch, No. 40 powder; and **coarse** powder is only required to pass through a sieve having twenty meshes to the linear inch, No. 20 powder. These are the five different degrees of fineness and names to distinguish them, adopted by the United States Pharmacopœia. For very fine powders bolting cloth is used, which gives a product as smooth as flour. Levigation is the term applied to a process for reducing solids to a powdered state by adding some liquid in which they are not soluble, the paste thus formed being rubbed up in a shallow mortar or on a glass slab with another piece of glass somewhat bell-shaped, with a solid, flat base, which is known as a muller. When a porphyry slab and muller are used the process is termed porphyrization. Another method is to use an excess of liquid, in which the fine insoluble powder is suspended, and then decanting the portion of the liquid containing the lighter particles, which is set aside, the fine powder subsequently subsides to the bottom of the receiver, and the supernatant liquid may then be poured off and the powder dried. This is known as **elutriation**; a good illustration is the preparation known as prepared chalk, which is made in this way. By a modification of the latter process the semi-liquid, pasty mass, containing the elutriated powder, may be placed in a funnel-shaped receptacle fastened in a wooden frame, having a short leg near its middle, and a handle.

The material having been placed in the receptacle, the apparatus is held in the hand, and the leg tapped slightly upon a table of chalk or other porous substance; the shock of impact causes a small portion to become detached from the rest and to fall in the form of small, conical masses or troches, which, with a little practice, may be made nearly uniform in size. Pastils (**Pastilla**) are small masses of this kind, which are usually made with aromatic substances and used for fumigation; but in reality "pastille" is only the French name for troche or lozenge, and therefore includes the former. Some substances are refractory to pulverization, and it is necessary to resort to some expedient to overcome this. Thus, gold-leaf may be pulverized by rubbing it into a paste with honey or potassium sulphate, afterward removing the foreign element by washing with water. Camphor is pulverized by the addition of a few drops of alcohol or chloroform, although it may be obtained from the spirits by the addition of water, and elutriation or filtration, and afterward removing the alcohol or water by evaporation. Metallic tin is granulated by agitating melted (fused) tin with chalk-powder, the latter being subsequently removed by elutriation or by chemical solution with an acid. Phosphorus may be pulverized by heating it in the presence of water until melted and keeping it agitated until cooled. Calomel, calcined magnesia, and sulphur may be sublimed, and, by introducing steam, an exceptionally fine product is obtained. A coarse powder is produced by evaporating a solution to point of concentration and continuing the evaporation, while stirring the liquid, until all the fluid is evaporated. This process is known as **granulation.** Granular effervescent salts are made by thoroughly mixing the perfectly dry material and moistening the mixture with strong alcohol. The pasty mass is pressed through a sieve, and the granules quickly dried in a hot chamber and packed in hermetically sealed bottles to exclude the moisture of the air. Pulverization is sometimes preceded by **exsiccation,** by which water of crystallization is driven off; this is usually required for salts like alum and sulphate of iron, which contain a large proportion of water of crystallization. Some metals, like zinc, are granulated by melting them and pouring them in a fine stream into water. Pepsin and similar adhesive substances are reduced to a powdered state by being dissolved and painted on glass plates, from which, after drying, it is scraped off in fine scales. If a finer powder is needed, a cold mortar, perfectly dry and washed with alcohol, is used. The operation is facilitated by combining some rather hard solid with the powder,—like milk-sugar.

Solution is the process whereby a solid or gaseous substance is made to lose its physical identity by the power of some liquid known as a solvent or menstruum. When the liquid has dissolved some, and will take up no more of the substance, it is called a saturated solution. A simple solution is one which contains the original substance chemically unaltered and will yield it again by evaporation. A chemical solution is one in which some chemical action takes place, and the evaporation of the liquid will yield a body having different chemical properties from the original substance. Solution is favored by agitation and usually by the application of heat. Rapid solution is accompanied by change of temperature and abstraction of heat from surrounding bodies, so that the process may be used as a cooling agency. Freezing mixtures are made in this way. On the contrary, where chemical change occurs, there is apt to be a rise of temperature.

A **decimal solution** contains one part of the substance in ten of the menstruum; a 1-per-cent. solution is a **centesimal solution.** The principal solvents employed in pharmacy are the following:—

Water (preferably chemically pure, or recently distilled water, as ordinary spring or river water contains more or less earthy and organic matter, in solution or suspension) is used in making liquors, medicated waters, infusions, decoctions, solutions, syrups, etc. **Alcohol** is used very largely, and is next in importance to water. As it has antiseptic qualities, solutions with alcohol are not liable to fermentation, as watery preparations are. Moreover, alcohol is a solvent for many substances that are insoluble in the former menstruum, such as resins, volatile or fixed oils, alkaloids, glucosides, etc., while gum, albumen, and starch are not affected by it. This affords an opportunity of dissolving out the medicinal qualities or principles, and leaving the inert, woody, and starchy matters. In some of the manipulations, dilute alcohol is directed which contains one-half water, or, more correctly, according to the pharmacopœia, it contains "45.5 per cent. by weight (53 per cent. by volume) of ethyl alcohol, and 54.5 per cent. by weight (47 per cent. by volume) of water." Alcohol is the basis of the spirits, elixirs, tinctures, medicated wines, and many of the fluid extracts of the pharmacopœia. Ether, benzol, chloroform, carbon bisulphide, acids, and oils are all recognized as solvents in appropriate cases.

Solids may be separated from liquids, or solutions containing them, by filtration, precipitation, decantation, siphonage, evaporation, and crystallization. **Dialysis** is a process by which a crystallizable substance in solution may be separated from non-crystallizable (colloid) substances. Graham, in 1861, brought out this very useful process, which depends upon the diffusibility of certain solutions through porous partitions. The usual form is a circular frame, like a sieve, in which the wire meshes are replaced by a diaphragm of parchment or parchment-paper (made by immersing unsized white paper in a cold mixture of two measures of sulphuric acid and one of water). The dialyzer is floated upon the surface of water in a proper receptacle, and the mixture to be separated is placed within it. A bladder suspended in a glass jar would answer the same purpose. This process is useful to separate alkaloids from organic mixtures, especially for purposes of quantitative testing. It is particularly applicable to toxicological investigations,—in separating poisons, such as arsenic, from the fluid material found in the stomach.

When the object in view is to separate active principles from the other constituents of drugs, a liquid is employed, termed a menstruum, in which the desired principles are soluble. The principal modes of **extraction** employed by pharmacy, at present, are maceration and expression, percolation, digestion, infusion, decoction. Maceration requires the drug to be in a coarse powder, contused or properly comminuted. The usual method is to place the powder and menstruum in a large bottle, until the soluble constituents are all taken up,—a process which may be facilitated by occasional shaking during a week or more. This was formerly the process employed in making tinctures, and still is followed by the German Pharmacopœia. In this country it is now superseded by the process of percolation, which is much more expeditious, and, when properly done, equally effective. **Percolation,** or displacement, is the process by which a powder packed in a conical or cylindrical receiver known as a percolator is exhausted of its active principles or medicinal qualities by the descent through it of a suitable solvent. **Lixiviation** is the name applied to this process when the substance is first incinerated, as in the process of extracting lye from wood-ashes. The U. S. Pharmacopœia gives specific directions for this process, which is largely used in making tinctures and fluid extracts, as follows: "The process of percolation, or displacement, directed in this pharmacopœia, consists in subjecting a substance, or substances, in powder, contained in a vessel called a percolator, to the solvent action of successive portions of menstruum, in such a manner that the liquid, as it traverses the powder in its descent to the recipient, shall be charged with the soluble portion of it, and pass from the percolator free from insoluble matter.

"When the process is successfully conducted the first portion of the liquid or percolate, passing through the percolator will be nearly saturated with the soluble constituents of the substance treated; and, if the quantity of menstruum be sufficient for its exhaustion, the last portion of the percolate will be destitute of color, odor, and taste, other than that possessed by the menstruum itself.

"The percolator most suitable for the quantities contemplated by this pharmacopœia should be nearly cylindrical, or slightly conical, with a funnel-shaped termination at the smaller end. The neck of this funnel end should be rather short, and should gradually and regularly become narrowed toward the orifice, so that a perforated cork, bearing a short glass tube, may be tightly wedged into it from within until the end of the cork is flush with the outer edge. The glass tube, which must not protrude above the inner surface of the cork, should extend from one and one-eighth to one and one-half inch (3 to 4 centimetres) beyond the outer surface of the cork, and should be provided with a closely-fitting rubber tube at least one-fourth longer than the percolator itself, and ending in another short glass tube, whereby the rubber tube may be so suspended that its orifice shall be above the surface of the menstruum in the percolator, a rubber band holding it in position.

"The dimensions of such a percolator, conveniently holding 500 grammes of powdered material, are preferably the following: Length of body, 14 inches (36 centimetres); length of neck, 2 inches (5 centimetres; internal diameter at top, 4 inches (10 centimetres); internal diameter at beginning of funnel-shaped end, 2½ inches (6.5 centimetres); internal diameter of neck, ½ inch (12 millimetres), gradually reduced at the end to ⅜ inch (10 millimetres). It is best constructed of glass, but, unless so directed, may be constructed of a different material.

"The percolator is prepared for percolation by gently pressing a small tuft of cotton into the space of the neck above the cork, and a small layer of clean and dry sand is then poured upon the surface of the cotton to hold it in place.

"The powdered substance to be percolated (which must be uniformly of the fineness directed in the formula, and should be perfectly air-dry before being weighed) is put into a basin, the specified quantity of menstruum is poured on, and it is thoroughly stirred with a spatula, or other suitable instrument, until it appears uniformly moistened. The moist powder is then passed through a coarse sieve,—No. 40 powders and those which are finer, requiring a No. 20 sieve, while No 30 powders require a No. 15 sieve for this purpose. Powders of a less degree of fineness usually do not require this additional treatment after the moistening. The moist powder is now transferred to a sheet of thick paper and the whole quantity poured from it into the percolator. It is then shaken down very lightly and allowed to remain in that condition for a period varying from fifteen minutes to several hours, unless otherwise directed, after which the powder is pressed by the aid of a plunger of suitable dimensions, more or less firmly, in proportion to the character of the powdered substance and the alcoholic strength of the menstruum, strongly alcoholic menstrua, as a rule, permitting finer packing of the powder than the weaker. The percolator is now placed in position for percolation, and, the rubber tube having been fastened at a suitable height, the surface of the powder is covered by an accurately-fitting disk of filtering-paper, or other suitable material, and a sufficient quantity of the menstruum poured on through a funnel reaching nearly to the surface of the paper. If these conditions are accurately observed, the menstruum will penetrate the powder equally until it has passed into the rubber tube and has reached in this the height corresponding to its level in the percolator, which is now closely covered to prevent evaporation, and the apparatus allowed to stand at rest for the time specified in the formula.

"To begin percolation, the rubber tube is lowered, and its glass end introduced into the neck of a bottle previously marked for the quantity of liquid to be percolated, if the percolate is to be measured,—or of a tared bottle if the percolate is to be weighed,—and, by raising or lowering this recipient, the rapidity of percolation may be increased or lessened as may be desirable, observing, however, that the rate of percolation, unless the quantity of material taken in the operation is largely in excess of the pharmacopœial quantities, shall not exceed the limit of 10 to 30 drops in a minute. A layer of menstruum must constantly be maintained above the powder, so as to prevent the access of air to its interstices, until all has been added or the requisite quantity of percolate has been obtained. This is conveniently accomplished, if the space above the powder will admit of it, by inverting a bottle containing the entire quantity of menstruum over the percolator in such a manner that its mouth may dip beneath the surface of the liquid, the bottle being of such shape that its shoulder will serve as a cover for the percolator.

"When the dregs of a tincture or similar preparation are to be subjected to percolation, after maceration with all or with a greater portion of the menstruum, the liquid portion should be drained off as completely as possible, the solid portion packed in a percolator, as before described, and the liquid poured on until all has passed from the surface, when immediately a sufficient quantity of the original menstruum should be poured on to displace the absorbed liquid, until the required quantity has been obtained.

"Authority is given to employ, in the case of fluid extracts, where it may be applicable, the process of repercolation without change of the initial menstruum." *

Fractional percolation is the same process applied to two successive portions of the powder, the result being identical with repercolation.

Pharmaceutical testing and analysis is the method followed in ascertaining the presence of certain constituents and determining the proportion if present. The methods followed are not different from those employed in organic chemistry and in the laboratory. The pharmacopœia supplies a list of standard reagents for the purpose of applying the tests prescribed in the text. As the processes of analysis are not peculiar to pharmacy, the space will not be taken here to consider them in detail. In practical pharmacy the microscope is indispensable for the recognition of drugs and adulterants and for the examination of crystalline deposits and sediments.

Expression is the process of forcibly separating liquids from solids. It is a very ancient method, the best-known form being the wine- or fruit-press. After macerating a crude drug for the desired length of time, the full amount of tincture is obtained by decantation and expression.

Precipitation is the process of separating solid particles from a solution by the action of physical or chemical means. If the precipitate is of lower specific gravity than the liquid it will float upon its surface; if, as usually is the case, it is of higher specific gravity it will sink to the bottom of the receptacle. Precipitates may be curdy, granular, flocculent, gelatinous, crystalline, amorphous, etc. A magma is a thick, more or less tenacious precipitate. Substances containing albumen are precipitated by heat; light precipitates silver salts; but the most frequent method of precipitation is by chemical action. This is resorted to (1) for the purpose of obtaining substances in the form of a powder, (2) as a means of purification, (3) for testing chemicals, and (4) to isolate chemicals. In assuming the crystalline form, some salts take up considerable water, which is known as water of crystallization; the amount varies in different salts, but it is important to bear this in mind with some salts like sulphate of iron or alum, as the water should be expelled by heat before making them into pills or powders. Such salts are liable to deliquesce and become moist or liquid by absorbing more moisture from the air, or in a dry atmosphere they may effloresce from loss of water.

The preparation of extemporaneous formulæ is not different in principle from the officinal, except that some extemporaneous preparations may be ordered which have no relation to the pharmacopœia. For instance, some preparations of the English, German, or other pharmacopœias are occasionally prescribed, or formulæ which are original with

* Pharmacopœia of the United States of America, 6th Decennial Revision, p. xxxv *et seq.*

the physician. Unofficinal articles, or new remedies, are also often included in the magistral prescription, but care should be taken that this is not done to excess. It is by no means creditable to a physician to be constantly trying much-vaunted new remedies or proprietary preparations, and neglecting to use the older remedies of established reputation and of standard composition, which have received the sanction of the pharmacopœia. The art of prescribing will now be taken up for consideration.

PRESCRIPTION-WRITING AND FORMULÆ.

In the progress of the science of medicine, it has been found necessary, owing to the accumulation of knowledge, to institute special departments of study, as well as specialties in practice. It having become inexpedient for a physician to collect his own herbs in the fields, to make his own preparations, and to dispense his own prescriptions, these duties have been delegated and entrusted to the trained pharmacist and his assistants, who have special qualifications for the task, to which they devote their whole time and attention. This division of labor is to the advantage of scientific medicine, as the practitioner of medicine is relieved of routine work and has more leisure to devote to the study of pathology, diagnosis, and therapeutics.

The Prescription.—The physician usually writes his directions regarding the medicines which the patient is to take according to a general form, the writing being called "the prescription" (*præscribo*, *præscriptum*, *præscriptio*, in Latin,—something written for, or ordered; in French, *ordonnance*). As a prescription furnishes very tangible evidence of the attainments of a physician, and, being preserved on the prescription-file of the pharmacist as a matter of record, may confront him in the courts of justice, it is of considerable importance that students should be well drilled in prescription-writing before graduating, so that they may be spared mortification and possibly the loss of reputation, caused by blunders or carelessly-written formulæ, to say nothing of the risk to the patient.

The first point to be settled, in composing a prescription, is to determine the therapeutic indication and to decide upon the drug to be employed, and in what form it shall be given,—whether solid or liquid, and whether alone or combined with other remedies. Following this is the question of dosage and the number of doses and the length of time during which the remedy is to be given, which determines the quantity to be ordered in the prescription. The body of the prescription, or the formula, may have the quantities written according to the metric system, but, as pharmacists and physicians are more familiar with apothecaries' weights and measures, it is better, for ordinary purposes, at least, to follow the prevailing method, as a matter of precaution, and to prevent mistakes. It has been found that, by adopting a certain form in writing prescriptions, the work of compounding and dispensing is made easier and more certain, and the task of translation facilitated. In framing a prescription, certain principles should be kept in mind, in order that the product shall be creditable and accomplish the purpose for which it was written. The tendency of the day is toward simplicity, the elegant pharmaceutical preparations at our command having removed the necessity of the resort to **polypharmacy,** as it is called, when a large number of agents are combined in one prescription. As remedies are modified in their action by association with others, it is often advantageous to make such a combination, and knowledge and experience are sometimes displayed to marked advantage in originating such complex formulæ. Instances of this will be abundantly given in the section devoted to the consideration of drugs. It used to be the rule that a prescription should contain four parts,—(1) the base, (2) the adjuvant, (3) the corrigent, and (4) the vehicle; the dose of the first having been decided upon, the quantities of the other ingredients were made to correspond with it, so as to make the desired quantity of the medicine to be taken at a dose.

The first rule in prescribing should be to make a judicious selection of the active remedy or remedies to constitute the basis of the prescription, always taking a single remedy, unless a distinct advantage can be gained by using others in conjunction with it. In this connection, it should be noted that some drugs can be given in larger doses when thus combined, whereas others must have their doses reduced. As a general rule, where agents are from the same therapeutical class they mutually enhance each other's effects, and must be given in smaller doses than when given alone; when they belong to different classes, and especially when they act upon different organs, the dose can often be largely increased with advantage. Having settled upon the main remedy and its associate, and the quantity desired to be given, the question of eligibility comes up, in deciding upon the special pharmaceutical form to be employed. There are frequently representatives of the drug in question in several pharmacopœial classes,—some in solid form, others liquid,—each having, or supposed to have, some special application or advantage in certain cases, and offering favorable opportunities for combination. It may be a matter of indifference which form or preparation of the remedy is chosen, but the probabilities are that it is not, and that some are better suited than others. Thus, some of the preparations of iron are astringent, others acid; others contain alcohol, or are combined with tonics and alteratives; one combination is especially diuretic, another is used as a styptic, and rarely given internally; one is used only as an antidote for arsenical poisoning, and so on.

Having decided upon the principal therapeutic agent, if we conclude to give it alone, that will complete the prescription formula, and we have only to add the directions to the pharmacist and to the patient (the latter directions being simply what is desired to be copied upon the label of the medicine-bottle or package). If we wish to combine our remedies, the following objects may govern our selection: First, an addition may be made of some agent which will assist the action of the main ingredient, or two or more may be selected which mutually aid each other. This aid may be chemical in character, as where dilute sulphuric acid is added to quinine sulphate to help in its solution, or hydrochloric acid is added to a digestive mixture containing pepsin; or it may be physiological, and intended to act upon some associated organ, so as to make the effect of the remedy more favorable; or, thirdly, to remedy some incidental disagreeable result. An example of the former is where resin-bearing purgatives, or cholagogue agents, and a sedative like belladonna or hyoscyamus are introduced into a purgative pill; an example of the latter is where hydrobromic acid is added to a cinchona preparation to prevent noises in the ears, or where carminatives are combined with a cathartic remedy, or the unpleasant effects of morphine are prevented by combining with it a small proportion of atropine. The object, not infrequently, may be purely pharmaceutical, as where a dry powder, as an excipient, is added in making pills. The third object of administering remedies in combination is to obtain a pleasant or at least as unobjectionable a form as possible.

When a remedy is exhibited in a form that the patient is utterly unable to swallow it, or is so repulsive that each dose causes nausea or vomiting, no matter how correct the prescription may be from the therapeutic stand-point, the patient will pronounce it a failure, and will probably relieve his feelings by uttering maledictions upon the doctor. On the other hand, if the remedy be attractive in appearance and pleasant to the taste, it will be regarded as a signal success, even though of less therapeutic activity. An agent is sometimes given merely for the mental and moral effect, without having any medicinal action directly. Such a combination is called a **placebo,** because it is administered simply to please the patient. Although placebos are rarely resorted to, patients should always be well treated, and with a little care much can be done toward making preparations pleasant. In choosing a physician, the voice of the patient would, in the majority of cases, be given, without hesitation, in favor of the prescriber who orders pleasant medicine, over him who has a special reputation for giving intolerably nasty ones. The young physician can get a hint from this which may greatly contribute to his success in after life. Here a practical acquaintance with the expedients which modern elegant pharmacy offers, for overcoming the objectionable characters of remedies, is of the highest service, and has no mean, intrinsic value from a financial point of view. A few suggestions may be given here. Solid medicines may be given in compressed pills, coated with chocolate, in pills sugar- or gelatin- coated, in capsules, or in suppositories. Powders can be given in *cachêts de pain*, gelatin capsules, or suspended in a dense syrup or other vehicle (such as stewed fruit or currant-jelly). Soluble or fluid agents, if unpleasant, are more difficult to hide, but they may be given in combination with aromatic or orange, elixir, fruit-syrup, or in some aromatic water. Many illustrations will appear, and formulæ will be given of good forms of combination in the discussion of individual drugs under each head. A proper understanding and appreciation of this principle of combination will not only make the remedies more effective, but the patient will be less likely to forget to take his medicine, and will thus co-operate with the physician rather than oppose him in every possible way. This is seen to the best advantage in the management of sick children, where the remedies must be palatable or the struggles of the child to escape a nauseous dose may do it more harm than the medicine will do good.

In combining remedies the question of incompatibility demands consideration. Remedies may be (1) pharmaceutically incompatible, (2) chemically incompatible, or (3) physiologically incompatible. Agents are pharmaceutically incompatible when the proposed combination is either impracticable or extremely undesirable. Thus, the addition of water to a tincture of a resin-bearing drug precipitates the resin or oleoresin, which floats upon the surface, thus spoiling the appearance of the preparation, and possibly permitting too large a quantity of the active principle to be taken with the first doses from the bottle. As the rule such tinctures should not be combined with solutions, aromatic waters, or infusions. Preparations of vegetable drugs containing tannic or gallic acid should not be prescribed with iron, as this combination produces an unsightly mixture, and the iron is precipitated in an insoluble form. A survey of the Materia Medica will afford many instances of the ineligibility of particular remedies in certain forms of combination. Volatile and corrosive substances or hygroscopic bodies should not be given with powders; bulky drugs should not be added to pills. In alkaloids of great physiological activity, such as strychnine, delphinine, or aconitine, the pill-form should not be resorted to on account of the danger of unequal mechanical division; and, in solution, it should be seen to that nothing be added that would render them insoluble. Some of the combinations, inexpedient from a pharmaceutical stand-point, are as follow:—

1. **Form Explosive Compounds.**—Chlorate of potassium and tannic or gallic acids. Bromine and alcohol. Nitrate of silver and creasote, or vegetable extracts containing glucose. Iodine and solutions of ammonia. Chromic acid and glycerin. Chloride of lime with sulphur. Spirits of nitric ether with certain fluid extracts. Calcium or sodium hypophosphite with dry powders, or when triturated alone.

2. **Form Unsightly or Undesirable Mixtures.**—Chloral with solutions containing alcohol. Vegetable tinctures containing oils and resins with water. Spirit of nitrous ether with potassium iodide, iron sulphate, tincture of guaiac, antipyrin, mucilage, tannic and gallic acids. Compound infusion of gentian with infusion of wild cherry or of cinchona. Copaiba and oils with watery preparations (unless attended by acacia or other emulsifying agent). Acids with ammoniated glycyrrhizin.

Chemical incompatibility is caused by chemical decomposition with the production of a compound (salt) having characters and reactions different from its components. It should be avoided, as the rule, except where expressly intended by the prescriber. A knowledge of chemistry will generally put the physician upon his guard, but there are special illustrations, which must be borne in mind, where the combination is particularly undesirable, and, when ordered in a prescription, will defeat the object of the treatment and bring discredit upon the attendant. The general rules of chemical incompatibility are usually stated as follows:—

As a rule, a remedy is not to be ordered in combination with its antidotes and chemical tests, especially if the latter depend upon the formation of an insoluble precipitate or a corrosive or poisonous salt. Thus, alkaloids are usually precipitated by mercurials and other metals, and may be destroyed by compounds containing free chlorine, caustic alkalies, or permanganate of potassium. Tannic and gallic acids usually precipitate the alkaloids in a nearly insoluble form. The alkalies usually cause precipitation when added to solutions of metallic salts. Glucosides are decomposed by free acids or by emulsins.

Special incompatibilities will be studied in connection with individual drugs. Among those that are most likely to give trouble are preparations containing corrosive chloride of mercury, nitrate of silver, solutions of iodine and iodides, arsenic, lead, quinine, strychnine, and tannic acid, and, as the rule, such combinations should be avoided and the agents given by themselves or simply in some vehicle. Care should be taken in mixing powerful oxidizing agents with easily-combustible bodies. Among the former are chromic acid, concentrated nitric or nitrohydrochloric acid, potassium chlorate or permanganate. Some of the latter are oils, alcohol, ether, glycerin, sulphur, and phosphorus. Mixtures of chromic acid and glycerin or alcohol, as already stated, are explosive; so is nitrate of silver with a vegetable extract or glucose. Compressed pills of chlorate of potassium sometimes explode from slight friction.

Physiological incompatibility is based upon the physiological action of drugs, the rule being that drugs having dissimilar effects upon special organs should not be combined in one prescription, especially where the principal action of the drugs is antagonistic. Inasmuch as the effects of individual remedies are not restricted to one organ or set of organs, and as it never happens that two drugs will be found exactly opposed to each other throughout their whole range of action, considerable latitude in this respect is permitted in prescribing. In fact, there is sometimes an advantage in modifying the activity of a drug by one which is antagonistic. For instance, morphine and atropine are opposed in their effects, and yet atropine is very frequently added to an opiate to diminish the disagreeable effects,—headache, nausea, and constipation,—and heighten the sedative and anodyne qualities. Illustrations of such incompatibility are largely to be found under the antidotes to the toxic effects of drugs, a remedy being considered incompatible with its physiological antagonists, as the general rule, to which, as already stated, exceptions may be often taken. Some prominent illustrations are the following:—

Acetanilide: Alcohol, ammonia, caffeine, cardiac stimulants.
Aconitine: Alcohol, ammonia, atropine, amyl nitrite, digitalis, strophanthus, strychnine.
Agaricus albus: Opium, strychnine, pilocarpine.
Agaricus muscarius: Atropine, digitalis, stimulants.
Alcohol: Ammonium acetate, digitalis, strychnine, caffeine, hyoscyamine.
Atropine: Aconitine, chloral hydrate, hydrocyanic acid, jaborandi, muscarine, morphine, physostigmine (eserine).
Caffeine: Opium.
Chloral hydrate: Ammonium salts, atropine, alcohol, many alkaloids.
Chloroform: Amyl nitrite, ammonia, digitalis, strychnine.
Digitalis: Aconite, muscarine, saponin.
Gelsemium: Opium, atropine, strychnine.
Hydrocyanic acid: Atropine, hyoscyamine.
Morphine: Atropine, caffeine, nicotine, physostigmine.
Muscarine: (See Agaricus muscarius, above.)
Opium: Atropine, gelsemium, veratrum viride.
Physostigmine: Atropine, chloral hydrate, morphine.
Saponin: Digitalis, strophanthus.
Strychnine: Amyl, chloral, potassium bromide.
Veratrum viride: Opium.

The risks of incompatibility in prescribing can be entirely avoided if due precaution is taken. Whenever a new combination is ordered, the prescriber should take it himself to the pharmacist and personally supervise the preparation of the prescription, and examine the completed product. If an insoluble precipitate be formed, it should be at once investigated and its character determined. Very often a skilled pharmacist will be able to detect an incompatibility in a prescription, owing to his practical acquaintance with the combining of drugs, and in this way point out the fact that such an unintentional incompatibility may exist, and thus show his willingness to work with the physician. It is expected by the general community that a physician should be able to recognize a remedy or preparation by its physical characters alone. In order to do this it will be necessary for him to cultivate a close acquaintance with drugs and the results of combinations which he wishes to order, so that he may pronounce a verdict upon a preparation and decide whether or not it is properly compounded. If he has not such technical knowledge he should make it his business to acquire it in a laboratory or a pharmacy.

Form and Language of the Prescription.—The reasons for adopting the Latin language, the language of science, for writing formulæ has already been sufficiently dwelt upon. However, if any physician choose to write his prescriptions entirely in English he is at liberty to do so; but the demands of accuracy require that he write the officinal English titles without abbreviation. Such titles as muriate of ammonia, balsam of copaiva, saltpetre or nitre, brown mixture, spirits of turpentine, etc., may be used in conversation, but in prescriptions the correct titles should be given: either **ammonii chloridum** or chloride of ammonium; **copaiba** (not a balsam); **potassii nitras** or nitrate of potassium; **mistura glycyrrhizæ composita** or compound licorice mixture; **oleum terebinthinæ** or oil of turpentine, and so on. Many popular titles are very objectionable; thus, oxalic acid is sometimes called essential salt of lemons or salt of sorrel, acetate of lead is called sugar of lead, while an attempt to trace the vulgar names of plants leads to endless confusion. Sometimes preparations of different strength may be indicated; thus, prussic acid may mean concentrated acid or the officinal 2-per-cent. dilute acid; oil of almonds may mean oil of sweet almonds or oil of bitter almonds, which differ very much in their properties and effects. The only safe rule, therefore, in writing prescriptions, is to know exactly what is intended to be ordered and to legibly write the scientific name and quantity of the article desired, and if this is done the language may be left to the choice of the prescriber. As a rule, it will be found that physicians who are competent to do so prefer to write in Latin, and those who cannot write them correctly in the language of the pharmacopœia cannot write them correctly in English either.

As to the form of a prescription, it is essentially a communication from a physician to the pharmacist, directing the preparation of the remedy; by tacit consent of all parties, it is acknowledged to be the property of the patient, who has the privilege of having it repeated or refilled at his pleasure. When the prescription is marked "not to be repeated," the patient is understood to assume all the responsibility of any injury which he may experience from disobedience to the physician's directions, the pharmacist generally satisfying his conscience by calling attention to the fact that the physician did not desire the remedy to be continued, and protesting that the entire responsibility must rest with the patient, but filling the prescription just the same. In this way the alcohol habit, the opium habit, the chloral habit, the cocaine habit, the antipyrin or bromide habit are fostered by the resources of modern pharmacy, which presents these agents in the form of cordials and other attractive preparations; so that physicians hesitate to prescribe them, for fear of the consequences of making patients acquainted with these seductive preparations, as there is practically no restriction on their sale.

Besides the formula, the complete prescription contains instructions to the pharmacist concerning the combining or compounding of the medicine and directions to the patient as to the quantity, manner, and time of taking the preparation. Finally, the document must be signed and dated and, as a matter of precaution, it is advisable to write upon it the patient's name and address, so that, if the pharmacist should make a mistake or deliver the wrong medicine, he will be able to trace it at once. This is also a safeguard against error in administration where more than one patient is under treatment in a family or institution.

Proceeding to the actual framing of prescriptions, assuming a knowledge of the Materia Medica and pharmacopœial titles sufficient to enable the prescriber to determine what remedy he wishes to give and its dosage, he writes upon a piece of paper, as legibly as possible, the formula that he has in his mind, making the case-endings agree with the requirements of the situation. For instance, as the first word is "Recipe," the imperative mood of the verb "take," requiring the accusative case, it follows that the nouns which follow referring to quantity should be considered as in the accusative case. Thus, "Recipe, gr. j, or ʒij," means, "Take 1 grain or 2 drachms" of any desired agent. The latter, however, must be placed in the genitive case whenever the quantity is expressed; thus, "℞ Aquæ calcis, fʒiv," means, "Take 4 drachms of lime-water." On the other hand, when the quantity is not given in any denomination of weight or volume, the subject itself being directly taken, the latter is put in the accusative case; thus:—

"℞ Vitellum ovi,
Aquæ cinnamomi, ... q. s. ad f℥j;

means, "Take the yelk of an egg, and enough to make one ounce of cinnamon-water (water of cinnamon)," the letters q. s. standing for **quantum sufficiat,** or, as much as may be required to make up the amount specified. If the case-endings are known, the proper cases may be ascertained by trying to insert the word "of"; where this can be done the word following it should be written in the genitive case; thus, in water of cinnamon, or syrup of orange, the words cinnamon and orange will always be in the genitive case. To students unfamiliar with Latin, the difficulties in the way of correct writing of prescriptions may seem insurmountable; but they will disappear after a little attention and practice. One of the best ways of learning the genitive case of pharmacopœial nouns is to study the list of fluid extracts or tinctures in which the remedial agent is in the genitive (fluid extract or tincture of—). Familiarity with the names of the Materia Medica will supply the needed information in the majority of drugs regarding the case-endings.

The general form of the prescription is:—

	℞ (for recipe, or take)	
Basis.	of A (in the genitive case), a certain quantity (in the accusative case).	
Adjuvant.	of B " " " " " " " "	
Corrigent.	of C " " " " " " " "	
Vehicle.	of D " " " " " " " "	
Pharmaceutical Directions.	Let such or such preparation be made.	
Directions to Patient.	Write (upon the label) the specific directions for dosage, time of taking, alone or with any vehicle, etc.	
Signature.		Physician's name.
Date.		
Name and Address of Patient.		For Mr. So-and-so.

It is not at all necessary that the classical arrangement of base, adjuvant, and so on, should be observed, but it seems natural to write the most important agent first, and follow this with any agent or agents which we desire to combine with it, and, finally, a menstruum or vehicle, if any be needed. For illustration, suppose it is desirable to give a patient an expectorant cough-mixture. In order to render the secretions more liquid we may use potassium iodide, or a vegetable substance, like ipecacuanha, and, perhaps, may decide to combine them. Associated with them we may give chloride of ammonium, which acts beneficially upon the bronchial mucous membrane, causing the development of more healthy epithelium. Finally, a suitable menstruum would make the mixture more palatable. We next decide upon the quantity for each dose, and the prescription now appears in this form:—

Recipe.

Potassii iodidi, ...	gr. iij.
Ammonii chloridi, ...	gr. xij.
Extracti ipecacuanhæ fluidi, ...	♏ij.
Syrupi sarsaparillæ compositi, ... q. s. ad	f℥ij.

Misce fiat mistura.

Or,

Take

of iodide of potassium,		three grains.
of chloride of ammonium,		twelve grains.
of fluid extract of ipecac,		two minims.
of compound syrup of sarsaparilla,	enough to make	two drachms.

Mix. Let a mixture be made.

Having settled that a dessertspoonful, or 2 drachms, will be a sufficient dose to give, we decide upon the number of doses to be ordered. If twenty be the number selected, the entire prescription will then equal twenty times two drachms, or five fluidounces, and, when completed, will form a mixture, with directions like the following:—

℞ (abbreviation).

Potassii iodidi,	(3×20 = 60 grs. or)	ʒj.
Ammonii chloridi,	(12×20 = 240 grs. or)	ʒiv.
Ext. ipecacuanhæ fluidi,	(2×20 = 40 ♏ or)	♏xl.
Syr. sarsaparillæ comp.,	(2×20 = 40 ʒ or) q. s. ad	f℥v.

M. fiat mistura.

Signa: Take a dessertspoonful every four hours for cough, as directed by
Phila., Sept. 30, 1892. Dr. X.

Another illustration may be taken:—

	℞	
Base.	Quininæ sulphatis,	gr. xlviij.
Adjuvant.	Acidi sulphurici diluti,	fʒj.
Corrigent.	Tincturæ cardamomi compositæ,	fʒvij.
Vehicle.	Elixir,	f℥iij.

Sig.: Take a teaspoonful with water after meals. Dr. A.

The principal object of the addition of the sulphuric acid is to increase the activity of the quinine by changing it into the more soluble bisulphate. The compound tincture of cardamom makes the mixture more acceptable to the stomach, and increases the tonic effect, in which the alcohol, both of the tincture and the elixir, will participate. Where the alcohol is objectionable, the syrup of orange may be substituted for the elixir.

There is no essential difference between prescriptions for internal remedies and those for topical or local use as regards their form; for instance, we may write as follows:—

℞ Olei tiglii,	fʒj.
Olei amygdalæ expressi,	fʒij.

M. Sig.: For external use. Apply with a camel-hair pencil, once daily, over a space as large as a silver dollar, as directed. Dr. B.

℞ Acidi gallici,	ʒj.
Glycerini,	f℥j.

M. ft. solutio.

Sig.: Apply, night and morning, to the throat as directed. Dr. C.

℞ Potassii chloratis, ... ʒij.
Glycerini, ... f℥j.
Ext. geranii fld., ... fʒiv.
Aquæ rosæ, ... q. s. ad f℥vj.
M. ft. gargarisma.
Sig.: Use as a gargle several times daily, diluting with water if necessary.

DR. D.

Time and Interval in Relation to Dosage.—In addition to the question of dosage and the proper form in which to administer remedies, the problem of the frequency of giving the dose must be decided; and the time of the day, the relation to meal-time, all come up for settlement. The old and prevailing three times daily or *ter in die* method of ordering medicine to be taken arose from the natural division of time and the custom of eating a morning, noon, and evening meal. Remedies affecting the stomach directly are usually given when the organ is empty,—that is, before meals,—while digestive agents, to assist the assimilation of food, would properly be administered during the period of digestion. Systemic remedies, in a similar manner, are best given a short time after meals, so as to mix with the food and be absorbed with it and so enter the circulation. Laxative pills may be taken after the principal meal of the day (dinner-pills), or, if they contain cathartics of a slowly-acting character, they are best given upon retiring at night, so that in case they cause griping it will not give so much pain or inconvenience as if it occurred during the day. On the other hand, salines, such as Rochelle or Epsom salts, or natural purgative waters containing them, are more efficient when taken early in the morning, when the stomach and intestinal tract are not occupied in digesting food, and are thus more directly affected. It is sometimes of importance that the bowels should be moved just before retiring at night; for instance, where there are hæmorrhoids, it is found that they are liable to come down during the act of defecation, and afterward to cause pain and irritation during the time the patient is in the erect posture. In such a case a laxative, such as compound licorice powder or rhubarb, may be given at an hour in the afternoon which a little experience will determine, so as to bring about the desired result. Narcotic and sedative remedies are more effective if given just before the patient is accustomed to sleep: just as bitter tonics intended to excite the appetite should be given a little before the times appointed for the meals. Remedies may be given for a temporary purpose, as where alum and molasses or an ipecac mixture is ordered for croup, or preparations ordered for headache or cough, which are to be discontinued as the symptoms are relieved or the object of the treatment is accomplished. In treating a patient who has a tape-worm it is considered advisable to have the intestinal tract nearly empty, and the action of the remedy is greatly assisted by a preliminary purging to carry off the mucus which is thrown out as a result of the irritation caused by the parasite. For the administration of a purgative or the removal of a tape-worm the medicine is frequently taken on Saturday night, so as to enable the patient to rest the following day in case of overaction of the drug. When it is desired to evacuate the stomach by an emetic, it is advisable that some warm water or gruel shall be swallowed, so as to moderately distend the organ and give the muscles something to contract upon. On the other hand, when vomiting is not desirable, as when ipecac is administered for dysentery and it is not intended to be rejected by the stomach, the patient should abstain from drinking water before or after taking the medicine. Seasons and locality have some effects upon dosage: in hot weather the system does not bear strong medication as well as in winter-time. In some localities, where malaria is rife, antiperiodics must be given in larger doses, and are required in almost every disease. The numerous modifying elements that arise from circumstance and place, or the condition of particular organs, will receive due attention in another part of this work.

The **modes of administration,** from a pharmaceutical stand-point, have already been referred to, but a few words remain to be said from the therapeutical or physiological point of view. Remedies produce systemic effects because they enter the blood and become a part of the circulating fluid, or they may occasionally produce an impression upon the peripheral nerves, and thus produce local or remote effects, owing to reflex action. It must also be admitted that disturbances of function, similar to those produced by medicines, may be produced by emotion or mental states. In certain very sensitive subjects, usually hysterical, it has been found, in Charcot's clinic, that the effects of remedies can be obtained by "suggestion," without administration of the remedy. This is very similar in principle to the metallotherapy of Burq and to the tractotherapy of Perkins. The subject just adverted to will be further discussed in the chapter upon Hypnotism and allied states. For the present we are concerned with the actual physiological action of remedies, which may enter the circulation (1) by the mouth and stomach, (2) by the rectum, (3) by the bladder or vagina, (4) by the skin, (5) by the broncho-pulmonary mucous membrane, and (6) by the veins, or granulating surfaces.

1. The mouth being the natural channel for the introduction of food or sustenance, it seems the most convenient route for the administration of medicines, and, in fact, is thus used as the rule. Nature has placed a sentinel here in the form of the gustatory nerves and papillæ, and innumerable expedients have been resorted to in order to enable badly-tasting remedies to pass without exciting repugnance or nausea. Patients

differ greatly with reference to their ability to take medicines. Some can take castor-oil with a relish, others enjoy asafœtida as a condiment to their food; some are so sensitive that they are nauseated even by the idea of taking medicine of any kind. The latter often tax the resources of the pharmacist and physician until some other channel is finally selected for introducing the remedy. The absorption of medicines is largely by means of the capillaries or small veins, but the lymphatics or lacteals also participate. After entering the blood the remedies are carried by it into the capillaries of the central nervous system and the various organs of the body. After remaining in the tissues for a greater or less length of time, and exerting certain characteristic effects upon the functions of the several organs, these agents again enter the circulation, and are excreted from the system by the emunctories. As the rule, the remedy acts as an excitant or stimulant to the organ by which it is separated from the blood. They are subsequently to be found in the various secretions and excretions, either in their original form or some derivative of it. The absorption of insoluble substances is dependent upon their being transformed into soluble form; this may be done by the acid gastric juice or the alkaline intestinal juice. In some cases of ingestion of corrosive poisons the individual may perish from shock, or spasm of the glottis; but, as the rule, there is sufficient time for absorption of the poison from the alimentary canal before death occurs. When a toxic agent has been swallowed it is important to evacuate the stomach and intestines at once, so as to prevent the continued absorption of the poison.

2. Remedies may be introduced by **enema**,—otherwise called injection, lavement, or clyster. In this instance the mucous membrane of the rectum takes the place of the lining membrane of the stomach. There can be no question with regard to the absorption of remedies by the bowel, since it can be readily demonstrated. Thus, suppositories of opium produce the usual systemic effects of this drug; quinine, introduced into the rectum, stops intermittent fever; nutritive enemata support life for months, and so on. Injections of starch, with laudanum, are especially useful in painful affections of the rectum or the other pelvic organs, and check secretion in diarrhœa or dysentery. When an enema is to be retained it should not be more than from 1 to 4 ounces, according to circumstances; as a lavement or clyster, as large an amount as can be borne by the patient without causing actual pain may be given,—thus, from 2 to 4 pints may be injected into an adult, from one-eighth to one-fourth this quantity for a child, or 1 or 2 ounces for an infant. The instrument used for this purpose is called a syringe. It may be the classical form, with a piston and receiver, the latter being furnished with a tube, through which the fluid is forced when the piston is forced down.

The best are made out of hard rubber; those made of pewter or glass are very inferior. In addition to these, we have the soft-rubber tube, terminating in a tube of metal or of hard rubber; in the course of this tube there is a rubber bulb, which, expanding after compression, exercises suction, and, by alternate compression and expansion, forces fluids along the tube. This is a great improvement over the old style, as it is easily operated and can be used as a self-injecting apparatus. The fountain-syringe is simply a rubber bag or receiver, of variable capacity, terminating in a tube, through which the water flows by force of gravity when the reservoir is elevated. A pneumatic syringe is also made, in which the solution is placed and is afterward forced through the tube by pumping air into the bottle, reversing the aspirator of Dieulafoy. The ordinary injection used for evacuating the bowel consists of warm water containing some Castile soap in solution. In addition to this, we may add 1 or 2 ounces of castor-oil or a teaspoonful or more of oil of turpentine, in order to make the injection more stimulating. Glycerin may be used for the same purpose, from 1 to 4 drachms being generally sufficient to evacuate the lower bowel. When **gaseous enemata** are administered, the gas diffuses rapidly into the blood, and is excreted by the lungs. It was thought that the introduction of sulphuretted hydrogen in this way might benefit tubercular lesions in the lungs (Bergeon's method); but it has not been found to be of much service clinically, and certainly not sufficient to warrant its employment in opposition to the many obstacles that suggest themselves to this method.

3. The bladder or vagina may be used for the administration of remedies; but usually agents here applied are only intended to act locally. A weak solution of nitrate of silver, or of some sedative antiseptic,—boric acid or carbolic acid,—is sometimes resorted to, with excellent effect, in cases of inflammation; but remedies are rarely, if ever, introduced by this channel into the system, although morphine, atropine, or other active remedies might be so administered.

4. The skin, or general surface, may be utilized in several ways for the introduction of medicines. In the first place, the agent may be simply applied to the surface and kept in contact with the skin,—the **enepidermic method.** Friction may be called to our assistance to force the agent through the skin,—the **epidermic method.** The cuticle may be removed by a blister or other means, and the agent applied directly to the derma,—the **endermic method.** Remedies may be introduced beneath the skin and thrown into the areolar tissue,—the **hypodermic method.** With regard to the first three but little need be said. There are in use a large variety of lotions and liniments, some of which are active counter-irritants, which are used principally for a local effect. At the same

time, remedies can be thus made to produce a systemic effect, as where mercurials are applied by inunction; or quinine is used in the same way. Occasionally, medicines applied to the surface for a local effect may produce a general one, as where a belladonna ointment or plaster produces dilated pupils or croton-oil causes a general eruption. The last-named or hypodermic method, however, will require a more extended notice.

By the subcutaneous or hypodermic method, remedies in a state of solution are introduced by means of a small syringe armed with a hollow needle which is made to perforate the skin. This plan was first brought to the notice of the profession by Dr. Alexander Wood, of Edinburgh, and, being adopted, soon acquired a remarkable popularity. It has some decided advantages over ordinary methods, in that it admits of greater precision in dosage, since the entire dose rapidly enters the circulation; whereas, given by the mouth, some may escape absorption. It produces prompt effects, the influence being observed in from five to fifteen minutes, which makes it invaluable in the case of pain. It combines a local with a general effect, as, according to Dr. Wood, the injection should be administered as near to the site of pain as possible. It is clean, it is convenient, and it is cheap because the patient has it given to him. On the other hand, if an overdose be accidentally administered the poisoning must be met by physiological antidotes, since it cannot be withdrawn from the circulation after being injected. If the needle be not strictly aseptic it may communicate disease, and instances have been known of pyæmia and tetanus following the use of the hypodermatic needle. The greatest objection of all is that, by its use, patients are taught the morphine habit, and are apt to become infatuated with the little instrument and the effects of the punctures, and soon become confirmed morphinomaniacs. It is the latter consideration particularly which has induced physicians to use the hypodermic needle with increasing caution, and to refrain from its use whenever the remedy can be given by the stomach.

The hypodermic syringe is usually made of glass, of twenty- to sixty- minims' capacity, the gradations being engraved upon the barrel or the piston-rod. The needles may be of steel or platinum; if of the former they may be gold-plated. Various modifications have been made in the size and shape, but the form used by Dr. Robert Koch, of Berlin, has an advantage, from an antiseptic stand-point, in that it is free from a piston and plunger. The fluid is sucked up by aspiration, by means of a rubber ball attached to the end of the syringe and, by compression of the ball, is again forced out. The needle is fitted upon the glass barrel by a carefully ground friction-joint, and the whole instrument can readily be taken apart and washed with antiseptic solutions or treated with hot water. The construction of the syringe is readily understood from the foregoing, but a more extended description can be found in the *Medical Bulletin* of February, 1891, by those especially interested in the Koch treatment and its technique. It may be stated that the American imitations of the Koch syringe are unsatisfactory and practically worthless from want of care in manufacture. Bartholow, who has given much attention to this method, especially recommends a silver-plated instrument having a flat side to the piston-rod, upon which is marked the quantity of solution contained in the barrel. He makes the very proper suggestion that, before using such an instrument, it should be carefully tested with a standard minim-glass, in order to see that it is properly graduated. The instrument must be kept surgically clean; the needles should be small and sharp, and the syringe frequently washed with antiseptic solution, in order to keep the packing of the piston in good order and prevent it from becoming dry. As regards the solution, it should be chemically pure and made with great accuracy, and not too concentrated. It should be fresh, because a fungus will develop in the course of a few days (*penicillium*), which destroys the alkaloid. Where the syringe is not frequently used it is better to rely upon extemporaneously prepared solutions made with recently boiled water, and powders, compressed tablets, or triturates containing the desired quantity. Distilled water that is not fresh is not so good as recently boiled water for making the solutions. Chloroform water, cherry-laurel water, or dilute carbolic-acid solutions will keep for a comparatively long time without spoiling.

In administering a hypodermatic injection, a part of the skin free from superficial veins should be selected; if the piston be pulled out slightly when the needle is in position, and blood is seen to flow into the syringe, the needle should be withdrawn and another spot selected. Profound narcotism (possibly fatal coma) might result from the injection of morphine directly into the circulation by puncture of a vein. The place being selected,—generally in the outer aspect of the arm or forearm, or on the back,—the skin is pinched up into a fold between the fore-finger and thumb of the operator's left hand. The needle is then introduced lengthwise into the fold, which is slightly elevated as the desired amount is injected; the needle is withdrawn from the little wound by a twisting motion, and the puncture rubbed a little with the finger. A small tumor or swelling is caused by the injection, which is dispersed into the cellular tissue by rubbing. No further attention to the puncture is necessary, although, if it be painful, the next day it may be washed with carbolized water (ʒj to Oj) as a local sedative as well as antiseptic. The following are frequently employed for hypodermic medication:—

Alcohol, ...	Dose, ♏x–xxx.
Æther, ...	" ♏xx–xxx.
Ammoniæ (aqua), ...	" ♏x–xxx.
Apomorphinæ hydrochloras, ...	" gr. $\frac{1}{10}$.
Arsenicum (Fowler's solution), ...	" ♏ii–v.
Acidum carbolicum, ...	" gr. $\frac{1}{6}$–ij.
Amyli nitris, ...	" ♏iii–v.
Atropinæ sulphas, ...	" gr. $\frac{1}{120}$–$\frac{1}{80}$.
Atropinæ et morphinæ sulphas, ...	" gr. $\frac{1}{160}$–$\frac{1}{120}$ and gr. $\frac{1}{4}$–$\frac{1}{3}$ resp.
Caffeinæ citras, ...	" gr. i–ij.

℞ Caffeinæ, ... gr. xcvj.
Glycerini,
Aquæ, ... āā f℥ss.

M. Ten minims contain two grains.

Cocainæ hydrochloras, ... Dose, gr. i–ij.

℞ Cocainæ hydrochlorat., ... gr. xij.
Aquæ aurantii florum, ... f℥iv.

M. Twenty minims contain one grain.

Curare, ...	Dose, gr. $\frac{1}{20}$–$\frac{1}{5}$.
Coniinæ hydrobromas, ...	" gr. $\frac{1}{15}$.
Chloroformum purificatum, ...	" ♏v–xv.
or Spiritus chloroformi, ...	" ♏xx–xl.
Chloral, ...	" gr. x–xv.
Colchicina, ...	" gr. $\frac{1}{100}$–$\frac{1}{60}$.
Duboisinæ sulphas, ...	" gr. $\frac{1}{150}$–$\frac{1}{60}$.
Ergota, ...	" gr. ii–iij.

℞ Ext. ergotæ fld. (Squibb's),
Glycerini,
Aquæ, ... āā ℨj.

M. Sig.: Use twenty to thirty minims by injection.

Hyoscina, ... Dose, gr. $\frac{1}{100}$.

℞ Hyoscinæ hydrobromat., ... gr. $\frac{1}{5}$.
Glycerini, ... ♏xx.
Aquæ, ... q. s. ad ♏c.

M. Sig.: Five minims contain $\frac{1}{100}$ grain.

Hyoscyamina, ... Dose, gr. $\frac{1}{100}$.

℞ Hyoscyaminæ sulphat., ... gr. ss.
Aquæ chloroformi, ... f℥j.

M. Sig.: Ten minims constitute a dose, gr. $\frac{1}{96}$.

Hydrargyrum (see pages on Hydrargyrum, in Part III).

Morphinæ sulphat., ... Dose, gr. $\frac{1}{8}$–$\frac{1}{2}$.

℞ Morphinæ sulphat., ... gr. viij.
Acidi carbolici, ... gr. iij.
Aquæ, ... f℥j.

M. Sig.: Ten minims equal gr. $\frac{1}{6}$. Powders or capsules may also be used.

℞ Morphinæ sulphat., ... gr. iv.

M. et divide in chartæ vel capsellæ no. xxiv. Each contain gr. $\frac{1}{6}$. To be used for making an extemporaneous solution.

Quininæ hydrobromas,		Dose, gr. i–x.
℞ Quininæ hydrobromat.,		gr. xxiv.
Aquæ destillatæ,		f℥j.

M. Sig.: Ten minims contain one grain of quinine.

℞ Quininæ sulphovinat.,	gr. cxx.
Aquæ chloroformi,	f℥iv.

M. Sig.: Ten minims contain five grains.

The quininæ bimuriata carbamidata, the double chloride of quinine and urea, is soluble in an equal part of water, and is especially adapted for hypodermatic injection.

Strychninæ,		Dose, gr. $\frac{1}{60}$.
℞ Strychninæ sulphat.,		gr. $\frac{1}{5}$.
Acid. acetic. dil.,	q. s. ad	solve.
Aquæ acidi carbolici,	q. s. ad	f℥iv.

M. Sig.: Twenty minims contain $\frac{1}{60}$ gr. strychnine.

Many other instances of eligible forms for the administration of drugs hypodermatically will be found, in the following pages, under the drugs concerned.

Parenchymatous injection is a form of hypodermatic injection in which the solution is thrown deeply into the tissues instead of merely under the skin. It is employed in cases of neuralgia to deposit the remedies closely in contact with the affected nerve. Bartholow formerly used chloroform in this way, with marked benefit in cases of sciatica. Bichloride of mercury has been injected into the lung-tissue in the treatment of acute and chronic pneumonitis. Carbolic acid, or tincture of iodine, has been injected into the cavity of the tunica vaginalis testis in the treatment of hydrocele; and acetic acid and ergot have been thrown into the substance of various new growths. Ether has caused the disappearance of sebaceous tumors when injected into their interior, and parenchymatous injections of cocaine are used as a local anæsthetic.

5. By **inhalation,** remedies may be introduced, through the route of the bronchial mucous membrane, into the blood. Although rarely employed, except as a means of local medication, this method promises, in the future, to play a more important part in therapeutics. The remedies may be in the gaseous form, as where oxygen or nitrous oxide is administered; they may be in a vapor, and inhaled with steam; or made into a spray with the atomizer, and thus inhaled; or they may be used in fumes, as where tar or asthma pastilles are burnt, or sulphur or mercury vaporized. Concerning the extravagant hopes that have lately been raised (especially in the treatment of pulmonary consumption) of the bactericidal effects of inhalations, the results have not been very favor-

able. When the smaller bronchial tubes and air-cells and their walls are filled with bacteria the only antiseptic that can reach them is that contained in the healthy white blood-cell. At the same time salicylic acid, sodium benzoate, sodium chloride, and other agents are capable of being introduced into the ramifications of the bronchial tubes, and, by liquefying and favoring the expulsion of the secretions and making them less septic, they are capable of affording much relief to the patient and retarding the progress of the disease, if not hastening the cure. Hay fever is much relieved by applications of cocaine and inhalations of weak solutions of quinine; a similar treatment may sometimes be devised for acute and chronic pulmonary affections. For the production of a fine spray by mechanical action, instruments known as atomizers are used. Hand-atomizers consist of bulbs, which, by compression, deliver a blast of air through a tube past a capillary orifice in another tube, the latter being partially immersed in water or other desired solution. The blast of air produces a partial vacuum, and the fluid ascends the tube until, escaping by drops, it is blown into fine spray at right angles to the extremity of the tube. This is a very convenient instrument for small quantities of medicated solutions. When the quantity is larger the hand would become tired, and steam may be resorted to, as in Codman and Shurtleff's well-known instrument, or we may use compressed air by means of an air-pump. Some very neat and even ornamental forms of the latter have been devised by ingenious instrument-makers, and they may now be met with in the offices of all physicians who pay special attention to treatment of diseases of the throat or nose.

6. The **intra-venous administration** of medicine is the most direct method at our command of obtaining prompt physiological effects from our remedies. The transfusion of blood is an ancient therapeutic device, and it naturally suggested the employment of remedies in the same manner. In the collapse of cholera intra-venous saline injections have saved numerous lives that were apparently in a hopeless condition. The formula adopted by Hayem is :—

Sodium sulphate,	gr. 390.
Sodium chloride,	gr. 80.
Sodium hydrate,	gr. 15½.
Water,	fld. oz. 3.

This should be filtered and brought to the temperature of the blood at the surface, or not more than 100° F. Of such a solution as much as 2 quarts have been used at one operation, but, as a rule, 1 quart will be quite sufficient. It is important to inject the fluid slowly, so as to imitate the natural blood-current. Solutions of phosphate and chloride of sodium (specific gravity about 1020) have also been employed with success. The late Dr. Fagge employed the latter solution in the treatment of diabetic coma with remarkable improvement after 26 ounces (imperial) had been thus used. In cases of collapse from hæmorrhage milk has been employed by a number of operators, with gratifying results. Halford, of Australia, has shown that, after a wound from a venomous snake, the intra-venous injection of aqua ammoniæ fortior (1 part) with aqua destillata (2 parts) is well borne and aids the system in sustaining itself under the effects of the poison, although it may not be directly antidotal, as was at first supposed. Dr. Eskridge has used undiluted aqua ammoniæ fortior, injected into the blood-current, without bad consequences and with recovery of the patient, who had been asphyxiated with hydrogen sulphide. It is also of service in thrombosis of the pulmonary artery, chloroform asphyxia, hydrocyanic poisoning, etc. The danger of admitting air into the vein may readily be averted with a little care. It is hardly necessary to add that the lancet and, in fact, all of the instruments should be surgically clean, and that every antiseptic precaution should be scrupulously observed.

Transfusion of blood has been performed many times, and various modifications of instruments have been invented to accomplish it. The trouble is, that when the emergency arises the instruments are not at hand, except in a large general hospital, and the practitioner must extemporize a transfusion apparatus out of a 4- or 6- ounce syringe and a rubber and glass tubes. Immediate transfusion is where the blood flows from the donor's blood-vessel into the recipient's, through a tube which had been previously filled with an antiseptic solution. A syringe may be introduced, so as to measure the amount of blood, as in the instrument of Martin, of Berlin. The instrument of Aveling, of London, is simply a rubber tube with a bulbous enlargement in the middle. The capacity of the bulb is 2 drachms. Silver cannulas are placed at the ends of the tube, which is about fifteen inches in length. Each cannula is guarded by a stop-cock, and the ends are beveled or rounded, so as to facilitate the insertion. The mode of operation is to carefully cleanse the apparatus by immersion in warm, recently boiled water. The air is entirely expelled, and a warm saline solution used to completely fill the tube. The veins of the donor and recipient being selected,—generally in front of the elbow,—the incision is made with a scalpel and a tube inserted into each, and held in place by the fingers of an assistant in preference to a ligature. Now, the stop-cocks being turned, the tube is pinched on the side toward the donor, and the fluid is forced onward ; the afferent tube is then pinched, and the bulb allowed to slowly refill, when it is again emptied and again refilled until the proper quantity of blood (6 to 8 ounces usually) has been delivered. The apparatus is then withdrawn, a ligature placed upon the veins, and a proper dressing applied.

In **mediate transfusion** the blood is drawn into a warm bowl, beaten or whipped with some broom-straw to remove the fibrin and prevent subsequent clotting; then the blood is taken up into a previously warmed syringe and slowly injected, through a cannula, into the vein, the median basilic generally being chosen for the purpose. In this way repeated charges may be slowly and gently delivered, but, as Bartholow insists, from 4 to 8 ounces of blood will usually be sufficient to strengthen the heart and avert threatened collapse. The use of lambs' blood was advocated by Gesellius and others, but the transfusion was generally followed by a rigor and sweating, which greatly prostrated the patient.

Transfusion has been practiced in phthisis and other chronic diseases without benefit. It is of greatest service in acute emergencies, such as severe hæmorrhage (traumatic or post-partum), hæmatemesis, intestinal hæmorrhage, epistaxis, etc. In the hæmorrhagic diathesis it has been successfully used by Dr. Buchser, of New York, but it has failed in simple anæmia. In acute poisoning by phosphorus or carbonic oxide transfusion has been resorted to successfully by a number of reporters. A modification of this method has been proposed by Albanese and Hueter in **arterial transfusion.** In this method an artery of one of the extremities is selected and divided (generally the radial or posterior tibial being taken), and the blood is injected just as in mediate transfusion. The advantage sought for is the prevention of clotting and the danger of embolism, and that there is less danger of the introduction of air. Where a large quantity is to be injected it might be better to employ this expedient, so as to avoid any danger of suddenly overwhelming a weak heart. The effects following the **transfusion of milk** have been found to be very much the same as those from the use of blood, except that albuminuria is more apt to follow. When milk is used it should be taken directly from the cow or goat, and after being carefully strained, without being allowed to cool, it should be gradually introduced into the circulation by means of the syringe and cannula. The results, in some cases, of the treatment after hæmorrhage have been to warrant further trial. At the same time, the report of those who have gone over the entire subject critically is, that nothing can be a complete substitute for human blood for the purposes of transfusion. The later plan of injecting a quantity of blood into a large serous sac like the peritoneum, as recommended by Ponfick, has found few followers, and, whereas some good results have been reported, others have occurred in which death resulted from peritonitis.

Medicines may be applied topically to wounds and granulating surfaces or injected into suppurating cavities. The fact that such agents may be absorbed and produce systemic poisoning should lead us to be careful in applying carbolic acid, corrosive sublimate, or other active antiseptics which have powerful toxic effects upon the human organism. Morphine may be sprinkled upon painful wounds for its sedative effects, and iodoform or carbolic acid also act as local anodynes, but when used too freely have caused fatal poisoning.

Idiosyncrasy; Individual Peculiarities Affecting the Dosage or Mode of Administration of Drugs.—Personal peculiarities on the part of the patient, as regards the effects of remedies, often cause serious embarrassment to the prescriber. They are usually attributed to **idiosyncrasy;** but this is merely a term wherewith to hide our ignorance of the real cause. One of the puzzles of experimental therapeutics is the occasional contrast in the action of remedial agents in different species of animals, —*i.e.*, pigeons are very slightly affected by opium and are not injured by a quantity which would be fatal in man; a deer can eat tobacco, or a rabbit belladonna-leaves, without producing toxic effects. Something of a similar character occurs among patients. It is simply impossible to anæsthetize some patients with ether, and we are obliged, in such cases, to resort to chloroform when a surgical operation is required. There is also a great difference with regard to susceptibility to the effects of alcohol; some persons are easily overcome by it, and quickly rendered helpless and unconscious; others can take very large amounts, and, while showing its physiological effects by inebriety, are not discommoded by it to the extent of losing control of themselves. Sometimes we encounter individuals who are rendered very uncomfortable by calomel, even a small dose bringing on neuralgia or gouty pains in the joints; others require quite large doses to produce any effects at all. Cinchona and its alkaloids (quinine, cinchonine, quinidine, etc.) sometimes cause disturbance of digestion and eruptions upon the skin, even purpura hæmorrhagica, cases of the latter having been reported by Dr. Woodbury.* The objections to taking quinine which we sometimes encounter are probably due to ignorantly confounding it with other agents, such as mercury. Some patients cannot take colchicum at all; others use it in large doses with only good results. Opium and its alkaloids, morphine especially, are often productive of unpleasant consequences; and, instead of soothing a patient and producing sleep, they occasion excitement, restlessness, headache, irritation of the skin (followed by vomiting and prostration), or an eruption resembling urticaria or erythema. In the same way the iodide of potassium, even in small doses, occasions severe coryza in some patients, while in others a vesicular eruption appears which is not unlike varicella or variola. Unexpected prostration and symptoms of poisoning have followed the administra-

* Philadelphia Medical Times, September 18, 1886.

tion of ordinary doses of chloral hydrate, terminating fatally, in spite of everything that could be done. This occurs so frequently from chloroform that its use as an anæsthetic has been abandoned by many surgeons, and by others it is employed only with great caution. Iodoform, as a surgical dressing, even may cause poisoning in certain susceptible persons. The new aromatic compounds, antipyrin, acetanilide, sulphonal, etc., occasionally excite a peculiar train of toxic effects, for which, as yet, no explanation, except idiosyncrasy, has been given. On the other hand, it is sometimes necessary to give large doses of quinine, opium, calomel, chloral, or iodide of potassium, in order to produce a desired or positive therapeutic effect. When such unpleasant effects forbid the employment of a remedy it becomes necessary to resort to a substitute, or **succedaneum**, as it is called, having similar therapeutic effects without the objectionable features of the former agent.

From all that has been said in the preceding pages, the explanation is easily given of the reason why the dose of a drug cannot be stated with the same definiteness as its specific gravity, for instance. While we can say that a certain quantity is a customary or usual dose, and that a larger quantity is the maximum dose, which, under ordinary circumstances, it is not well to exceed, at the same time we may find patients who cannot take even the ordinary dose without great discomfort, and others who actually require extraordinarily large doses before obtaining the anticipated therapeutic result. The Committee on Revision has very wisely left the question of dosage to be settled between the physician and the pharmacist. It is customary, when a very large dose is stipulated in a prescription, for the pharmacist to ascertain from the physician if the dose was intended or was due to a mistake, owing to haste or to interruption while writing it. Physicians can save delay, in a case where a large dose is intentional, by underlining it or putting a star after it, to indicate that notice has already been taken by the author of the prescription, and it is not necessary to call it to his attention again.

Prescribing for Children.—If the doses for adults are subject to such fluctuation and uncertainty, it is evident that any calculation by mathematical formula of the dose for a child at any given age, based upon the adult dose, must be unreliable. Several such schemes have been proposed. Thus, Dr. Young's plan was to diminish the dose in the proportion of a fraction whose numerator is a figure representing the child's age and the denominator the age of the child increased by 12. The rule would therefore be: Multiply the adult dose by a fraction expressed by 12 increased by a figure corresponding with the years of a child's age divided by the age. Thus, if a child's age is 6 years and the adult dose 20 grains, we have the following formula:—

$$20 \times \frac{6}{12+6} \text{ or } \frac{1}{3} = 6\frac{2}{3} \text{ grains.}$$

The fact that the development of children depends upon other factors than age is sufficient to show the fallacy of this scheme, especially if we remember that some children, like adults, are very susceptible to medicines. A somewhat more rational plan than the preceding is based upon the weight of the child, which is taken as the numerator of a fraction whose denominator is 140, which is arbitrarily taken as the average adult weight. Inasmuch as many circumstances besides the age and weight of an individual affect the question of dosage, and as this is even more evident in prescribing for children than among adults, we cannot advocate any such mathematical formulæ for ascertaining the dose for children. Caution should be observed in prescribing narcotics to very young children; a single drop of laudanum has caused the death of an infant, while, on the other hand, they bear, without injury, relatively large doses of belladonna, conium, arsenic, and of mercury. Ptyalism should never be intentionally set up in children by an excessive use of mercury, because it may be followed by inflammation and sloughing of the lips and cheek and other serious lesions. In writing a prescription for a child it is sometimes of advantage for the pharmacist to know the fact, which may be indicated by addressing it "for baby," or "for Willie or Mary," or simply "for Mr. Blank's child."

In concluding this part of the work, the following table will be found useful in reading and writing prescriptions:—

Latin Terms and Phrases Employed in Prescriptions.

WORD OR PHRASE.	USUAL CONTRACTION.	ENGLISH EQUIVALENT.
A *or* Ab (prep. with ablative)	A *or* Ab	From *or* Out of.
Ad (with accusative)	Ad	To *or* Up to.
Adde	Add.	Add.
Ad duas vices	Ad 2 vic.	In two takings *or* doses.
Ad tertiam vicem	Ad 3 vic	At three takings *or* doses.
Ad libitum	Ad lib.	At pleasure.
Absente febre	Abs. feb.	Fever being absent.
Adstante febre	Ad. feb.	Fever being present
Adhibendus	Adhib.	To be administered.
Admove	Admov.	Apply.
Aliquot	Aliquot	Several.
Alternis horis	Alt. horis	Every second hour.
Alvo adstricta	Alv. adstrict.	The bowels being bound.
Ana	āā	Of each.
Ante cibum	Ante cib.	Before food.
Aqua astricta	Aq. astr.	Ice.
Aqua bulliens	Aq. bull.	Boiling water.
Aqua ex flumine	Aq. ex flum.	River-water.
Aqua fervens	Aq. ferv.	Hot water.
Aqua fluvialis	Aq. fluv.	River-water.
Aqua fontis *or* fontana	Aq. font.	Spring-water.

WORD OR PHRASE.	USUAL CONTRACTION.	ENGLISH EQUIVALENT.
Aqua pluvialis	Aq. pluv.	Rain-water.
Aqua pura	Aq. pur.	Pure water.
Bene	Bene	Well.
Bis in die	Bis die *or* Bisind.	Twice daily.
Bougia	Boug.	A long suppository *or* Bougie.
Bulliat	Bull.	Let it boil.
Capiat	Cap.	Take.
Caute	Caute	Cautiously.
Cibus	Cib.	Food *or* Meal-time.
Cochleare magnum	Coch. mag.	A tablespoon.
Cochleare medium	Coch. med.	A dessertspoonful.
Cochleare parvum	Coch. parv.	A teaspoonful.
Cola *or* Coletur	Col. *or* Colet.	Strain.
Collyrium	Collyr.	An eye-wash.
Coloretur	Coloret.	Let it be colored.
Compositus	Co. *or* Comp.	Compound.
Congius	Cong.	A gallon.
Continuantur remedia	Cont. rem.	Continue the medicine.
Coque, Coquantur	Coq.	Boil.
Cras, Crastinus	Crast.	To-morrow.
Cras mane sumendus	Cras mane sum.	Take to-morrow morning.
Cujus	Cuj.	Of which, of any.
Cujus libet	Cuj. lib.	Of any you please.
Cum (with ablative)	Cum	With.
Cyathus	C. *or* Cyath.	A glass.
Cyathus vinarius	C. vin.	A wine-glass.
Debita spissitudo	Deb. spiss.	Proper consistence.
Decubitus	Decub.	Lying down *or* A bed-sore.
De die in diem	De d. in di.	From day to day.
Diebus alternis	Dieb. alt.	Every other day.
Diebus tertius	Dieb. tert.	Every third day.
Dilue, Dilutus	Dil.	Dilute, diluted.
Dimidius	Dim.	One half.
Divide	Div.	Divide.
Dividatur in partes æquales	Div. in par. æq.	Let it be divided into equal portions.
Donec alvus soluta fuerit	Donec alv. sol. ft.	Until bowels are open.
Dosis	D.	Dose.
Drachma	Dr. *or* ʒ	A drachm.
Durante dolore	Dur. dolor.	During pain.
Eadem	Ead.	The same.
Ejusdem	Ejusd.	Of the same.
E *or* Ex	E	Out of, from.
Fac *or* Fiat	F. *or* Ft.	Make *or* Let be made.
Fac pilulas duodecim	F. pil. xij	Make 12 pills.
Fervius	Ferv.	Hot.
Fiant chartulæ duodecim	Ft. chart. xij	Let 12 papers be made.
Fiant pilulæ duodecim	Ft. pil. xij	Let 12 pills be made.
Fiat emplastrum	Ft. empl.	Let a plaster be made.
Gargarisma	Garg.	A gargle.
Gradatim	Grad.	By degrees.
Gutta, Guttæ	Gtt.	Drop *or* Drops.
Guttatim	Guttat.	By drops.
Haustus	Haust.	Draught *or* Potion.
Horâ decubitus	Hor. decub.	Bed-hour.
Horâ somni	Hor. som.	Bed-time.
Horæ unius spatio	Hor. 1 spat.	One hour's time.
Idem	Id.	The same.
In dies	Ind.	Daily.
Infrico	Infr.	To rub in.
Infusa	Inf.	Let it infuse *or* steep.
Intime	Int.	Thoroughly.
Jus	Jus	A broth (juice).
Linimentum	Lin.	A liniment.

WORD OR PHRASE.	USUAL CONTRACTION.	ENGLISH EQUIVALENT.
Lotio	Lot.	A lotion.
Macero	Mac.	To macerate.
Magnus	Mag.	Large.
Mane	Mane	In the morning.
Mane primo	Man. prim.	First thing in the morning.
Medicamentum	Med.	A medicine.
Mica panis	Mic. pan.	Crumb of bread.
Minimum	M. *or* Min.	A minim.
Misce	M.	Mix.
Mitte	Mitt.	Send.
Mitte decem tales	Mitt. x tal.	Send 10 like this.
Modicus	Mod.	Moderate-sized.
Modo præscripto	Mod. præsc.	In the manner written.
Mollis	Moll.	Soft.
Morbus	Morb.	A sickness.
More dictu	Mor. dict.	In the manner directed.
More solito	Mor. sol.	As accustomed.
Ne tradas sine nummo	Ne tr. s. num.	Deliver not without the money.
Nocte maneque	Noct. maneq.	Night and morning.
Nomen proprium	Nom. prop.	The proper name.
Non repetatur	Non repetat.	Let it not be repeated.
Octarius	O., Oct.	A pint.
Omni horâ (*or* Omnis horis)	Omn. hor.	Every hour.
Omnibus alternis horis	Om. alt. hor.	Every second hour.
Omni bihoris	Om. bih.	Every two hours.
Omni quadrante horæ	Om. ¼ h.	Every fifteen minutes.
Omni mane vel nocte	Om. mane vel noc.	Every morning or night.
Optimus	Opt.	Best.
Partes æquales	P. æq.	Equal parts.
Parvulus	Parv.	Small.
Penicillum camelinum	Penicil. cam.	Camel-hair pencil.
Per (accusative case)	Per	Through *or* By.
Phiala prius agitata	P. p. a.	The bottle being first shaken.
Post (accusative)	Post	After.
Pro (ablative)	Pro	For *or* According to.
Pro ratione ætas	Pro rat. æt.	According to patient's age.
Pro re nata	P. r. n.	As occasion arises.
Quantum libet	Q. lib.	As much as pleases.
Quantum sufficiat	Q. suff.	As much as suffices.
Quâque horâ	Qq. hor.	Every hour.
Quoque	Quoq. *or* Q.	Also.
Quotidie	Quotid.	Daily.
Recipe	℞	Take.
Redactus in pulverem	Red. in pulv.	Powdered.
Repetatur	Repetat.	To be repeated.
Scrupulum	Scrup. *or* ℈	A scruple (20 grains).
Secundum artem	Sec. a.	According to art.
Semi *or* Semisse	Ss.	A half.
Semihora	Semih.	Half an hour.
Sesqui	Sesqui	One and a half.
Signa	Sig.	Write.
Simul	Simul	Together.
Sine	Sin.	Without.
Singulorum	Sing.	Of each.
Si opus sit	Si op. sit	If need exists.
Solve	Solv.	Dissolve.
Statim	Stat.	Immediately.
Stet *or* Stent	St.	Let it (or them) stand.
Subinde	Subind.	Frequently.
Succus	Suc.	Juice.
Sumat talem	Sum. tal.	Take one such.
Sume	Sum.	Take.
Talis	Tal.	Such a one.

WORD OR PHRASE.	USUAL CONTRACTION.	ENGLISH EQUIVALENT.
Tere	Tere	Rub.
Ter in die	T. i. d.	Thrice daily.
Tritura	Trit.	Triturate *or* Grind.
Tussis	Tus.	Cough.
Ultimus præscriptus	Ult. præsc.	The last ordered.
Ut dictum	Ut dict.	As directed.
Vel	Vel	Or.
Verus	Ver.	Genuine.
Vesper	Vesp.	The evening.
Vitellus	Vitel.	Yelk of an egg.

POISONS AND ANTIDOTES.

The following table is placed here for convenience of reference; for further details of treatment the reader is referred* to the paragraphs relating to toxic effects and antidotes under the individual titles in the section devoted to drugs.

A general formula for administration in cases of poisoning by an unknown agent is sometimes useful as a sort of universal antidote Dr. Murrell recommends the following combination :—

℞ Liquor ferri sulphatis (ad saturandum),	100
Aquæ,	800
Magnesiæ,	88
Carbonis animalis purificatæ,	40

The iron solution is to be kept separate from the mixture of calcined magnesia and animal charcoal until wanted, and then the ingredients should be put in a bottle and well shaken together. The solution should be drunk while the insoluble ingredients are in a state of suspension. A wineglassful at a dose, frequently repeated.

Poisons.	*Antidotes.*
Acetanilide, Antipyrin.	Diffusible stimulants, hot alcoholic drinks, hot coffee, stimulating enemata, hypodermic injections of atropine, digitalis, or nitroglycerin.
Acids :— Acetic, Hydrochloric, Nitric, Oxalic, Phosphoric, Sulphuric, Tartaric.	Magnesia, chalk, dilute solutions of alkaline carbonates, soap, tooth-powder. Demulcents : milk, albumen, oils.
Alkalies :— Caustic potash, Concentrated lye, Soda, Lime, Ammonia, etc.	Vinegar, dilute acids, lemon-juice. Demulcents : milk and oil, flour and water, etc.

* For those who wish further information concerning poisons and their antidotes, we would highly recommend Dr. Murrell's little book, "What to Do in Case of Poisoning."

Poisons.	*Antidotes.*
Alkaloids.	Finely-divided animal charcoal, tannic acid, coffee.
Poisonous vapors and gases :— Ammonia, Bromine, Chlorine, Iodine, Carbonic oxide (CO), Carbon dioxide (CO_2), Charcoal fumes, Coal-gas, Fire damp, Choke-damp, Marsh-gas, Hydrogen sulphide.	Fresh air, oxygen inhalations, artificial respiration. Intra-venous injections of ammonia. Transfusion of blood.
Aconite.	Diffusible stimulants, tannic acid, coffee or tea infusion, alcohol, ammonia. Hypodermic injections of digitalis, strophanthus, or nitrite of amyl. Hot pack. Faradization.
Alcohol.	Coffee, acetate of ammonium, ammonia, stimulating enemata, catheterization.
Anæsthetics.	Artificial respiration, inhalation of ammonia or nitrite of amyl, faradization, inversion of the body.
Antimony.	Tannic acid, albumen, milk, and demulcents, with hypodermic injections of morphine and atropine.
Apomorphine.	Chloroform mixture; digitalis hypodermically.
Arsenic.	Freshly-precipitated hydrated sesquioxide of iron (℥ss to each grain of poison), or hydrated oxide of iron with magnesia, or dialyzed iron. Animal charcoal, magnesia, with opium to relieve pain and vomiting or diarrhœa. Demulcents.
Atropine (Belladonna).	Morphine, cautiously given; fixed alkalies. Caffeine or fresh infusion of coffee or tea, artificial respiration. Physostigmine, muscarine, and pilocarpine are physiological antidotes.
Belladonna.	(See atropine.)
Brucine.	Same as for strychnine.
Calabar bean (Physostigmine).	Stimulants, fixed alkalies, atropine hypodermically, artificial respiration.
Cannabis Indica.	Atropine.
Cantharides.	Opium, demulcent drinks, saline cathartics. Avoid oils and fats.
Carbolic acid.	Soluble sulphates, saccharated lime, stimulants and anodynes.
Chloral.	Hot infusion of tea or coffee, strychnine hypodermically, warmth and exercise.
Cinchona (Quinine, Cinchonine, Quinidine, etc.).	Tannic-acid and astringent infusions: iodine forms insoluble compounds with the alkaloids. Morphine and atropine hypodermically.
Codeine.	(See opium.)
Colchicum.	Opium, stimulants, astringents.
Conium.	Alkalies, astringents, strychnine hypodermically.

Copper.	Morphine, albumen, demulcents.
Corrosive sublimate.	Albumen, atropine, and morphine.
Croton-oil.	Opium, stimulants, demulcents.
Curare.	Strychnine and atropine, oxygen inhalations, artificial respiration.
Cyanide of potassium (Hydrocyanic acid).	Artificial respiration, ammonia inhalations. Cold affusions to the spine, transfusion of blood. Ether hypodermically.
Digitalis.	Opium, nitro-glycerin solution.
Gelsemium.	Atropine, strophanthus, hot alcoholic stimulants, hypodermic injections of ether.
Hyoscyamus.	Same as for atropine.
Lead salts.	Magnesium sulphate, opium, potassium iodide. Baths.
Lobelia.	Morphine, strychnine, strophanthus, stimulants.
Mercurials.	(See also corrosive sublimate.) Albumen, demulcent drinks, opium or belladonna.
Morphine.	(See opium.)
Muscarin, Mushrooms.	Stimulants and cathartic agents; atropine hypodermically, with morphine, if needed.
Nitrites:— Amyl, Sodium, Nitro-glycerin.	Stimulants, digitalis, atropine, artificial respiration, hot and cold douches, ergot.
Oil of bitter almonds.	(See cyanide of potassium.)
Opium (Morphine, Codeine).	Emetics or stomach-pump, coffee, exercise, friction or flagellation, caffeine by the rectum, atropine hypodermically, faradization, artificial respiration, warmth.
Phosphorus.	Old oil of turpentine; sulphate of copper. Avoid oils and fats. Transfusion of blood.
Picrotoxin.	Chloral, bromides, morphine.
Pilocarpine.	Atropine.
Savin.	Soluble sulphates, demulcents, anodynes.
Silver (Lunar caustic).	Table-salt, chlorides, demulcents, potassium iodide.
Snake venom.	Ligature of limb, with application of cupping-glass or caustic alkali. Ammonia inhalation, stimulants. Artificial respiration. Heat to surface.
Stramonium.	(See atropine.)
Strychnine.	Chloral, potassium bromide, chloroform by inhalation, alkalies, tannin.
Tobacco.	Strophanthus, hot applications, and cardiac stimulants; strychnine hypodermically.
Turpentine, oil of.	Magnesium sulphate, demulcents, opium.
Veratrine.	Diffusible stimulants, caffeine; rest in recumbent posture.
Zinc salts.	Sodium carbonate and demulcents; anodynes if needed.

GENERAL THERAPEUTICS AND CLASSIFICATION OF REMEDIES.

Classification has been found as difficult in Materia Medica as in every other branch of natural science. It is impossible to mark out, with exactitude, definite limits to the action of drugs. If, from one point of view, a medicine be described as diuretic, we are sometimes obliged to admit that it might be no less properly placed among the cathartics or diaphoretics. When we seek to understand the mechanism of its action and its influence upon the composition of the urine, we must study its effect upon the central nervous system, the cardiac nerves and ganglia, the heart-muscle, and the muscular coat of the arterial system. The organs concerned in sanguification may likewise be affected, and this result is evidenced by the changed proportion of the urinary constituents. If a drug specially impresses the chief nerve-centres, its range of influence must extend more or less powerfully and directly to every important organ. It need not, therefore, seem strange that no classification of remedies has permanently endured. In describing the properties and applications of drugs, the alphabetical arrangement is adopted as the most simple and convenient. Nevertheless, as our main object is to obtain a practical command of our therapeutical resources, it will always be useful to associate our remedies in classes, so that, in the absence or failure of any one, a substitute or a successor shall readily suggest itself to the mind. For these reasons the author deems it useful to precede the discussion of individual drugs by a brief summary of the salient characteristics of the various groups into which they may be arranged.

However imperfect a system of classification may be, it, nevertheless, serves to accomplish this useful object. The mental association of drugs which possess, in the main, similar properties renders the knowledge of the therapeutist more available, and assists him when it becomes necessary to alternate or combine his remedies. At the same time the individual or divergent action of medicinal substances is likewise emphasized, and this is a point of great importance in the judicious selection of agents. Though the combination of many remedies in one formula is to be deprecated, yet it is often highly advantageous to supplement the deficient action of one drug by the addition of one or more endowed with different but desirable virtues. The existence of chemical incompatibilities, however, should never be overlooked in forming such combinations, though it must be acknowledged that chemical and therapeutical incompatibilities are not always identical. Remedies may be divided into classes (after Garrod):—

Classification of Medicines.

- INTERNAL REMEDIES.
  - MEDICINES AFFECTING NUTRITION.
    - Blood tonics (hæmatinics).
    - Alkalies.
    - Acids.
    - Astringents.
    - Refrigerants.
    - Antipyretics.
    - Alteratives.
  - MEDICINES ACTING THROUGH THE NERVOUS SYSTEM.
    - The Brain.
      - Exhilarants.
      - Narcotics and Anodynes.
      - Anæsthetics.
    - Spinal Cord.
      - Stimulants.
      - Sedatives.
    - Nerve-Centres and Ganglionic System.
      - Antispasmodics.
      - Tonics and Antiperiodics.
    - Heart and Circulatory System.
      - Vascular stimulants.
      - Vascular sedatives.
    - Special Organs.
      - Alimentary Canal.
        - Sialagogues.
        - Antisialics.
        - Emetics.
        - Anti-emetics.
        - Purgatives.
        - Anthelmintics.
        - Stomachics.
      - The Liver.
        - Hepatic stimulants.
        - Hepatic depressants.
      - Respiratory Apparatus.
        - Expectorants (pulm. stim.).
        - Pulmonary sedatives.
      - Cutaneous System.
        - Diaphoretics.
      - Urinary System.
        - Diuretics.
        - Lithontriptics.
      - Generative System.
        - Embolics.
        - Emmenagogues.
        - Ecbolics.
        - Aphrodisiacs.
        - Anaphrodisiacs.
      - The Eyes.
        - Mydriatics.
        - Myotics.
- EXTERNAL REMEDIES.
  - Irritants.
    - Rubefacients.
    - Epispastics or blistering agents.
    - Pustulants.
    - Escharotics and Caustics.
  - Sedatives.
  - Demulcents.
  - Emollients.
  - Astringents and Styptics.
  - Antiparasitics.
- CHEMICAL AGENTS.
  - Antiseptics and Disinfectants.

Hæmatinics are remedies which exert a direct influence upon the composition of the blood. Useless, or even deleterious in health, such a drug tends to improve, in certain diseased states, the quality of the blood, and, consequently, the nutrition of the entire organism. Destruction of its corpuscular elements and drain of its albumin indicate that the nutrient fluid-tissue urgently requires increased and appropriate pabulum. This supply is, in health, derived from the food; but, in pathological conditions, must be administered in a more concentrated and less complex form. Remedies belonging to this class are, or contain, normal constituents of the body, and are necessary to the maintenance of structure and the performance of function.

Hæmatinics are preparations of iron, preparations of manganese, codliver-oil, other animal oils, and vegetable oils.

Alkalies.—When alkalies, in concentrated form, are brought into contact with animal tissues, they enter into chemical combination with the oxygen present, and thus give rise to an active, destructive inflammation. Alkalies are, likewise, solvents of albumin. These physical and chemical properties render the caustic alkalies useful in producing powerful counter-irritation. Their escharotic effects have been made use of in chronic synovitis, myelitis, and meningitis, and in the destruction of morbid tissue, whether of neoplastic or inflammatory origin. Potassium, in large doses, depresses or paralyzes the activity of nervous and muscular tissue.

The alkalies combine with and neutralize acids. Therefore, they are useful in overcoming hyperacidity of the stomach, whether due to the excessive production of hydrochloric acid or to fermentative changes, with the production of fatty acids. They promote the secretion of acid and restrain that of alkaline fluids. Hence, when administered immediately before a meal, an alkali excites a flow of gastric juice, and, in this way, promotes digestion and is serviceable in dyspepsia. On the other hand, given immediately after a meal, such a remedy, by neutralizing the gastric juice, embarrasses digestion, and fermentation proceeds unchecked. It can readily be understood, therefore, how the prolonged use of alkalies in dyspepsia at length disorders appetite and aggravates the condition for which they were originally prescribed. A dilute alkaline solution checks the discharge of acute eczema, which possesses the same reaction; it allays the itching and smarting of this disease, or the burning pain of superficial burns and scalds. Paræsthesia, whether dependent upon constitutional disorder or excited by local causes, is often amenable to the influence of an alkaline lotion. The same preparation is beneficial by neutralizing acid secretions from the bowel, vagina, or the skin, and obviating their effects.

A diminished alkalinity of the blood in rheumatism and gout is caused by the presence, respectively, of lactic or uric acid in excessive quantity. The alkalies are advantageous in these diseases, combining with the acid and facilitating its elimination. The same result takes place in the urine. The reaction of that fluid being rendered alkaline, uric acid is dissolved or forms soluble combinations, irritation of the urinary tract is quieted, and the precipitation of uric acid in the kidney or bladder is prevented. Alkalies are useful when a uric-acid calculus is present. They may be able to dissolve a small and soft stone. At all events, they prevent further deposit and relieve the local irritation which the foreign body has occasioned.

Prolonged administration of an alkaline remedy may be injurious and give rise to emaciation and debility from the accelerated disintegration of nitrogenous tissue. These remedies aid in the resolution of inflammatory exudations. Finally, an alkali acts as a chemical antidote in case of poisoning by an acid.

Alkaline remedies consist of: solution of potassa, carbonate and bicarbonate of potassium; solution of soda, carbonate and bicarbonate of sodium; carbonate of lithium; calcined magnesium and carbonate of magnesium; lime-water, precipitated carbonate of calcium and prepared chalk. The combinations of potassium, sodium, and lithium with the vegetable acids do not act as alkalies in the stomach, but, being converted into carbonates in the blood, they alkalinize the urine as they escape from the system.

Acids.—When given after meals, these supply the acid medium in which pepsin is efficient. They, therefore, improve the appetite and digestion, and are useful in digestive disorders. They promote secretion, allay thirst and nausea. Administered before a meal, they check hyperacidity of the stomach. The mineral acids possess astringent properties, and are of service in lessening hæmorrhages, morbid secretions, and discharges. They are, likewise, antiseptic, disinfect the alimentary canal, and restrain deleterious fermentation of its contents. In a concentrated form they act as escharotics.

The properties of vegetable acids are similar to, but generally feebler, than those of the mineral acids. They are, however, with the exception of tannic acid, devoid of astringency. On the other hand, they exert a more decided influence upon the eliminative organs, and stimulate the secretions of the skin, kidneys, and bowels. In saturated solution, the vegetable acids are irritant, or even caustic. They have antiseptic virtues and assist digestion.

Both mineral and vegetable acids are beneficial in certain morbid states of the blood, as purpura or scurvy, and in fevers. The principal acids used in medicine are: acetic acid, benzoic acid, citric acid, lactic acid, tartaric acid, hydrochloric acid, nitrohydrochloric acid, nitric acid, phosphoric acid, and sulphuric acid.

Astringents coagulate albumin and excite contraction of unstriped muscular tissue. In strong solution, most of these substances exert a caustic action. They are useful in overcoming a relaxed or debilitated condition of muscular fibre, and, by contracting arterioles and capillaries and the gland-ducts, they repress secretion. They likewise restrain peristalsis. Astringents are of avail in the treatment of hæmorrhage and hypersecretion.

Agents of this class are derived both from the inorganic and organic kingdoms. The action of the vegetable astringents chiefly depends upon the presence of tannic acid or some of its modifications or allied forms. The principal members of this group of remedies are tannic and gallic acids, kino, catechu, krameria, geranium, and hamamelis. The mineral astringents comprise the salts of bismuth, zinc, alum, copper, lead, and silver. The salts of iron with mineral acids also exert a similar effect.

Refrigerant remedies are those which allay thirst produced by fever. The local action of water, or pieces of ice allowed to melt upon the tongue, affords temporary relief. Glycerin, topically applied, is of service in moistening the tongue. The vegetable and mineral acids, in weak solution, excite the secretion of saliva.

Antipyretics reduce abnormal temperature, either by limiting the generation of heat or by favoring its loss through radiation, conduction, and the work of evaporating the perspiration. Agents which diminish oxidation, depress the circulation, or which, presumably, exert a specific corroborant influence upon the heat-centre, lower temperature by lessening heat production. Those which dilate the cutaneous vascular system favor the loss of heat. Immersion in water below the temperature of the body is a highly valuable method of decreasing fever-heat.

Drugs which limit the production of heat by diminishing tissue change are: alcohol, antipyrin, benzoic acid, camphor, carbolic acid, cinchonine, eucalyptol, phenacetine, quinine, resorcin, salicylic acid and its combinations, thymol. Those which lower temperature by acting on the circulation are: aconite, antimony, digitalis, gelsemium, thallin. Drugs which increase radiation are: acetanilid, alcohol, antipyrin, nitrous ether, thallin. Those which dissipate heat in evaporating the perspiration are: antimony, nitrous ether, opium and ipecacuanha, pilocarpus.

Alteratives.—This term has been bestowed upon a class of remedies which possess the power of modifying deranged nutritive processes. Given persistently, in small doses, alteratives improve the quality of the blood and often increase the number of its red corpuscles. Appetite, digestion, secretion, absorption, and elimination are promoted. The circulation and respiration are invigorated, the nutrition and functional activity of the nervous centres improved.

Alteratives counteract the effects of various forms of toxæmia, as that of chronic malaria, syphilis, scrofula, tuberculosis, carcinoma, and of slow mineral poisoning. They promote the absorption of inflammatory exudations.

The principal agents of this class are: Chloride of gold and sodium, preparations of arsenic, preparations of mercury, preparations of iodine, iodoform, iodol, chlorate of potassium, antimony, mezereum, sulphur, sulphides, colchicum, guaiacum, sanguinaria, xanthoxylum, calcium chloride, stillingia, sarsaparilla, codliver-oil, and phosphorus.

Exhilarants determine an active cerebral circulation and stimulate the functions of cerebral centres; but if administered for too long a time or in excessive quantities, a depressing effect is produced. The effect upon the higher is reflected to the lower centres, the heart strengthened, the respiration deepened, and muscular vigor promoted. Substances belonging to this class support the system under prolonged and unusual strain, and are often useful in the treatment of mental alienation. Among exhilarants may be ranked the preparations of belladonna, hyoscyamus and stramonium, erythroxylon coca, tea, coffee, ether, and alcohol.

Narcotics and Anodynes.—Narcotics cause sleep, anodynes allay pain. Sound sleep obliterates the perception of pain; the relief of pain permits sleep. A close relationship exists, therefore, between these varieties. A narcotic or hypnotic will often abolish pain, while an anodyne will frequently overcome wakefulness. In some substances, however, the narcotic, and in others the anodyne, influence is most conspicuous. When sleeplessness depends upon anxiety, mental excitement, or prolonged intellectual effort, the treatment differs from that to be adopted when insomnia is due to pain. Narcotics act chiefly by influencing the circulation through the brain, anodynes by their effect upon sensory centres.

The chief remedies belonging to this class are the following: opium, chloral hydrate, chloralamid; bromides of potassium, sodium, or ammonium; hypnal, paraldehyde, sulphonal, somnal, and urethan.

Anæsthetics.—Agents of this class abolish consciousness and sensation by inhibiting the functions of the higher cerebral centres. When their influence is continued, the sensory and motor centres of the spinal cord and of the medulla oblongata are in turn affected. The first result of their inhalation is a stage of intellectual, emotional, and motorial excitement. This is succeeded by a stage of narcosis. Anæsthetics destroy life by paralysis of the centres situated in the medulla oblongata. They are employed for the purpose of relaxing spasm and producing a condition of unconsciousness, during which surgical operations may be painlessly performed.

The chief members of this group are: ether, chloroform, bromide of ethyl, and nitrous oxide.

Spinal Stimulants.—Agents belonging to this class, when given in medicinal doses, exalt the functions of the cord, invigorate the action of the heart and lungs, promote secretion and nutrition.

These remedies are useful in atonic dyspepsia, atony of the bowel or bladder, cardiac weakness, emphysema, neuralgia, spinal neurasthenia, paralysis, and phthisis.

The principal members of this group are: nux vomica and its related species, ignatia and hoang-nan, alcohol and camphor in small doses.

Spinal Sedatives.—These are substances which have the property of reducing the functions of the spinal cord. They may act directly upon the nerve-cells, or produce their effect by an influence on the circulation through the cord. Excessive doses cause paralysis. Spinal sedatives are valuable in conditions of irritation or congestive excitement of the cord. The chief remedies belonging to the group are: bromide of potassium, bromide of sodium, lobelia, gelsemium, conium, hydrocyanic acid, potassium nitrate, and physostigmine salicylate.

Antispasmodics.—Antispasmodic drugs allay irregular action of the voluntary or involuntary muscles by a calmative influence upon nerve-centres. They are of use in many disorders characterized by nervous excitement and muscular spasm, such as hysteria, colic, asthma, and intestinal colic. The principal antispasmodic remedies are: ammoniac, valerian, asafœtida, camphor, musk, castor, and ether.

Tonics.—Tonics improve appetite, digestion, assimilation, and secretion, strengthen the circulatory apparatus, improve the composition of the blood, invigorate the muscular system, and promote the nutrition of nerve-centres and fibres. The most powerful members of this class possess antiperiodic virtues. Tonics are useful in the treatment of digestive disorders, in depressed conditions of the nervous system and nutrition in general, and in diseases characterized by periodicity. The former variety includes: gentian, calumba, chirata, serpentaria, and eucalyptus. The preparations of iron and manganese act as tonics when the quality of the blood is impaired. Certain mineral salts, as the oxide of zinc, the oxide of silver, and the sulphate of zinc, exert a similar influence in nervous affections, as chorea and epilepsy.

Vascular Stimulants.—Members of this class strengthen the action of the heart and blood-vessels. They are therefore advantageously employed in weakened conditions of the central organ of the circulation, in transudation due to blood-stasis, and in hæmorrhage. Chief among vascular stimulants are: alcohol, preparations of ammonium, caffeine, convallaria, digitalis, strophanthus, and scoparius.

Vascular Sedatives.—These remedies render the heart's action more slow and less forcible. They moderate cardiac excitement, and are of service in febrile and inflammatory affections of a sthenic type. Examples of this class are: aconite, veratrum viride, gelsemium, antimony, muscarine, pilocarpine, hydrocyanic acid.

Sialagogues.—Sialagogues excite the secretion of saliva, either by an irritant local effect, with a reflex stimulation of the salivary glands, or by a specific influence upon the glands during their elimination. Examples of the former variety are: capsicum, mustard, ginger, pellitory, and mezereon; of the latter: preparations of iodine and mercury, pilocarpus, muscarine, and physostigma.

Antisialics check salivary secretion. This is the action of belladonna, opium, and potassium chlorate.

Emetics.—Emetics cause vomiting, either by irritating the terminal filaments of the gastric nerves or by exciting the nervous centre, which presides over the act of emesis. Remedies which act by direct irritation are: alum, mustard, copper sulphate, zinc sulphate, and mercury subsulphate. General or systemic emetics are: apomorphine, ipecacuanha, and tartar emetic.

Anti-emetics allay irritability of the gastric nerves or the vomiting centre. Bismuth, cerium oxalate, creasote, carbolic acid, chloroform, ether, calomel, and silver nitrate soothe gastric irritation. Opium, hydrocyanic acid, bromides, and chloral hydrate quiet the excitement of the nerve-centre.

Purgatives produce evacuation of the contents of the intestinal canal by increasing secretion or transudation along the tract and by exciting peristaltic movements. According to the intensity of their action, purgatives or cathartics are subdivided into several varieties: 1. Laxatives cause slight increase of secretion and peristalsis, resulting in softened stools. Among laxatives are ranked manna, sulphur, figs, prunes, olive-oil, cascara sagrada, hyoscyamus, soap, etc. 2. Simple purgatives, or purgatives proper, are more decidedly stimulant, and occasion semi-liquid motions. Belonging to this group are: senna, aloes, rhubarb, castor-oil, and calomel. 3. Drastic cathartics are strongly irritant to the intestinal mucous membrane, and occasion transudation from its vessels and almost fluid stools. The action of drastics is accompanied by considerable griping pain. Examples of drastics are: jalap, colocynth, gamboge, scammony, elaterium, podophyllum, and croton-oil. Excessive doses of simple purgatives have a very similar effect. 4. Hydragogue purgatives remove abundant serum from the intestinal blood-vessels and produce large, watery motions. An analogous action is exerted by various salts of the alkalies and alkaline earths. Large doses of the drastic cathartics have the effect of hydragogues. The principal saline purgatives are the sodium sulphate, magnesium sulphate, magnesium citrate, potassium tartrate and bitartrate, tartrate of potassium and sodium. 5. Cholagogue purgatives stimulate, either directly or indirectly, the liver, cause an increased flow of bile, quicken the peristaltic movements, and produce greenish, liquid evacuations. Among the cholagogues are included mercury, aloes, euonymin, iridin, rhubarb, leptandra, and podophyllum.

Anthelmintics cause destruction or expulsion of intestinal worms. Those agents which destroy are termed vermicides; those which expel are known as vermifuge remedies. Tape-worms are killed or removed by means of aspidium, kamala, kousso, pomegranate or pelletierine, pumpkin-seed, turpentine, and chloroform. Remedies which act against round-worms are: santonin, spigelia, chenopodium, and azedarach. Seat-worms are destroyed by enemata of table salt, tannic acid, quassia, eucalyptol, etc.

Stomachics.—Stomachics stimulate the gastric mucous membrane, increase appetite, promote the secretion of gastric juice, and assist digestion. They restrain abnormal fermentation and dispel accumulation of flatus. Among stomachics are: capsicum, piper, cardamom, cloves, mustard, ginger, horse-radish, calumba, chirata, nux vomica, etc.

Hepatic Stimulants.—These are medicines which excite the liver to increased functional activity. They occasion an augmented formation of bile, and thus promote the normal elaboration of nitrogenous aliment. By many agents of this class the newly-formed bile is rapidly swept along the intestine by a cathartic action and its re-absorption prevented. The conversion of nitrogenous waste into its soluble end-product, urea, is thus favored by these remedies, some of which are known to cause increased elimination of urea. Others, again, stimulate the glycogenic function of the liver.

The principal substances which increase the production of bile are: nitro-hydrochloric acid, ipecacuanha, sodium phosphate, mercuric chloride, aloes, podophyllin, rhubarb, colocynth, euonymin, iridin, etc. The quantity of urea is increased by ammonium chloride, arsenic, antimony, phosphorus, and iron. The glycogenic function is stimulated by nitro-hydrochloric acid, amyl nitrite, and sodium bicarbonate.

Hepatic Depressants.—Agents belonging to this class reduce functional activity of the liver, diminishing the formation of bile, urea, and glycogen. Those which lessen the secretion of bile are: opium, acetate of lead, alcohol, and quinine. The amount of urea is decreased by opium, alcohol, quinine, and colchicum. Glycogen is diminished by opium, phosphorus, arsenic, and antimony.

Expectorants.—Expectorant remedies modify the character of the bronchial secretions and facilitate their expulsion. Small or nauseating doses of emetic substances increase and liquefy the secretions of the mucous membrane. Larger doses, by causing vomiting, mechanically aid the expulsion of mucus from the air-passages. The term "stimulating expectorants" is given to a group of drugs eliminated by the bronchial mucous membrane which they stimulate, and the secretion of which they at the same time alter and improve. Certain substances, when dissolved in the mouth, aid expectoration by a stimulating influence upon the cilia of the trachea and bronchi. These are called ciliary excitants. The nauseating expectorants are: antimony, ipecacuanha, apomorphine, lobelia, pilocarpus, etc. Among the stimulating expectorants are: ammonium chloride, balsams of Peru and Tolu, senega, squill, sulphur, and turpentine. Ciliary excitants are: ammonium chloride, potassium and sodium chlorate, gum acacia, etc.

Pulmonary sedatives relieve cough by allaying irritability of the respiratory centre or the terminal fibres of the nerves distributed to the bronchi and lungs. Examples of this class are: opium, belladonna, stramonium, hyoscyamus, hydrocyanic acid, etc.

Diaphoretics increase perspiration by stimulating the sudoriparous glands in the course of their removal, as sulphur, guaiacum, sarsaparilla, serpentaria, mezereon, and camphor. Other agents produce the same effect by causing relaxation of the cutaneous capillaries. In this subdivision are found the nauseants and emetics, as tartar emetic, ipecacuanha, lobelia, and Dover's powder, as well as opium, ether, and alcohol. A third group of remedies excites diaphoresis by an influence upon the sweat-centres, as pilocarpus, veratrum viride, and salts of potassium.

Diuretics.—The quantity of urine excreted is increased by remedies which raise general or local arterial tension, and by those which stimulate the secreting cells of the kidney. The free ingestion of water assists the action of diuretic drugs, and is mechanically serviceable by irrigating the renal tubules. Among the stimulant diuretics are found cantharides, copaiba, cubeb, turpentine, colchicum, squill, broom, juniper, potassium nitrate, and calomel. The principal agents which act by elevating blood-pressure are: digitalis, belladonna, nux vomica, and alcohol.

Lithontriptics.—This name has been given to a class of remedies which increase the flow of urine, and at the same time, by modifying its chemical reaction, dissolve and prevent the deposition in the urinary passages of uric, phosphoric, or oxalic acid, or insoluble salts of those acids. If precipitation has taken place, they are given with a view to dissolve or remove gravel or calculi. The carbonate, bicarbonate, and citrate of potassium, the carbonate and citrate of lithium, are the principal solvents for uric acid. The agents which are given for the purpose of acting upon phosphoric calculi are: benzoic acid, benzoate of ammonia, and dilute nitric acid.

Ecbolics.—These remedies, also known as oxytocics, stimulate the pregnant womb to contraction. They may thus lead to abortion, if prematurely given, but, administered during labor, are often of valuable assistance by invigorating the organ. It is surmised that ecbolics may act either by causing direct irritation of the muscular structure of the womb, or exciting contraction through an influence upon the uterine centre in the cord. The principal ecbolics are: ergot, cotton-root bark, ustilago, savin, rue, and cimicifuga.

Emmenagogues.—Emmenagogues excite the menstrual flux either by a direct stimulant effect upon the uterus, or indirectly by improving the quality of the blood and nutrition in general. Small doses of **ecbolic** remedies are usually emmenagogue. Direct emmenagogues are: ergot, savin, cantharis, rue, myrrh, etc. Indirect emmenagogues are: preparations of iron and manganese, nux vomica, codliver-oil, etc.

Aphrodisiacs excite the genital functions. This object they accomplish by stimulation, either direct or reflex, of the centres which govern the genital organs. Whatever promotes nutrition tends indirectly to invigorate the sexual apparatus. The chief aphrodisiac agents are: cantharis, phosphorus, small doses of opium, alcohol, camphor, and damiana.

Anaphrodisiacs diminish sexual desire and power. They allay excitability of the genital centres and diminish irritation or hyperæmia of the generative organs. Among anaphrodisiacs are included bromides of potassium, sodium and ammonium, iodide of potassium, large doses of camphor or opium, tobacco, gelsemium, etc. Whatever depresses general systemic vigor has likewise an indirect anaphrodisiac effect.

Mydriatics produce dilatation of the pupil by stimulation of the end-organs of the sympathetic, with contraction of the radiating fibres of the iris as a result, and by paralysis of the third nerve, causing relaxation of the circular fibres. The principal mydriatics are: atropine, homatropine, daturine, duboisine, and hyoscyamine.

Myotics cause the pupil to contract by stimulating the circular fibres of the iris. Eserine, or physostigmine, acts when locally applied, and is used by ophthalmologists for this purpose. Other drugs which contract the pupil, though not administered for that purpose, are opium, pilocarpus, and muscarine.

Irritants are applied to the skin in order to produce nervous and vascular reaction. According to the degree of their action, they are classed as **rubefacients,** or those which simply redden the surface; **epispastics** or **vesicants** are those which occasion blisters; and **pustulants,** which excite sufficient inflammation to form pus. The rubefacients, most in use are mustard, capsicum, arnica, turpentine, chloroform, ether, and iodine. Among vesicants are ranked cantharides, euphorbium, mezereon, and iodine. The principal pustulants are tartar emetic, croton-oil, and nitrate of silver. The prolonged application of a rubefacient often gives rise to a blister.

Escharotics or **caustics** destroy tissue and lead to the formation of a slough. The principal escharotics are: carbolic acid, glacial acetic acid, chromic acid, strong mineral acids, caustic potash, and caustic soda.

Local sedatives diminish nervous and vascular excitement in the part to which they are applied. They consequently relieve local inflammation and pain. Among agents of this group are bismuth, acetate of lead, aconite, cocaine, opium, belladonna, etc.

Demulcents are bland substances used to protect mechanically the gastro-intestinal tube from contact with irritant poisons, to allay inflammation of the same canal, of the respiratory or genito-urinary passages. Many of them possess some nutritive value. This class embraces acacia, flaxseed, elm, marsh-mallow, Iceland and Irish moss, starch, gelatin, olive-oil, etc.

Emollients are applied to the external surface. They resemble demulcents in being of a bland, soothing character, protect the surface from friction and from air, relieve tension and diminish pain. Among emollient substances are: lard, olive-oil, spermaceti, glycerin, starch, cacao-butter, etc.

Local Astringents and Styptics.—The astringents and acids, which are useful in checking hæmorrhages and morbid discharges when administered internally, have the same effect when locally applied.

Antiparasitics, Disinfectants, Antiseptics.—The term **antiparasitic,** or **parasiticide,** is generally restricted to agents which have the power of destroying the animal and vegetable parasites which may infest the exterior of the body. **Antiseptics** act upon pathogenetic micro-organisms, prevent their growth and multiplication, and neutralize or destroy the toxic products of these micro-organisms. **Antiparasitics** are germicidal. **Antiseptics,** though not necessarily germicidal, protect the system against infection. The principal antiparasitic remedies are: sulphur, iodine, mercury, carbolic acid, and boric acid. The most valuable antiseptics are: mercuric chloride, carbolic acid, creasote, salicylic acid, chlorine, naphthol, aristol, quinine, thymol, sulphurous acid, iodol, iodoform, resorcin, etc. **Disinfectants** are used for the purpose of destroying the organic germs of disease, as they may exist in the atmosphere, clothing, water, pathological discharges, etc. Substances which accomplish this purpose are: sulphurous-acid gas, chlorine, bromine, zinc chloride, mercuric chloride, etc. Heat is also disinfectant.

Dosage.—By the dosage of a remedy is meant the amount or quantity of the agent required to produce a definite therapeutic result. Naturally a considerable margin exists, owing to different degrees of vigor in patients, and to the amount of impression we desire to make upon the bodily functions. It is evident, then, that, even among patients of the same age, some will require larger doses than others in order to produce a particular effect. Thus arises the distinction between the **minimum** and **maximum** doses, the former being the smallest dose capable of physiological or therapeutical effect, the latter being the largest dose which it is considered safe to give. The **toxic** dose is larger than the maximum dose, and, when administered, rapidly develops the physiological action of the drug in a high degree, giving rise to what are known collectively as symptoms of poisonous action of the remedy. **Broken** or **fractional** doses are merely doses much smaller than those usually given, and intended to develop the physiological effects by degrees, being the reverse of toxic doses in the sense that they singly produce no marked disturbance, and are within perfectly safe limits. In the following pages reference may be found to a **full** or **single dose,** the **interrupted dose,** and the **continued dose.** The **full dose** is the maximum amount which the patient will require to produce the physiological action of the remedy, and it is usually not intended to be repeated. For instance, an ounce of sulphate of magnesium, or several cathartic pills, may be ordered to accomplish a certain therapeutic result, and, this being obtained, there is no need to give any more. Where the symptoms frequently recur, as where purgative remedies are required in chronic constipation, or nitrite of amyl for angina pectoris, it becomes necessary to repeat the administration of the remedy from time to time, the system having opportunity to recover fully from the effects of one dose before another is administered. We have then what is called the **interrupted dose,** which is generally smaller than the full dose, although exceptionally it occurs that by the frequent repetition of a remedy the system becomes accustomed to it, and larger doses are required to produce the same effect, or it progressively fails in therapeutic value. The **continued dose** is where each succeeding dose is given before the effects of the preceding has passed away, so that when the intervals are short a **cumulative action** of the remedy is seen. The latter obviously depends upon the rapidity of rate of elimination of the agent; some drugs, like alcohol or ether, are excreted very quickly, and exert a cumulative action only when the intervals are very short; others, like digitalis and the mineral poisons, are excreted slowly, and may show a cumulative effect after awhile, even when only one or two doses are given daily.

Systemic, Specific, and Analeptic Remedies.—A **systemic** remedy is one which is not designed to affect the organs by which it enters the circulation, nor those by which it is finally excreted; it is given with a view of bringing about some change in the general solids or fluids of the body, so as to affect nutrition, and, as a rule, does this through some effect upon the nervous system. Remedies designed to affect special organs, such as the liver, kidneys, heart, genito-urinary tract, or alimentary canal, are local or organic remedies. Remedies are also divided into inorganic and organic, in relation to their nature and origin, as they belong to the mineral kingdom or to the animal or vegetable kingdom. A **specific** remedy is one having the power to stop the course of a particular disease and act as an antidote to its effects. There are no "sure cures" in medicine, and no true specifics. Still, the manifestations of malaria are so uniformly controlled by cinchona, syphilis by mercury, rheumatism by salicylic acid, and gout by colchicum, that these remedies are considered as approaching the character of specifics, although they sometimes fail, and often must be combined with other remedies in order to produce the best results. **Analeptic** remedies are those which build up the system; they are tonics and restoratives; they stimulate the nutritive functions, and some of them, such as codliver-oil, act as food. A remedy is said technically to be indicated when the symptoms show that the function of some part of the body is disordered; and our knowledge of the physiological action and clinical effects of the remedy indicates to us the probability that its administration would produce a favorable result; thus, an emetic would be indicated in narcotic poisoning or in croup, a purgative would be indicated in fæcal impaction of the bowels or in cerebral congestion; the sponge-bath and antipyretics are indicated in fever. It is not meant that there is any mysterious relation existing between certain diseases and particular remedies in the sense that nature is crying out for a certain drug, and that no other would be serviceable, or that the patient would necessarily die if the medical attendant failed to discern the indication or to decipher the cabalistic inscription by which nature tests his skill. Diseases arise from causes; the object of treatment is (1) to remove the cause of disorder, if possible, and if not (2) to obviate its effects by removal of the patient to more sanitary surroundings, or place him in improved physiological condition, and better able to resist the onward course of the disease; and (3) to make the patient comfortable and do what is possible to hasten recovery. This is rational medicine; it is also scientific medicine because based upon exact knowledge of the effects of drugs and other remedial agents. From various sources an immense fund of information has been collected and reduced to laws or rules, the application of which, to individual cases of disease, constitutes the art of medicine, or practical therapeutics.

PART II.

Non-pharmacal Remedies and Expedients Employed in Medicine Not Classed with Drugs.

This portion of the work will be devoted to the discussion of certain agents and expedients employed in clinical therapeutics, which cannot be properly classed with drugs. Each will be considered under its own heading, with the following titles: Electrotherapy; Kinesitherapy, Massage and Rest-Cure; Pneumotherapy; Hydrotherapy and Balneology; Climatotherapy; Psychotherapy, Metallotherapy and Suggestion, or Hypnotism; Diet in Disease; Mineral Springs; Effects of Heat and Cold, Light and Darkness, Music, etc., concluding with a brief review of various methods and expedients, chiefly mechanical and local in their effects. Although the latter find a limited place in practical medicine, they are, as the rule, surgical expedients, and are, therefore, in this place, less fully considered than they would be in a treatise specially devoted to that department.

ELECTRICITY IN MEDICINE—ELECTRO-THERAPEUTICS.

Present Standing and Importance of Electro-Therapeutics.—The scientific application of electricity to the human body for the treatment of disease has recently been greatly stimulated by its remarkable commercial development. Electrical science being essentially of modern origin, new principles and new economic applications being announced almost daily, it becomes absolutely necessary for a discussion of the employment of electricity in medicine to be introduced by a few words upon the present state of our knowledge of this department of physical science. A very brief consideration of the laws of electricity, with explanation of its terms and its technique, therefore, will precede a review of its therapeutic applications. It is unfortunate and embarrassing, to the medical student particularly, to find confronting him, at the very threshold of this subject, a mass of literature which has come down from a period when purely empirical methods prevailed and the nature of this force and its effects, both physiological and therapeutical, were very imperfectly understood. Not infrequently, even at the present day, medical writers betray a want of knowledge of its fundamental principles. There is less excuse for this now than ever before, because the ingenuity of electricians and expert instrument-manufacturers has been attracted in this direction and has brought to our aid apparatus of precision, both for therapeutics and for diagnosis, with which it is the duty of every physician to acquaint himself. Even if he does not propose to apply it to a great extent in his practice, he should do this much, at least, for his own protection, since he must at times rely upon some form of apparatus; and some of the electrical instruments which are offered for sale are of poor construction, entirely unfit for efficient medical use. Moreover, many bring discredit upon medical electricity by claiming to be specialists who are mere tyros, if not open charlatans, ignorant of the first principles of medical or of physical science. It is a comparatively easy matter for the well-trained physician to recognize and expose such pretenders, especially should they venture to boast of their results in public or before medical societies.

The Foundation of Success in Electro-Therapeutics.—The study of electro-therapeutics requires not only that we shall be versed in the laws and terms of electrical science, but also that we shall have good anatomical and physiological knowledge. It is, moreover, very evident that we must be familiar with pathology in its most comprehensive sense, in order to form a correct judgment, or prognosis, as regards the probable utility of electrical or any other treatment in a given condition, so that this valuable agent may not be brought into disrepute by being used in unsuitable cases. As it is important that such knowledge shall be acquired systematically, all reputable medical schools should teach thoroughly the principles of electricity and the construction of medical electrical apparatus and batteries, this course of study being made practical and attractive by abundant didactic and clinical instruction in this important branch of therapeutics. Since the best results can be obtained in this direction only by a due recognition of the importance of this branch in the curriculum, it is hoped that there soon will be established a chair of electro-therapeutics in every university and medical college in the country.

Definition of Electricity.—The laws underlying electrical manifestations have been discovered and formulated; but electricity itself is an unknown force, just like heat or light. We may define electrification as **a condition of matter when acted upon by a peculiar force known as electro-motive force.** This "electro-motive force" is a form of energy which is convertible into and is, therefore, said to be correlated with the other physical forces, in accordance with the well-known law of conservation of force demonstrated by Helmholtz. That is to say that, whereas light, heat, motion, chemical action (electrolysis), and magnetism result from electricity, so, by the law of the correlation of forces, light, heat, motion, chemical action, and magnetism may be transformed back again and be manifested as electricity.

Principle Underlying Electrical Manifestations.—It is upon this principle that all forms of apparatus for economical and medical applications of electricity are constructed. Atmospheric electricity, which Benjamin Franklin proved to be identical with friction-electricity, certainly exerts an important influence upon health; and instances have been recorded where an electrical shock (lightning-stroke) has been followed by important physiological changes (*i.e.*, relief from paralysis, etc.); but no attempt at systematic therapeutic application has, as yet, been made with electricity from this source directly. The usual sources are chemical action, heat, magnetism, and motion (friction).

The Electrical Current; its Physical Characters and Properties.—Although electricity is simply a condition of matter, or a "mode of motion,"—a "peculiar vibration or tension of the molecules of a body said to be electrified,"—it is convenient to speak of it as if substantial and, in fact, as matter in a fluid state. In some respects it appears to be analogous to water when the latter is acted upon by the force of gravity and atmospheric pressure; and authors have fallen into the habit, for convenience of description, of speaking of it as "the electric fluid," "the electric current"; also of the direction in which the current "flows"; its "pressure"; the "resistance" it encounters from poor "conductors"; the "waste of the current"; a "continuous" or "interrupted" current, and so on, the simile being heightened by comparing the dynamo, or source of the current, with a steam force-pump. It must be constantly kept in mind, however, that this is figurative language, adopted simply for convenience. It should not be inferred, for instance, when the human body is in circuit, that anything material flows through the body; the correct view is that the parts between the poles are more or less affected by a peculiar form of molecular activity which takes place in the tissues, and during this period the parts are in a characteristic condition, which will be referred to later on. This change may be simply physiological, and not inconsistent with restoration to a healthy condition; or it may be pathological, and produce permanent lesions. If the current be sufficiently powerful, decomposition will be produced (electrolysis), or the parts adjacent to the poles may be carbonized or blistered by the development of heat produced by resistance to the current (galvanic cauterization, or electrocausis). It is within the limits of physiological action, where no immediate and demonstrable change is ordinarily produced, that electro-therapeutics enjoys its widest field of medical application. Thus, in the treatment of neuralgia, muscular or nerve paralysis, the induction of artificial respiration, counter-irritation, etc., electricity finds constant employment in clinical medicine. Currents of greater strength are used in the electrolysis of morbid growths, removal of hypertrophied scars, destruction of hair, electrolysis of stricture of the urethra, etc. Under the method of Apostoli, currents of great strength are used in reducing uterine fibroids, checking hæmorrhage, etc. The destructive effects of the galvano cautery are used in removing hypertrophies from the nose and for similar small operations, for which it is especially adapted.

Correlation of Electrical and Other Forms of Force.—Electricity cannot be said to have a separate existence of its own, electrification being simply a state or condition of matter depending upon the exercise of a force which produces certain physical, chemical, and physiological effects. The laws governing electrical action have been formulated, so that it may now be applied to medical and other economic purposes with precision and absolute control. Progress in every department of science depends upon the accuracy of measurement, which affords an opportunity for exact comparison and record. Electricity is no exception to this, although, owing to its nature, it presents peculiar difficulties not met with in other departments.

Electrical force is exceedingly rapid, and is easily converted into other forms of energy; so that it almost defies ordinary methods of measuring, such as are used in estimating velocity, weight, or heat. With the best conductors, its passage between distant points is nearly instantaneous.

Electrification and Electro-Magnetism.—As already stated above, electrification is the property or peculiar state which matter may assume under special conditions. Certain bodies, while in this state, exhibit peculiar and characteristic phenomena. For instance, when two dissimilar metals capable of being electrified are partly immersed in a liquid capable of permitting the passage of the current and of acting chemically upon one of them (*i.e.*, an electrolyte), if the free portions (or part outside the fluid) of the two metals are brought in contact or connected by a metallic conductor, such as a piece of copper wire, certain results may be observed to occur. One metal is slowly acted upon by the fluid; the other is not; but bubbles of hydrogen appear upon its surface. Under such circumstances the junction of the two metals will be found to possess electrical properties. Usually, for convenience, the metals are joined by a conjunctive wire, which must also be capable of becoming electrified and of acting as a conductor (or rheophore). When in this condition, in relation to the two metals just mentioned, the wire will attract iron filings; or, if brought over a compass parallel with the needle, or a bar magnet suspended by its centre, it will cause deflection of the magnetic needle, which, if the current be strong enough, tends to assume a position at right angles to the wire, deviating more or less from the magnetic pole and the so-called cardinal points of the compass. If a coil of wire be suspended so as to be free to move in all directions, it will, under the influence of an electrical current passing through from one end of the wire to the other, assume a north and south polar position, in the line of the magnetic meridian of the earth. Such a coil, while electrified, therefore, has assumed the properties of a magnet; it also attracts small pieces of iron, and may be used to convert a mass of steel or hard iron into a permanent magnet. If into the centre of a long coil, or spool, of insulated wire some **soft** iron (which does not become permanently magnetized) be inserted, we have a temporary **electro-magnet** formed, which only exhibits the properties of a magnet when the current is passing in the coil. This principle is of great utility, and appears in the interrupting mechanism of Faradic batteries, telegraph-sounders, telephone-receivers, electric-light generators (dynamos), and numerous other forms of apparatus.

Intimate Relationship of Electricity and Magnetism.—There are many points of similarity between electricity and magnetism, and the most plausible explanation of the latter is that the magnet is in a molecular state, which gives rise to permanent electrical currents connecting the poles. In the same way the conjunctive wire, during the passage of the electrical current, is in a condition in which it influences the magnetic condition of other objects near it, just as if it were surrounded by **lines of force** in a series of concentric rings. This may be illustrated, if not demonstrated, by placing some iron filings upon a plate of glass or a card and applying a strong magnet beneath, or by running a wire carrying a current perpendicularly through its centre. The iron filings will, under the influence of electricity, arrange themselves in concentric circles, exhibiting the directions of the lines of force, just as they do around the poles of the magnet.

Lines of Force.—These lines of force, in the case of the magnet, flow in the air from the north to the south pole and back again through the iron, thus making a permanent closed circuit. In the case of the wire the concentric lines or whirls of force encircle the electrified conjunctive wire, so that when consecutive loops are arranged in the form of a helix or coil the lines of force become parallel with the long axis, and the coil now exhibits magnetic properties. The space in which these phenomena are noted is considered the magnetic field, or area of induction. By reversing the experiment and passing a permanent magnet into a coil of wire a current of electricity is temporarily set up, which is manifested at the extremities of the wire. This is the principle upon which magneto-electric machines are made or electric-light dynamos constructed. Coils or spools containing insulated bundles of soft-iron wire may be placed upon a frame and made to revolve rapidly within the magnetic field around the poles of a large magnet. When this is done electrical currents are set up, which are momentary; but, when a high speed is attained, they become practically continuous. By an ingenious arrangement in wrapping the wires, the currents set up on entering the field and upon leaving it, which are in different directions, are "commutated," or switched, so that they are made to re-inforce each other, and thus make a single current of definite direction and practically continuous.

Properties and Effects of the Current.—The effects of electricity are (1) physical, or chemical, (2) physiological, (3) therapeutical. The methods of generating electricity are (1) physical (friction-electricity, thermo-electricity, dynamo-electricity, etc.), (2) chemical (galvanism), and (3) physiological (as shown by certain fishes,—torpedo,—and the human body to a less marked degree). Electricity is the same force under all circumstances; but each form of current possesses certain qualities, which depend upon the method of its generation. The principal qualities of an electric current are constancy, pressure, and volume. Assuming that a current under consideration is constant, or practically so, we have only to keep in mind the two latter,—pressure and volume,—and when these are well understood the difficulties of comprehension of electrical phenomena, about which so much has been written, almost entirely disappear. Returning to the analogy already named, of a pump forcing water through a pipe, we may regard every device for originating a current of electricity as a pump of more or less power. To complete the analogy, the discharge-pipe should be long enough to go around the circuit and terminate in the suction-pipe, so that the pump being set in motion and the apparatus filled with water, the current of water will be continuous. The force which starts the water is heat converted into motion; that which starts electricity is electro-motive force acting under a certain amount of tension or pressure, which will be shown hereafter to be due to difference of potential. If the power is withdrawn the circulation will cease, because of the obstruction (friction, inertia) which the water has to overcome. In hydraulics the force required to perform the work, with the resistance, is the subject of calculation, and the size and character of the engine are regulated according to the work to be done. In electricity the amount of electro-motive force or power of the apparatus is measured by **volts** instead of foot-pounds, and the resistance or friction is calculated according to a standard unit of resistance, known as the **ohm.** Just as, in the case of water, with a certain amount of pressure against a given amount of resistance, a definite number of gallons per minute will flow along the conductor, so, in electrical terms, we have a definite volume or strength of current, resulting from a certain amount of voltage against a given number of ohms of resistance. It is easily seen that a powerful pump would be at a great disadvantage in trying to force water through a half-inch pipe, and this difficulty is increased should the pipe be long. In order to get satisfactory results the pipe must be sufficiently large to carry off the water with facility and not offer too much resistance by friction. Therefore large pipes are better conductors than small, and short better than long ones. This is also true in electricity, and the rule is that **the conducting power** (other things being equal) **of a conductor is directly in proportion to the area of the cross-section, and inversely to the length.**

Electro-Motive Force—Difference of Potential.—To return, now, to the first illustration of two dissimilar metals in the electrolyte, we find that the current starts simultaneously with the joining of the metals (either directly or by means of a conjunctive wire), which "closes the circuit" and makes a current possible. The force which starts the current is called the electro-motive force; it is always the same for the identical combination of metals, and is independent of the size of the plates. The hypothesis with regard to the origin of the electro-motive force is, that it is due to a difference of potential of the two plates, the current flowing from the higher potential to the lower, just as water will flow from the higher level to a lower in case two reservoirs are connected. The higher is known as the positive (+) and the lower potential is called the negative (—), and identical metals always have the same relation to each other, which only awaits favorable circumstances to manifest itself.

Electrical Measurement: Volts, Ohms, and Ampères.—The unit of measurement of electro-motive force, as already stated, is the **volt,** which is a little less than the electro-motive force of the zinc and copper combination in the Daniell cell (which is $1\frac{79}{1000}$ volts). The unit of measurement of resistance is called an **ohm**; it is represented by the resistance offered by a column of pure mercury, 106 centimetres long and 1 square millimetre in area of cross-section, at a temperature of 32° F. This is called the legal ohm, because it was adopted by the International Electrical Congress, which met in Paris in 1884; it is a little less than the British Association unit, which previously had been the standard,—in the proportion of 1 to 1.0122. The resistance referred to is mainly that encountered by the lines of force in passing through the surrounding media; the tissues composing the human body, for instance, offer considerable resistance to the passage of the current, depending, of course, upon how far the current is required to pass through the tissues, upon the size of the electrodes, and other circumstances.

The volt, or unit of electro-motive force, is sufficient to overcome a total resistance equivalent to one ohm and supply a volume of current equal to one ampère. The **ampère,** therefore, is the amount of current produced when one volt of pressure is opposed by one ohm of resistance; it is the unit of measurement of current strength. It is directly proportional to and may be measured by the amount of chemical decomposition (electrolysis) produced by the current in a unit of time. Thus, the current that will deposit 0.00111815 gramme (or 0 017253 grain) of silver upon a silver plate immersed in a standard solution of silver nitrate in a second of time has the strength of 1 ampère. This amount of electricity being more than is ever required for medical purposes, the unit is divided, for convenience, into thousandths, or milliampères. Any number of ampères can be sent through a conductor, provided the generator has sufficient electro-motive force and the conductor itself can carry the current; if the resistance is too great the wire will be destroyed by being fused or carbonized. In other words, where the resistance becomes disproportional the electricity, according to the law of correlation of forces, is liable to become converted into heat and light.

Ohm's Law.—The number of ampères of current flowing through a conjunctive wire within a given time depends upon both the electro-motive force or pressure and the resistance. This is expressed mathematically as follows:—

$$\text{Intensity of current strength} = \frac{\text{Pressure, or electro-motive force (volts),}}{\text{Resistance, external and internal (ohms),}}$$

or $C\ S = \frac{E}{R}$. In other words, the strength of any current is **directly** as the voltage and **inversely** as the total resistance. The above is known as Ohm's law, which has constant practical applications, as will be demonstrated in the pages that follow.

Passage of the Current—Rheophores, Electrodes, Anode and Cathode Poles.—To confine ourselves for the present to the **galvanic cell,** we observe that the electrical impulse starts from the surface of the plate, which is chemically acted upon (generating or positive plate), and is conducted through the electrolyte to the negative or collecting plate, from whence it passes along the conjunctive wire in the opposite direction until the place of origin is reached. Should the conjunctive wire be divided in its course, the end connected with the collecting plate will be the **anode** or positive; the other extremity is the **cathode** or negative pole,—these names having reference to the course of the current, which is always from the anode to the cathode, or from the positive to the negative pole. In the closed circuit, therefore, the circuit is completed by the conjunctive wire above and by the intervening column of liquid below. As metals are usually better electrical conductors than liquids, it follows that the current encounters, under ordinary circumstances, the greater resistance inside of the cell (internal resistance), since the resistance offered by the conjunctive wire, which is a metallic connection usually (external resistance), is comparatively small.

Practical Work of a Battery—Electrolysis.—It may be laid down, as a rule, for any given battery that its efficiency will be at the maximum when the electro-motive force is sufficient for the work desired to be done and the external and internal resistances are balanced or equal. The external resistance arises partly from the nature of work to be done and partly from the resistance offered by the conductor, being increased according to its length and diminished according to its thickness. This also applies to the column of fluid between the plates. Therefore, we reduce the internal resistance if we bring the plates close together, and also increase their size so as to expose a larger surface in contact with the liquid, which, in effect, increases the thickness (cross-section) of the intervening column. The electro-motive force or pressure is increased by multiplying the number of cells until we obtain the required voltage for the work to be performed or resistance to be overcome. The **work** is a part of the external resistance, and both it and the required current strength are now matters of mathematical calculation and measurement. Where the work does not require much current strength, as in heating the cautery, or electrolysis, the external resistance, therefore, not being very great, the battery may be balanced by increasing the size of the plates, using only a comparatively small number of cells. Where, on the contrary, the work requires great current strength, as where the human tissues are made part of the circuit, the plates should be of convenient, moderate size, but the electro-motive force must be increased by additional elements (more voltage), so that for ordinary medical work from 40 to 80 cells would be needed. It is evident, therefore, that the battery must be adapted to the work required of it; a galvano-cautery battery will not do for general medical purposes, nor can the ordinary small-celled medical battery be economically used for the cautery. The reason for this is obvious from the preceding explanation; any further attempt at a mathematical demonstration would only cause confusion. The larger cells cause more rapid decomposition of an electrolyte (or deposit a greater quantity of silver from the solution in the voltameter in a unit of time), or afford greater ampèrage of current with a good conductor than where small cells are used, because the larger cells have less internal resistance; and this is found to correspond with the results of experience.

In order to ascertain the number of ampères of current flowing through a circuit, divide the number of volts of electro-motive force by the number of ohms of resistance in the entire circuit. Thus, we have by Ohm's law:—

$$C \text{ (current strength in ampères)} = \frac{E \text{ (electro-motive force, in volts)}}{R \text{ (total resistance, in ohms)}}$$

The electro-motive force of each cell, when acting and in good order, is fixed and is invariable for the same combination, without regard to the size of the elements. The entire electro-motive force (voltage) is the sum of that of the entire number of cells. The resistance, however, is variable, and depends upon many factors. As already stated, the work to be done is to be counted as part of the external resistance. To this must be added the resistance of the conjunctive wire and electrodes; also that within the cell, or the internal resistance. Thus, where there are a number of cells connected in series, the amount of the resistance of each cell must be multiplied by the total number of cells in order to obtain the total internal resistance.

It is impossible, without a thorough comprehension of Ohm's law, which lies at the foundation of electrical phenomena, to have any correct idea of the medical application of electricity. Once understood, everything becomes comparatively clear, and all forms of batteries or generators become simple and intelligible. If we have any two of the factors out of the three—$\left(C = \frac{E}{R}\right)$—we can ascertain the third one by a simple calculation. Having the electro-motive force (volts) and resistance (ohms), both external and internal, we can calculate the current strength (in ampères). Having the current strength and the voltage, we can determine the total loss, or resistance; or, having the latter and the current strength, we can ascertain the voltage, or electro-motive force. We also have a means of directly ascertaining the current strength at any time by an instrument called a milliampèremeter, or the voltage by a voltameter.

Electrical Dosage and Measurement.—This is not the place to go into the details of apparatus, but we may anticipate a little, in order to explain how the current strength can be measured absolutely by the ampèremeter, milliampèremeter, or milliammeter. The resistance of a galvanic cell, or the total resistanee of a battery, may be determined by adding to the external resistance (by means of apparatus constructed for the purpose, containing graded **resistance coils**) until the current is reduced to one-half of its former strength, whence we learn that the added resistance just equals the original resistance, because the current strength is always inversely as the resistance. If the current is taken directly from the cell, and there is no external resistance, then the added resistance just equals the resistance inside of the cell or battery. The internal resistance of any form of cell may thus be measured by reducing the external resistance to a minimum, using a short and thick conjunctive wire of copper or silver, so that the external resistance may be ignored. After having measured the current strength and estimated the total resistance, the determination of the electro-motive force, or voltage, becomes a matter of simple calculation, since $E\ M\ F$ (voltage) $= C$ (in ampères) $\times R$ (in ohms).

In the foregoing reference to a combination of single cells to form what is called "a battery," it was stated that they are connected **in series**,—*i.e.*, the anode of one cell being attached to the cathode of the next,—the dissimilar plates or elements being thus connected together. If, on the contrary, we join all the poles of the same character,—*i.e.*, all the zincs and all the coppers, or carbons,—we have an arrangement known as a **parallel arc**, or they may be combined in sets, or **multiple arcs**, of five, ten, or any other desired number. The object of this arrangement is to reduce the internal resistance when the external resistance is small; but, as it also reduces the electro-motive force, it is not a useful arrangement, **except where the plates are too small** for the work required. With cells of the ordinary size this expedient is rarely resorted to at the present day.

Sources of Electrical Energy Other than Galvanic.—Thus far we have considered only the cell as a source of electricity, producing what is called the galvanic or battery current. Other forms of electricity will now be considered; these are induced or Faradic currents, friction or static currents, and magnetic or dynamic currents from all sources.

Essential Identity of Electricity.—It is of the highest importance to bear in mind that electricity from any source is the same force; it only differs in degrees of pressure (tension, electro-motive force), volume, and constancy. Returning for a moment to the analogy of water passing through pipes, we may have variations in **pressure** (differences of potential), or the force which enables the stream to overcome obstacles, as well as in **volume**, the latter depending principally upon the abundance of supply, the size of the pipe, and the material out of which it was constructed. Under precisely the same conditions of current strength, or pressure, and resistance, all the so-called different varieties of electricity will produce exactly the same effects. The current from the induction coil, which is intermittent and reversing (to-and-fro current), as has already been stated, can be commutated or made to flow in one direction, and the interruptions may be so rapid as to make the current practically continuous; it then becomes capable of producing the same effects—chemical and physiological—as are produced by the cell-current. Static electricity, properly directed and controlled, also will magnetize iron, heat a wire, or cause electrolysis. The current from a magneto-electric machine will cause contraction of muscular fibre, produce heat and light, or electrolysis, when the same relations of pressure and volume and resistance are observed as with the chemical or galvanic current.

Induced Currents.—The phenomenon of induction must here be considered before proceeding further. It has already been explained that an electrical current is accompanied by a disturbance of the molecules of the surrounding media, which occur in "whirls" or lines of force circulating around the conjunctive wire. This is shown by the influence upon the compass-needle, which assumes a position at right angles to the wire bearing the current. If a coil of copper or iron wire be substituted for the magnetic needle, electrical phenomena will be excited and temporary currents started up whenever the circuit of the primary wire is closed or broken. These are more powerful if the primary wire be itself rolled into a spool or coil and placed inside of the secondary or induction coil. It is necessary to have the primary wire covered with insulating material, so that adjacent turns do not come in immediate contact with each other, and, also, to have it comparatively thick, so as to carry a large volume of current. On the other hand, it is of advantage to have the secondary wire (also insulated) of fine wire, so as to bring as many turns or coils of it under the influence of the lines of force at any given time, as is convenient. As the electro-motive force (pressure, tension, or power of overcoming resistance) is **directly in proportion** with the number of coils of wire brought under the influence of lines of force (just as it is increased by the number of cells of the battery), it is evident that a fine wire in the secondary coil will yield a current of greater electro-motive force than a coarse wire. In this way the apparent paradox is explained of a galvanic current without sufficient strength to produce muscular contraction (because of the high resistance of the tissues), passing along a wire arranged in a particular manner, causing a current in a secondary coil of fine wire of sufficient electro-motive force or tension to produce active muscular contractions and painful sensations.

Varieties of Quality in Faradic Currents.—The electro-motive force, tension, and intensity or current strength of a faradic current from a properly-constructed apparatus depends principally upon (*a*) the strength of the current flowing through the primary coil at any given time; (*b*) the actual number of convolutions of wire exposed to the influence of lines of force in the secondary coil when in action; (*c*) the suitability to the work of the wire composing and connecting the extremities of the secondary coil, or the coil to which the electrodes are attached. It is seen, therefore, that much depends upon the secondary coil and the value of the connecting wire as a conductor. Many instruments are provided with connecting cords containing cheap, braided, brass wire, which is a poor conductor; well-insulated, flexible, copper wire is more suitable. Moreover, the secondary coil should have a large number of convolutions, and must, therefore, be made with fine wire; although, if too fine, it will impair its conducting power by introducing too much resistance. Finally, the flow of electricity through the primary wire should have sufficient volume for the work. Ordinarily, one cell of moderate size will be all that will be required.

Mechanical Current Interrupter or Rheotome—Neef's Hammer.—Since the currents in the secondary coil are only manifested at the times when the current in the primary wire is closed and opened, some device is needed to interrupt the current in the first wire. This may be done by any mechanical means, but the common method is that known as Neef's hammer. The principle upon which this is constructed is quite ingenious. Taking advantage of the fact that a current of electricity flowing along a wire arranged in a coil will cause soft-iron rods placed therein to become magnetic, although they immediately afterward lose their magnetism because soft iron cannot be permanently magnetized, we have the means of automatic interruption provided by the current itself. The construction of faradic or induction batteries is essentially such as is here described, with minor variations in details of the apparatus.

Coarse and Fine Secondary Coils—Adams's Faradometer.—It must be remembered that the ordinary rules governing electrical phenomena hold good with the induced current, and that, while we have increased electro-motive force by increasing the number of convolutions of wire **independently of the size of the wire,** the conducting power is inversely as the area of cross-section of the wire, and the current strength is correspondingly reduced by using the very fine wire, because it offers greater resistance. This is the explanation of the muddle which some writers appear to have fallen into with regard to the relative utility of the coarse and fine secondary wire coils of a faradic battery. When large electrodes are employed, and only a small portion of the body brought into circuit (as where individual muscles are to be acted upon), or, in other words, when the external resistance is low, the coarse wire is more effective, because it has less internal resistance and the current is better balanced. On the other hand, where a large part of the body is to be acted upon or the electric brush is to be used the external resistance is great, and better results are obtained from the fine coil,—which has greater internal resistance, it is true, but also has more electro-motive force.

This is the gist of the whole matter, and requires no further explanation. Some of the confusion may be traced to the fact that, while we have instruments for measuring the galvanic or battery current (voltameter, milliampèremeter), we have not as yet had any form of apparatus adapted to measuring induced currents, with the exception of the faradometer of that accomplished electrician, Dr. Wellington Adams, which has been recently invented; but this has not yet been introduced, so far as we can learn, in medicine.

Nature of Current from the Primary Coil.—A note may be introduced here relative to the so-called primary current, or the current from the primary coil of a faradic apparatus. The momentary magnetism set up in the core of soft iron when the current is interrupted starts a temporary current in the primary wire. When the circuit is closed no current is manifested by the wire composing the primary coil, because it is short-circuited through its connection with the cell. On the contrary, where the circuit is open and the current is suddenly stopped, an electrical impulse is set up; and if these interruptions are quite rapid these impulses follow each other so closely as to constitute practically a current which, when proper connections are made, is found to be of small volume and strength, but all in one direction. The current derived from the secondary coil, on the contrary, is set up, both at the making and breaking of the circuit, in opposite directions, and cannot be said to have any direction under ordinary circumstances. At the same time, it must be stated that these currents are not equal in strength,—that made on breaking the current being more powerful than that on closing the circuit; and if the external resistance be very great the weaker current is unable to pass, and the effects produced ultimately are those of a single current in one direction. As already stated, a commutator may also be employed, by which both currents can be made to flow in one direction, and thus be made to approximate in their properties those arising from galvanic or static sources.

Static Electricity.—The static or friction electrical machine is a familiar source of electrical phenomena; but within recent years great improvements have been introduced in the construction of these forms of apparatus which have made them useful and available for medical purposes. The principle upon which they are constructed is the old one of rubbing amber, or glass, with a non-conducting material, like silk. The ordinary form is that of a circular sheet or plate of glass, which is made to rapidly revolve in such a way that it is slightly rubbed with an exciting material, the glass and the rubber being insulated from each other and connected with the terminal posts, from which the current may be taken. To the further discussion of this current and its applications in medicine we will return later on.

Electricity and Life-Force.—Electrical units of measurement—the volt and the ampère—bear a fixed value and relation to other units used in measuring force, light, heat, etc. From what has already been stated, it is clear that the proper way to regard electricity is simply as a form of energy, which may be converted at will into other forms. As Hippocrates wrote, "There is no sacred disease, and all diseases are equally sacred," so we may say that "there is no mysterious force, but all forces are equally mysterious." The favorite statement of charlatans, that "electricity is life," is only true in the sense that heat and other forces are essential to life; but none of them can be correlated or transformed into life-force, about which—as of every other form of energy—we know absolutely nothing, except through its manifestations in connection with matter.

Electrical Measurements.—The relations of electricity to other forms of energy may be very briefly recapitulated. The prevailing system of measurement in science is based upon what is known as the Centimetre-Gramme-Second system of units, taking the units of length, the unit of weight, and the unit of time as the basis of calculation. The amount of force acting upon a gramme of matter so as to produce a velocity of 1 centimetre per second, is the **Dyne,** or centimetre-gramme-second unit of force. The force exerted by gravity upon a gramme of matter at the level of the sea is 980 dynes; or, in other words, 1 dyne equals $\frac{1}{980}$ of the weight of a gramme at the earth's surface. Having determined the value of the unit of force, we next find that the unit of work or energy is the work done in exerting a force of 1 dyne over the distance of 1 centimetre, which is denominated the **Erg,** and is equivalent to $\frac{1}{7357500000}$ horse-power. For convenience in electrical calculations, which, with absolute centimetre-gramme-second units, would involve the use of numbers too large for daily use, the Electrical Congress adopted a series of conventional units, consisting of the **Volt,** the **Ampère,** and the **Ohm.** "The **volt** is equal to 100,000,000 of ergs, or of absolute centimetre-gramme-second units of force, or 10 to the eighth power (expressed 10^8); the **ohm** is equal to 1,000,000,000 of absolute centimetre-gramme-second units, or 10 to the ninth power (expressed 10^9)."

The unit of electrical power is the product of the pressure (electro-motive force) of a current in **volts,** when multiplied by the volume expressed in **ampères.** The **Watt** is the term used to express this volt-ampère unit of electrical energy. It is equivalent to $\frac{1}{746}$ horse-power (746 Watts equal one horse-power), from whence $\frac{E \times C}{746}$=Horse-power of any given current. A coulomb is the working unit of electrical energy. When a current having the strength of one ampère passes through a one-ohm resistance-conductor in one second of time, we have an ampère-second, or coulomb, of electricity. It is the unit of measurement of quantity obtained by multiplying the number of ampères by the time in seconds.*

The **Farad** is the unit of capacity. The prefix **mega** means an increase of one million times, and micro = $\frac{1}{1000000}$; they are often used in practical electricity. Thus, the capacity of submarine cables is usually about one-third micro-farad per knot.

Sources of Electricity for Medical Purposes.—The chief forms of apparatus for the generation of electrical energy now in use are:—

The Galvanic Cell.

The Faradic Coil.

The Static Apparatus.

The Magneto-Electrical Machine, or Dynamo.

The Storage Batteries, or Accumulators.

A brief description of the principal forms of these now in use will be necessary in order to understand their further application:—

Galvanic Cells.—Galvanic cells are supplied of various forms and combinations, but essentially they are alike, and consist of two plates (generating and collecting) partially immersed in a fluid electrolyte, which acts chemically upon one (the positive or generating plate) and also conveys the current across to the other (the negative or collecting plate), as already explained. The great fault of such an arrangement as a source of electricity is that the current is not constant; it may start out with its full strength, but from various causes it soon declines to almost zero. This is found to be due to two principal causes: (1) so-called polarization of the negative plate, by bubbles of hydrogen clinging to the surface, and (2) chemical changes in the electrolyte, its action upon the positive plate making it progressively weaker; and it also offers more resistance to the current because more dense owing to the formation and solution of zinc salt. These objections to the single-fluid batteries have been overcome to a large extent by inserting a porous diaphragm between the two plates and immersing them in separate solutions; thus, in the two-fluid batteries, as they are called, the negative pole is placed in a cup of unglazed porcelain, which when moistened does not obstruct materially the passage of the current. The negative plate is surrounded by a solution which has a chemical affinity for hydrogen, and which acts as a "hydrogen-consumer," thus preventing polarization. As regards constancy, all chemical batteries will gradually run down, although some do so much more rapidly and less regularly than others.

* For these definitions the author is especially indebted to the very lucid exposition of the subject contained in "Electricity in its Application to Medicine." By Wellington Adams, M.D. Geo. S. Davis, Detroit. In 2 vols. 1889 and 1890.

Different Forms of Cells.—It has been found that certain forms are better adapted for medical purposes; and, as already explained, the battery must be especially selected for a particular kind of work. Some are made for cautery work, others for neurological and diagnostic purposes, and others still for gynæcological practice, or for charging secondary or storage batteries. Some are portable, others are stationary. The following are the principal forms in use :—

SINGLE-FLUID BATTERIES.

The Grenet Cell.—Positive element, zinc; negative, carbon; electrolyte, dilute sulphuric acid containing chromic acid or potassium bichromate as a hydrogen consumer. The advantage of this form of cell is that the zinc can be lifted, by a mechanical contrivance, entirely out of the fluid when the battery is not in use, or can be immersed to any desired extent according to the amount of electro-motive force required. It is convenient for office work in connection with a faradic coil, or for running a small incandescent lamp. This form of cell is comparatively expensive and has not sufficient voltage for use when a part of the human body is in circuit, unless a large number of cells are used; very compact and useful portable batteries of this kind, however, are now constructed containing from ten to sixty or more cells, twenty-four to forty cells being well adapted for ordinary medical purposes, but not for gynæcological work by Apostoli's method. The solution used is known as the "electropoion" (or electric generating) fluid; it consists of one part commercial sulphuric acid diluted with ten parts of water, to which, after it has become cold, add one part of finely-powdered bichromate of potash and dissolve by agitation. Dr. Seiler, of Philadelphia, recommends the addition of sulphuric acid to a concentrated solution of bichromate of potash, then filtering off the solution after the potassium sulphate has crystallized out, and suqsequently adding sufficient water to bring it up to the proper proportion desired. Dr. Adams considers sodium bichromate preferable to the potassium salt.

The *Leclanché cell* has zinc for the positive element, and originally a porous cup containing manganese dioxide and gas-carbon for the negative, with a saturated solution of ammonium chloride as the electrolyte; later forms, such as the Gonda and the Axo, substitute large blocks of gas-carbon for the porous cup. This has less electro-motive force, but is remarkably constant and requires very little attention. It is in common use, on this account, for electric bells and other purposes. Where a hundred or more such cells are combined, the voltage, although not great, yet is sufficient for most medical purposes. There is no chemical action in this cell until the circuit is closed. It contains no acids or poisonous solution (except that chloride of zinc is formed in it), it generates no corrosive vapors or offensive odors, does not freeze in winter, and only requires the occasional addition of water or fresh solution to replace that lost by evaporation. One charge of the solution will last from six or eight months to twenty-four or thirty, depending on the amount of use made of it. The Leclanché cell originally consisted of a cylindrical rod of zinc as a positive element, and a porous cell in which the negative element, consisting of equal parts of manganese dioxide and gas-carbon, was packed. In the course of time the negative element had to be renewed. Later forms of this battery, as stated above, simply substitute blocks of gas-carbon for the porous cup, which never need renewing. One form (the Law battery) is of this character and is of excellent construction, the cells being hermetically sealed by a cover, which prevents evaporation and creeping up of the ammonium salts. The electro-motive force is 1.5 volts (1.35 according to Dr. Adams's measurement) and gives a current of one to two and a half ampères *through a short circuit* or where the external resistance is small. This is the best form of open-circuit battery for medical use, according to Adams.

The Gravity Cell.—The positive element is zinc and the negative copper; the electrolyte, dilute sulphuric acid containing sulphate of copper in solution. This is a great improvement upon the old sulphate-of-copper battery, which polarized (ran down) very quickly. A large glass cell is employed, and the copper plate is placed at the bottom of the liquid, or near it, and upon it are placed some crystals of sulphate of copper. Near and just below the surface of the liquid is suspended a horizontal plate of zinc, armed with radii like the spokes of a wheel, in order to expose as much surface as possible to the action of the fluid. The greater density of the sulphate-of-copper solution keeps it at the bottom of the cell, around the negative plate, where it acts as a hydrogen-consumer; whereas, the sulphuric acid, liberated by the decomposition of the copper sulphate, ascends to the positive. The copper separates from the solution in metallic form and is deposited upon the negative plate, while the crystals supply the place of that which was decomposed, and thus keep the solution saturated, making the cell continuous in its action. This form of cell is used for telegraph work, but is not used for medical purposes. It is very uniform in action, but has small electro-motive force; it is generally worked with a closed circuit, while batteries for medical use are kept usually with an open circuit except when actually in use.

The Smee Cell.—Positive, zinc; negative, silver covered with platinum and with a rough surface to prevent adhesion of hydrogen; electrolyte, dilute sulphuric acid (1 to 20). This form of battery is almost obsolete in medical practice, although occasionally used in connection with the faradic coil. It has a high intensity, but is not constant. It is useful in the arts for electroplating.

Two-Fluid Batteries.

The Daniell Element consists of a glass jar, or receiver, a positive plate of zinc, with a negative plate of copper, the copper plate being placed inside of the porous cup, which contains a saturated solution of sulphate of copper, the zinc being placed in dilute sulphuric acid in the containing jar. Some crystals of copper salt are placed in the interior of the porous cell, to keep the fluid saturated. The internal resistance of this cell is rather high, but is diminished by using large plates and placing them close together. It has an electro-motive force of 1.05 volts, and is quite constant. A modification of this cell, by Siemens and Halske, of Berlin, was regarded by Remak as an improvement, but, according to de Watteville, is no longer used. The interior of the porous cell was packed with paper pulp, which, when wet with solution, is a better conductor than the solution alone. It has been superseded by cells of higher electro-motive force and of simpler construction.

The Grove Cell.—The generating plate is zinc; the collecting plate is platinum, the latter being immersed in dilute nitric acid (hydrogen-consumer), contained in a porous vessel, and the former in dilute sulphuric acid. The advantages of this battery are its high electro-motive force (nearly two volts), its low internal resistance (usually less than one-fourth ohm), and its simplicity. The objections are its cost, the corrosive fumes which it gives off while in use (nitrous acid), which attack the connections, and, finally, its want of constancy.

Bunsen Cell.—This is the same as the preceding, except that a large piece of gas-carbon is made to replace the small platinum plate. The electro-motive force is even higher than the Grove; but the internal resistance is also higher, since carbon is not so good a conductor as platinum. In this cell the bichromate-of-potash solution may be placed in the porous cup instead of nitric acid, thus making it a double-cell Grenet.

Dry Cells.

Chloride-of-Silver Battery of De la Rue.—Owing to the inconvenience of acids, an effort has been made to do away with them by substituting a paste made of flour and sulphate of zinc, in which the plates (chloride of silver, in the form of a rod, and two zincs) are permanently fixed and the cells hermetically sealed. Although the cells are small, they are able to produce decided physiological effects. The cells are only dry in the sense that they are permanently closed. They each represent an electro-motive force of nearly one volt, and vary in internal resistance from three or four ohms to one-half an ohm, according to size. When used through proper external resistance, these batteries are applicable to many purposes. The chief objection is their high cost and the fact that, when exhausted, they can only be renewed by the maker or patentee.

The Care of the Battery.—In order to have the greatest efficiency, it is evident that the battery must be in good working-order, the connections perfect, the electrolyte active, and the zinc clean. The best method of keeping the zinc with a clean surface is to amalgamate it with a little pure mercury. This is usually done by scraping away all foreign material with an old file and washing the surface with some weak acid solution (sulphuric or hydrochloric, usually); a little metallic mercury is now dropped upon the surface and rubbed over it with a brush or piece of rag attached to a stick. The zinc, when freshly amalgamated, shines like silver, and presents a uniform, amalgam-coated surface. When this is not done the current may be weakened and diverted by what is known as "local action." Small foreign bodies or impurities in the zinc, being electro-negative to the zinc, set up little electrical circuits and cause local action, which makes holes in the plate and weakens the current proportionately. No rule can be given as to the time when the zincs should be amalgamated or fresh solution used; it depends very much upon the kind of cell and the amount of use; but when the galvanometer shows that the battery is much below its proper efficiency, this attention may be needed to restore it.

Requirements of a Galvanic Battery.—Dr. Wellington Adams formulates the following as the theoretical conditions of a perfect battery:—

"1. A high electro-motive force.

"2. A low and constant internal resistance.

"3. A constant electro-motive force irrespective of the current produced by the cell.

"4. A consumption of inexpensive materials.

"5. A lack of consumption of all material when no current is being produced,—that is, when the circuit is not closed.

"6. A ready means of occasionally examining its condition and working and of adding fresh materials when required."

Work of a Galvanic Battery.—It should always be borne in mind that the electro-motive force of a galvanic cell is independent of its size, a cell no larger than a thimble possessing as much electro-motive force as one the size of a barrel **where the elements are the same.** The character of the elements, therefore, determines the electro-motive force, or the tension, of the current, all cells having similar elements possessing the same difference of potential. Moreover, one cell will yield the same quantity or volume of current on a short circuit, theoretically, as a hundred, and no more electricity can be obtained from the latter than the former on **a short circuit** (no external resistance). But one hundred cells arranged in series will have a hundred times the power of overcoming resistance of that possessed by one cell. Finally, the strength of a current which any cell will give is largely affected by its internal resistance, this depending upon the size or extent of surface of the elements, their proximity, and the character of the solution and of the negative plate, as conductors, all other things being equal. The **pressure,** or **electro-motive force,** depends upon difference of potential, while the **quantity** of electricity depends directly upon the rate of consumption of the positive plate, or the intensity of chemical action going on in the cell.

Galvano-Cautery.—For galvano-cautery work large Grenet cells may be employed. In this case, the external resistance being small, the conjunctive wire being short and a good conductor, everything is gained by increasing the size of the plates and bringing them close together, thus diminishing internal resistance and balancing the battery. Polarization may be prevented by agitating the liquid, or other means. From four to six cells of rather large size are sufficient. A very good mechanical arrangement has been devised, by which the zincs, attached to a frame, are raised or lowered by pressing a lever or treadle with the foot; by this means the battery is only in use for a short period at a time, and polarization has less time in which to take place. The storage battery is also used for galvano-cautery work.

Faradic or Induction Apparatus.—The construction of this very useful form of apparatus has already been explained (see page 104) and the theory of its action considered, by which currents of high electro-motive force and small quantity are obtained from those of low electro-motive force with relatively large quantity. Usually one cell of the Grenet or Smee type is used as a source of electricity, which flows along the primary wire. As already stated, the second coil should consist of a large number of spiral turns of fine wire, each insulated from the other; but an extra coil of coarser wire may be used when the external resistance is small. The currents induced by the making and breaking of the circuit in the primary wire, by clock-work rheotome or by the action of the automatic interrupter, are of momentary duration and opposite in direction. In the wires connecting the extremities of the secondary coil, in ordinary medical batteries, therefore, **on a short circuit,** there is, properly speaking, no direction to the currents; they are rapidly-reversed to-and-fro currents. At the same time, they are not of equal strength, and, if the resistance be great, the current set up upon closing the circuit is unable to pass around, and only the current set up at the time of breaking the circuit is left, which, of course, will be in one direction. Moreover, if the interruptions are sufficiently rapid it will be practically continuous. It has already been pointed out that, by a device known as a commutator, the first current may be reversed so as to re-inforce the other; but this is not usually found in medical faradic apparatus. The poles of such a faradic apparatus may, therefore, be properly marked + and — (or positive and negative), if the currents are all in one direction. In addition to the extra or induced currents set up in the second coil, there are similar induced currents in the primary coil, as its electrical equilibrium is disturbed by the making and breaking of the circuit. If connections are made with the ends of the primary coil this (which is generally, though incorrectly, called by instrument-makers "the primary current") may also be utilized in medicine. The current from this coil differs in several features from the current from the second coil: 1. Owing to the fact that fewer lines of force are involved, the **intensity,** or **electro-motive force,** is much less than in the latter. 2. As at the moment of starting the current the circuit through the cell is shorter than through the electrodes, the first induced current passes through the cell, leaving the second only to pass along the rheophores; therefore, it is an interrupted induced current, all in one direction,* and not a to-and-fro current. 3. The current is increased in intensity by inserting a bundle of soft-iron wire in the interior of the coil, or by bringing the secondary coil over it, just as the secondary current is increased.

Number of Currents from a Faradic Battery.—Some batteries give only the current from the second coil; some give, in addition, the extra current from the primary coil. The only current of real general utility is that from the coarse and fine secondary coils, having a high electro-motive force and small quantity. This is capable of passing through a high resistance, such as that offered by the tissues of the human body; a resistance which would require from sixty to eighty cells of a galvanic battery, arranged in series, to overcome. From this it is seen how futile it is to expect to obtain a galvanic current for medical purposes from the cell or cells accompanying the ordinary faradic instrument. Therefore, medical batteries professing to give, in portable form, both galvanism and induced currents, so as to suit all cases, will not fulfill the requirements of practice. Physicians find it necessary to have both a faradic and a galvanic instrument, or several of different kinds, suited to different cases. With regard to a variety and combination of coils and their effects, we may quote from a recent article on "The Different Physiological and Therapeutical Properties of the Induced Currents of

* See page 104 for more detailed explanation of the difference between the currents from the first and second coils.

Electricity" (*Medical Record*, February 14, 1891), by Dr. A. D. Rockwell, who summarizes his conclusions as follows :—

1. From the continuous-coil apparatus, owing to its combination of helices, the wires of which differ in thickness and length, proceed four qualities of current that vary in a most remarkable degree in all the properties of electricity,—physical, physiological, and therapeutical.

2. That the variation is observed most markedly when applications are made internally to the vagina, uterus, rectum, or bladder, by the bipolar method.

3. From the primary or first induction coil we obtain a current of quantity that is barely perceptible externally, but internally, and especially by the bipolar method, acts with greatly increased efficiency.

4. From the combination of the primary and secondary induction coils we obtain a current of greater tension, but which still acts mildly when applied externally. Applied internally, however, its effects are far greater than the first coil, both in exciting the sensibility and contractility, and the utmost caution must be exercised in its use. In the same degree, also, it acts upon the vagina, rectum, bladder, and testes. This current is especially applicable in the treatment of enlargements of the uterus due to subinvolution, but is of little or no value when the enlargement is due to fibrous tissue. It is of especial value in post-partum hæmorrhage, and, from its power to excite the sensibility and contractility of the bladder and rectum, it may be used with good effect when these organs are anæsthetic, or suffer from diminished or lost contractility.

5. From a combination of the first, second, and third induction we obtain the maximum power to excite both sensibility and contractility on the external surface of the body, each additional coil simply giving a decreasing power over sensation and contraction. Applied internally, however, it acts far less powerfully than either of the two previously-named currents; but in the ordinary forms of paralysis of voluntary muscles it will more readily call forth contractions than the current from any other combination of coils.

6. From the first, second, third, and fourth induction coils combined, a current is obtained differing from and superior to all the others in its sedative and general tonic effect upon the system at large. It neither acts upon the sensibility nor muscular contractility when applied externally, as does the third current of the series; nor with a tenth or even a twentieth part of the acuteness when applied internally, that characterizes the second current of the series. For the purpose of general faradization, however, it is the only proper current to use, and for applications to the vagina and uterus, for the relief of many forms of pain, it possesses properties that are invaluable.

Rapid and Slow Interruptions.—All faradic batteries are now provided with some form of the magneto-electric, automatic interrupter; although the rheotome, or current-breaker, may also be governed by clock-work, by the hand, or any other convenient method. Ordinarily, the interrupter, or rheotome, is attached to a spring, as already described (page 104), and the interruptions occur with such rapidity as to make a buzzing sound or even a musical note. An improvement upon this is found in some first-class instruments, which enables the operator to increase the interval at will between the shocks, according to the case. In some patients, the muscles are thrown into tetanic spasm by very rapid interruptions, and here the slow interrupter is of great service.

Size of Instruments.—Faradic batteries are made of different sizes and various shapes. For treatment of cases of poisoning, or in obstetric practice, and, in fact, in many medical cases, the small case, such as the Gaiffé, or one of its modifications and imitations, may be all that is required. But for diagnosis and general clinical use a better one, provided with slow interrupter and a large secondary coil, is indispensable, such as is provided by Otto Flemming, the Galvano-Faradic, the McIntosh Company, and others.

Combined Currents. Galvano-Faradization.—No real advantage is obtained by combining the primary and secondary currents in the faradic apparatus; but de Watteville and others have combined the galvanic and faradic currents in order to give greater volume to the latter, and enable it to penetrate more deeply into the tissues.

The Static or Franklinic Apparatus.—This is the oldest form of electricity known. It is exhibited when a piece of glass is rubbed with resin, or when vulcanite is rubbed with silk. Now, if either the glass or the resin be brought in the vicinity of some small pieces of paper, or other light objects, phenomena of attraction and repulsion will be manifested. This condition is known as electrification; and it has been found, from various experiments, that:—

1. Articles attracted by the glass are repelled by the resin, and those repelled by glass are attracted by the resin; hence the theory that there are two kinds or components of electricity, called, for convenience, a positive and a negative. 2. Many other bodies, when rubbed together, produce similar phenomena, and become either electro-positive or electro-negative. 3. Articles which give electro-positive electricity when rubbed with one excitant may give the electro-negative electricity when rubbed with something else; so that the form of electrical disturbance depends upon the relations of the bodies which produce it. For instance, glass, when rubbed with resin, produces electro-positive phenomena; when rubbed with fur it is electro-negative.

4. The electrical conditions of both articles are disturbed, and to an equal extent, the quantity of electricity upon the glass rod being exactly equalled by that on the resin or fur.

5. The amount of electrical difference between the two bodies is known as "the difference of potential," since it is the measure of the force which would have to be exerted in order to restore them to their original state of equilibrium.

6. Electrical phenomena are produced in bodies brought into the vicinity of either a positively or negatively excited electrode. This is induction, and the electricity thus caused is known as induced electricity. It is found that, under such circumstances, in a body capable of conducting electricity, the form of electricity will be contrary to that of the electrode, and they will be mutually attracted. Hence the rule, "Unlike electricities attract, like electricities repel, each other."

7. Electricity of this character is confined to the surface of bodies, and can be confined or stored up in appropriate apparatus, *i.e.*, in what is known as the Leyden jar, and is, therefore, known as "static electricity."

8. A body is charged by conduction when its electricity is conveyed to it through a rheophore or metallic connection. It is said to be charged by induction when the electricity is due to the action of surrounding bodies without contact, as already explained.

9. The phenomena of static electricity resemble and are identical with electricity from other sources, when of small quantity and exceedingly high tension (or electro-motive force). The terms positive and negative, therefore, resolve themselves into differences of potential, the current flowing from the higher to the lower potential, as in the current from the galvanic cell.

The foregoing brief *résumé* of the phenomena of static electricity is a necessary introduction to the study of electro-static machines. They consist, essentially, of an apparatus designed to convert motion into electricity by means of friction and induction.

Forms of Static Instruments.—Electro-static machines are either **frictional** or **induction** machines, the latter requiring to be independently charged before they will act. Frictional machines are identical in principle with the experiment first mentioned, where glass was excited by rubbing. In its usual form the glass is a circular plate or disc suspended by its centre, and capable of revolving when turned by a crank. It is provided with a rubber or cushion of leather covered with amalgam of tin and mercury, this being slightly pressed against the side of the plate, so as to cause friction when the plate is revolved. There is also a comb of metal, the points of which do not quite touch the surface of the plate.

The cushion and comb are connected by means of metallic conductors, each with one of a pair of brass balls, which are the poles or electrodes of the apparatus. When the glass disc is revolved the rubber excites positive electricity upon the glass surface, and is itself negatively excited; owing to the amalgam, its charge is carried to the electrode in connection with it. The surface of the glass which is positively excited passes under the comb, which conducts the charge of positive electricity to the brass ball corresponding with it. The charge of positive electricity steadily increases, until the difference of potential is so great as to cause a disruptive discharge between the two poles. This temporarily restores the equilibrium of the glass, which passes again under the rubber and the phenomenon is repeated. The pole in connection with the comb which is positively excited will, if brought near the negatively excited pole, discharge itself as a spark passing between the poles, when the difference of potential is sufficient to enable it to jump across the intervening space. If it is desired to apply this form of electricity to medical purposes light brass chains or other conductors are attached to the poles, and by means of suitable electrodes sparks may be drawn from different parts of the human body. If we insulate the patient by seating him upon a chair with glass castors or a stool supported by glass, we may connect him with either pole, the other being grounded, and he will become stored with either positive or negative electricity, and sparks may be drawn by bringing the opposite electrode, or any object by means of which communication may be had with the earth, near him. Other applications besides this so-called electric bath will be mentioned farther on.

The Holtz Machine.—The improved Holtz apparatus is at present the best of the induction or influence machines. It consists essentially of two varnished-glass discs,—one being stationary, the other revolving. The stationary plate has two apertures, through which project the ends of two strips of paper, called **inductors,** which are attached to the outer side of the plate. The free extremities of these inductors emerge upon the inner side opposite a pair of metal combs, each connected by a metal rod and by a conductor with one of the poles. The action of the machine is thus explained: "Let one of the inductors be charged,—say, positively,—and let the two electrodes be brought into contact. As a result, the comb opposite the inductor is charged negatively by induction and a positive charge appears at the other comb, since the combs are in communication through the joined electrodes and the positive electricity is repelled away from the inductor itself. Since the combs consist of sharp points, the negative electricity upon the first comb begins to discharge itself against the glass plate in a direction toward the other inductor and comb. Both of these, therefore, discharge positive electricity on the plate,—the comb upon one side, the inductor upon the other,—while the inductor itself receives a negative charge. Clearly, therefore, a part of the negative charge upon the front of the plate is neutralized, and the positive charge upon the back is carried around again toward the positive inductor. This increases the action of the positive inductor, since the inductor itself discharges negative electricity upon the plate and becomes itself more and more strongly electrified positively. If the electrodes are now separated sparks will pass between them"* when the plate is made to revolve. The object of having the holes in the stationary plate is to diminish the capacity of those parts of the plate which are opposite them, and thus cause them the more readily to give up some of their charge. In some cases Leyden jars are attached to the electrodes, the object being to increase the energy of the sparks given off, and, in fact, make it resemble the induced current.

Magneto-Electricity and Dynamos.—The fact that a magnet introduced into the interior of a coil of wire is capable of disturbing its electrical equilibrium and instituting electrical impulses has led to the construction of medical electrical machines, in which coils of wire, attached to a revolving frame, are made to rapidly pass through the lines of force around the poles of a large magnet. Currents are set up in the coil as it enters and as it leaves the magnetic field, and by proper connections these currents are conveyed to electrodes, by which they can be applied to the body. These currents are of high tension, but of feeble quantity,—resembling, in this respect, the Faradic machines, which are much more efficient and convenient, so that they have driven the others out of use. Within a few years, however, improvements have been made in the construction, and large magneto-electrical machines are made, which are run by steam and are called dynamos. They are now employed in electric lighting, and, as a source of power, for many purposes. The wires carrying these currents in the street-mains have been utilized as a source of electricity for medical purposes, and we may briefly refer to the subject here. There is a distinction of great importance to be observed between the currents supplying the arc light and the incandescent light; the former requires a 10-ampère current, with electro-motive force of about 60 volts, while the latter has something like one-half ampère, with an electro-motive force of 110 volts. Owing to this difference in quantity and pressure, it is easily seen that their utility for medical purposes varies greatly. The arc-light current is capable of causing fatal results, while no serious result would follow the use of the incandescent (Edison) current, unless it was accidentally connected with

* Liebig and Rohé, "Practical Electricity in Medicine and Surgery," p. 27. The F. A. Davis Co., publishers, Philadelphia, 1890.

an arc current flowing in a neighboring wire, in which case its current would be immediately increased, and, unless protected by a previous insertion of a fusible plug in the circuit before reaching the patient, serious results might follow. Where an arc current only is available, it is conducted through what is known as a "converter," which is essentially a coil of wire surrounded by a secondary coil, from which the induced current, having higher intensity and less quantity, is obtained just as in the Faradic apparatus. It is not necessary to discuss the construction of motors and dynamos, nor the different methods of arranging the wires in the armatures, in order to obtain currents of higher or lower potential.

For these details the reader is referred to Liebig and Rohé's recent work on "Medical Electricity," to which reference has already been made, and other monographs on medical electricity, electric lighting, etc. Small dynamos have been constructed for use in clinical work, but they are expensive, unreliable, and unsatisfactory, when compared with galvanic and static machines now furnished. The electric-light current may be utilized by physicians for running small electric motors for dental drills or nasal instruments, and for running the static machines, and other purposes. It is also made available and portable for medical use as a source of electricity, through Faure's invention of the storage battery, in which the current is completely under control.

Storage-Batteries, or Accumulators.—While the Leyden jar, one of its modifications, is the only means, strictly speaking, for accumulating electricity, the name of storage battery has been, by general consent, applied to a form of apparatus in which chemical action produced by a current of large volume and low pressure, is utilized to yield, at will, a current of low volume and large electro-motive force. The form known as the Planté cell originally consisted simply of two insulated plates of lead immersed in dilute sulphuric acid. If, through this apparatus, a current be passed for a certain length of time, it will be found that certain chemical and physical changes have taken place, and one plate is seen to be covered with a layer of oxide of lead. Now, if the current be reversed, the other plate will become oxidized, and the first plate will be deoxidized and again become metallic lead, but the surface will be converted into a spongy condition. The plates are now said to be "formed," the spongy lead being the negative plate and the oxidized the positive, —the current, in other words, flowing from the plate containing the oxide through the circuit, or conjunctive wire, and into the cell through the spongy plate. During the process of charging the cell the current is made to flow in the opposite direction,—into the cell through the positive plate, and out through the other. After charging, the positive plate is still more oxidized. Subsequently, when the circuit of the cell is closed, a current is set up, which continues as long as there is sufficient difference in potential between the plates to overcome the resistance, and during this time the positive plate becomes progressively less and less oxidized, and the negative more. In the present form of the Faure cell, the lead plates are cast in molds, which give the plates a peculiar shape. They are called "grids," because they contain numerous holes or perforations, which are to be filled with oxide of lead, mixed into a paste with sulphuric acid. Two oxides are employed,—the red oxide (Pb_3O_4) for the positive plate, and yellow oxide (PbO) for the negative. After the plates have been thus prepared, they are "formed" by passing a current obtained either from the electric-light main or battery, of proper intensity, through them, when immersed in dilute sulphuric acid. When several storage cells are used, they are always coupled in parallel, the positive plates all being joined together by a lead strip, and the negatives similarly united. In this way, each additional cell proportionately diminishes the internal resistance. The storage cell is largely used in medicine and surgery, in connection with the galvano-cautery, dental engine, or drill, and electric light for exploratory purposes. It is usually found convenient to use from four to six cells. They may be charged either from a large galvanic battery (sixty to one hundred cells), or from the Edison incandescent electric-light current. Storage cells each represent an electro-motive force of about 2 volts. When in use, as soon as the electro-motive force falls to 1.8 or 1.7 volts, the battery should be disconnected, and at once recharged. It should not be allowed to run down further than this, and should not be permitted to remain, when not in use, in an uncharged state, for it will lose in efficiency, if neglected. The capacity of a storage battery is usually indicated in ampère-hours,—that is, by the number of hours it will furnish a current of given intensity. A battery with a capacity of 100 ampère-hours, theoretically, will furnish a current of 10 ampères for ten hours, or of 5 ampères for twenty hours, etc. In practice, however, the capacity diminishes with the intensity of the current; so that the above battery might furnish 25 ampères for only three hours, instead of four, or 50 ampères, possibly, for only one hour, instead of two. The size of the cells and their number are made to correspond with the particular work they are intended to perform, as the best work can be done only when a battery is discharged at its "normal" rate,—that is, the kind of work that it was made for. The cells may contain a number of plates, thus greatly increasing the surface exposure and diminishing the resistance. The objection to storage batteries is their weight, but recent improvements have been made by which both the weight and cost have been materially reduced.

Electrical Apparatus Other than Batteries—Electrodes, etc.—In addition to a source of supply of electrical energy for medical use, certain apparatus is needed. The rheophores, or current carriers, have already been mentioned. The electrodes or poles are of different shapes, adapted to the part of the body they are intended to be applied to. As metallic electrodes cause pain when strong currents are used, it is customary to cover the electrode with a moist sponge or leather; what is better, is a layer of absorbent cotton, and moistened with salt water because it is a better conductor than plain water. Where large-volume currents are used it is necessary to increase the size of the electrode in order to avoid electrolysis of the tissues; for instance, in the Apostoli method one of the electrodes is made of a mass of clay applied over the surface of the abdomen, while the other, being comparatively small, is usually made of carbon and is applied so as to produce the desired local effect upon the uterine structures. Electrodes for cautery purposes are usually made of platinum, in the form of loops of wire of different sizes, according to their destined purpose. The wire may be used as an écraseur, and heated to the desired degree by the current as it cuts its way through; but much tension cannot be put upon a wire that is heated, because it is soft and less able to resist when in this condition. The electrodes ordinarily employed for the percutaneous method of administering electricity are of great variety of shapes, varying with the taste of the user. They may be double, each pole being insulated until joined by some object, such as the mucous membrane; these are used for intra-uterine, laryngeal, or eye work. A similar electrode is used as a searcher for bullets, an electric bell being placed in circuit, which rings when metallic connection is made.

Galvanometers, Milliampèremeters, or Milliammeters—The Dynamometer and Coulombmeter.—Besides batteries and electrodes, an instrument for measuring the quantity or intensity of a current is needed. The galvanometer is constructed upon the principle of the deflection of a magnet, by the passage of a current of electricity parallel with it. A magnetic needle surrounded by a coil of insulated wire will be deflected from its usual position in relation to the earth's magnetism (north and south) and made to revolve more or less to a position approximating a right angle; the greater the strength of current, the greater the deflection, although not directly related, since doubling the current does not double the amount of deviation. As the galvanometer is marked in milliampères, it is commonly known as the milliampèremeter, or, abbreviated, simply milliammeter. Such an instrument is called direct reading if it indicates at any moment the strength of current in ampères. Very good instruments are made by Waite & Bartlett, Fleming, and by McIntosh.

Wellington Adams pronounces in favor of the Weston milliammeter. For exact measurement of electrical work a **coulombmeter** is used, which depends upon the amount of decomposition or electrolysis taking place within a certain time while the battery is in use. An instrument of this kind is used in connection with the electric lamps, to discover at stated periods exactly the quantity of electricity which had been used. Besides these, practical electricians make use of another instrument, known as the **dynamometer.** In this instrument the amount of attraction between coils of wire, carrying currents in the same direction parallel with each other, is measured by the amount of angular deflection. In the dynamometer, instead of a magnetic needle, we have a coil of wire to be acted upon. When the current is reversed it is changed simultaneously in both coils, and the same effect is produced as when the current was constant; hence, with this instrument, we may measure the strength of alternating currents, which could not be done with the ammeter. The deflection of the dynamometer is proportional to the product of the two currents; consequently, in order to determine the strength of the current itself, it is necessary to take the square root of the amount of the anterior deflection of the suspended coil.

Different Forms of Rheostat for Determining Resistance.—A form of apparatus for accurately measuring resistance, or **ohm-meter,** consists of a box containing a number of coils of wire, the resistance of which is definitely known, which can be introduced into the circuit either in connection with the unknown resistance or in substitution for it, the latter being a more direct method. The apparatus commonly used for this purpose is known as the "Wheatstone bridge."

A **rheostat** consisting of a column of water in a glass tube, or a series of resistance-coils, or a mass of plumbago,* as in the Massey current-controller, is almost indispensable in using the galvanic current, since by its means the entire battery of forty to eighty cells is brought into action at once, the current being gradually raised from zero to the desired amount and afterward lowered again before removing the electrodes.

Labile and Stabile Applications—Ascending and Descending Currents—General Faradization and Galvanization.—When the electrodes are kept upon certain spots, the application is said to be "stabile"; when they are moved about, it is a "labile" application. When the poles are so placed that the current passes toward the periphery, it is said to be **descending**; when reversed, it is **ascending.** This applies both to the faradic and galvanic currents. In general galvanization a moist foot-plate or foot-bath may be attached to the negative electrode, while the

* A plumbago current-controller was patented by Dr. John Butler, author of "Electro-Therapeutics and Electro-Surgery," Philadelphia, 1879 and 1882.

positive, covered with wet cotton, is held to the forehead or occiput. The caution is given by most electro-therapeutists not to use very strong currents if the head is in the circuit, nor to abruptly make and break or reverse the current; nor should the application be kept up for a longer time than five to eight minutes. General faradization is accomplished by applying one electrode to the spine, in the cervical or dorsal region, and passing the other rapidly over the surface of the extremities. It is often, and very advantageously, combined with massage.

Rheotome.—A mechanical device for interrupting the galvanic current is called a rheotome, and is an indispensable part of the outfit, as furnished by the principal manufacturers. The slow interruption may be made mechanically,—by the hand or foot or by clock-work,—but the automatic interrupter is most commonly used. (Described on page 104.) The same result may be accomplished, though less satisfactorily, by brief applications, simply "dabbing" one electrode on the part, the other being stationary.

Current-Collector, or Pole-Board.—In a complete battery outfit it was formerly considered absolutely necessary to have what is called a **collector,** which represents the extremities of the wires communicating with the cells, so that by simple movement of a switch any number of cells are thrown into circuit. The simplest form of collector is in the shape of a dial, consisting of a single row of metal buttons arranged in a circle. In the centre is a metallic post, which has a movable arm which swings around the circle, bringing into action as many as are required, the buttons having a circle of numbers just outside of them corresponding with the number of cells. If the arm of the dial-collector be sufficiently wide to touch two adjoining buttons, breaking the current will not occur when the arm is moved from one to another. With a large battery two dial-collectors are employed,—one representing single cells, the other accessions of two, three, or five cells. Since the introduction of the milliammeter and the rheostat, or current-controller, the necessity for a pole-board collector is much less imperative, and it may be entirely dispensed with without inconvenience.

The Current-Reverser.—The **commutator,** or pole-changer, is also a valuable, if not indispensable, adjunct to a good battery. It is a mechanical contrivance, by means of which the polarity of the electrodes may be reversed without changing their position. This may be done by a simple switch; but, where rapid reversals are required, the best form is a split button. The revolving shaft carries a disc bound with brass, in which there are two interruptions of continuity or vacant spaces. Upon the circumference four flexible metallic connections impinge, so that, as the handle is turned, the poles are brought alternately in connection with each electrode. The ordinary pole-changing switches have adjustable contact-springs beneath the levers, which make close contact with the buttons beneath, the surface of which should be kept clean and bright. By employing two pole-changing switches, one connected with a galvanic and the other with a faradic battery, the change may not only be made from one polarity to another, but also from the chemical to the induced current, without removing the electrodes. Such a switch-board, as first devised by de Watteville, and known as a "current-alternator, reverser, and combiner," is manufactured by Messrs. Waite & Bartlett Company.

Some Points with Regard to Electrodes.—With regard to electrodes, Erb recommends the following standard sizes:—

1. Fine electrode, $\frac{1}{2}$ centimetre ($\frac{1}{5}$ inch) in diameter.
2. Small electrode, 2 centimetres ($\frac{3}{4}$ inch) in diameter.
3. Medium electrode, 5 centimetres (2 inches) square.
4. Large electrode, 6 by 12 centimetres ($2\frac{1}{2}$ by 5 inches).
5. Very large electrode, 8 by 16 centimetres (about $1\frac{1}{4}$ by $6\frac{1}{2}$ inches).

The electrodes may be made of carbon (gas-coke), copper, or lead. Where a dry electrode is required carbon is preferred; it also makes a useful form for intra-uterine applications. Where a large surface is to be covered sheet-lead may be employed on clay, as used by Apostoli. Electrodes are often covered with leather or sponge, but the most cleanly and convenient covering is absorbent cotton, as suggested by Dr. G. Betton Massey, a fresh piece being applied over the electrode for each *séance*. The cotton is moistened with warm water, or with medicated solutions if desired for cataphoric purposes. Various forms of electrodes have been devised for laryngeal, intra-uterine, and other special purposes, which fill up the pages of the manufacturers's catalogues, and need not be detailed here. An exceedingly compact and complete electro-therapeutic cabinet, having galvanic, faradic, and static apparatus, with all the needed accessories, in a space of thirty-four by twenty-four and sixty inches high, has been devised by Dr. Wellington Adams, of St. Louis, Mo. It is not only an ornament to a physician's office, but he claims that it is really the most useful cabinet that has yet been produced. *

Physiological Effects.—The utility of electricity in medicine depends upon its power of producing physiological effects and stimulating certain functions. It is known that all muscular movements are attended by the liberation of electric currents, and, in fact, a form of battery may be made entirely of muscles, as in Galvani's celebrated experiment. On the contrary, currents of electricity, made to traverse a muscle in its

* See "Electricity: its Application in Medicine," by Wellington Adams, M.D., vol. ii, p. 33. George S. Davis, publisher, Detroit, Mich., 1890.

normal state, will produce contractions. In the same manner, if an electrical current be applied to a motor nerve, by introducing part of its trunk in the circuit, the muscles to which it is distributed will contract; sensations of pain or numbness will be caused by stimulating a sensory nerve; a peculiar taste in the mouth is caused by passing electricity through the gustatory nerves; sensations of flashes of light are caused by electrically exciting the optic nerve, etc. So that properly adjusted currents of electricity cause responses in accordance with physiological function of the organ to which they are applied. Very little is known with regard to the electrical condition of the deeper tissues of the interior of the body during the period of the passage of a current of electricity between the positive electrode (or anode) and the negative (or cathode), when they are applied to the surface of the body. If the electrodes are dry, the galvanic current penetrates with difficulty, since the dry skin offers a very high resistance, and is a poor conductor of electricity. If the electrodes are moistened with salt water, a small portion of the current passes directly through, from one to the other, in a straight line, but the major portion is deflected by various routes of less resistance, a considerable quantity probably following the layer of fascia and blood-vessels under the skin.

When a nerve-trunk is included in the path of the current, the part of the nerve near the anode is in a condition of decreased irritability and that near the negative of increased irritability. In the normal condition the greatest effect, therefore, is observed under the cathode, or negative pole. By numerous experiments it has been found that the contraction occurs with the weakest current, with cathodal closing; the anodal-closing contraction requiring twice the strength of current; the anodal-opening contraction about the same; while the cathodal-opening contraction requires four times as much. This may be expressed in symbols as follows:—

Normal nerve-muscular reaction $= Ca\ Cl\ C > An\ Cl\ C > An\ O\ C > Ca\ O\ C$. The changes in the electrical irritability of nerve and muscle are classed by Liebig and Rohé under three heads:—

1. Quantitative, or an increase, diminution, or total disappearance of electrical irritability to one or both currents.

2. Qualitative, consisting in a modification in kind of the normal reactions of nerve and muscle to electrical currents. This is the so-called "reaction of degeneration."

3. Mixed or combinations of quantitative and qualitative variations of irritability. This class may also be included under the consideration of "reaction of degeneration."

The reaction of degeneration of Erb indicates a departure from the normal conducting power of the nerve and muscle, and this is usually the result of degeneration of the nerve, but it may be secondary to some lesion of the spinal cord at the point of origin of the roots of the nerve. The phenomena of reaction of degeneration are:—

Disappearance or diminution of nervous irritability to both galvanic and faradic currents.

Disappearance of faradic and increase of galvanic irritability of the muscle, generally associated with increased mechanical irritability.

Tardy, delayed contraction of the stimulated muscle, instead of the quick, lightning-like contraction of the normal muscle.

Appearance of certain decided changes of the normal formula, as just given, to $An\ Cl\ C > Ca\ Cl\ C > An\ O\ C > Ca\ O\ C$, or some modification of this. But the typical change is the tardiness of muscle-contraction, which indicates degenerative changes of the muscle or nerve, following peripheral paralysis.

Monopolar and Dipolar Electric Baths.— The dipolar electric bath is essentially different from the franklinic electric bath (general franklinization), in which the patient is placed upon an insulated chair or stool and connected with one (negative or positive) pole of a static or friction apparatus. The results of some recent experiments are reported by W. S. Hedley, M.D., in the *British Medical Journal* (February 20, 1892, page 381), in which the effects of the bath are carefully studied. For the dipolar bath the following apparatus is required: An oak bath-tub six feet long, two feet six inches wide at widest part, the waste-pipe being insulated from earth by a short length of rubber hose inserted near the bath; a battery of seventy-four Leclanché cells, or other battery, having an electro-motive force of seventy-five volts; the electrodes, thirty by twenty square centimetres, rest at each end of the bath; the water is unmedicated, about twelve and one-half inches in depth, and the temperature 98° F. The resistance of the water before the entrance of the patient measures 165 ohms, but increases rapidly as the water cools (thus, at 92° F. it is 194 ohms; 87° F., it is 264 ohms; and at 70° F., 440 ohms). A strap is stretched across one end as a head-rest, and the subject lies immersed in the water except his head, the shoulders being eight inches from the positive electrode and feet three inches from the negative. It was found by measurement that a small portion of the electric current (or lines of force) pursued the most direct course through the patient's body; upon measurement, however, it was found that the strength of the current which thus passed through the tissues was less than one milliampère; the waste of current in administering a dipolar electric bath is, therefore, much in excess of what is generally supposed. In proper hands this method of administration is an available method of general galvanization; if painful at all it is at most only pleasantly painful, and, on account of its wide distribution and even application, it is a good method for appropriate cases. The question of density becomes a complicated one in this form of bath. Here it is evident that not only the size of the electrode is to be considered, but the amount of diffusion the current undergoes in passing through the water from the electrode to the body. This depends partly upon the size of the electrode, partly on the distance, and partly on the conductivity or the specific resistance of the water. In other words, says Dr. Hedley, " we have not only to consider the size and position of the electrodes electrizing the water, but we have to look upon the whole extent of water in contact with the body as a huge electrode, carrying a widely diffused current with a density, of course, diminished in proportion to its diffusion."

Various other forms of electric bath are in use; for instance, in what is termed the needle bath, where the patient is surrounded by coils of pipe containing minute perforations through which water flows with force against the surface of the skin, he may be placed upon an insulated mat connected with one pole of the galvanic or faradic battery, while the other is connected with the water-pipes; in this way the current is carried by the water acting as an electrode. Where one electrode is held by the patient, applied directly to different parts of the body, the other being immersed in the bath, we have what is called the monopolar bath. The monopolar bath is not as well adapted to the treatment of disease as the dipolar, according to Stein, because of the great difference of current density between the immersed surface and that part to which the other electrode is applied. Eulenberg considers it quite unsuited for scientific work. In the dipolar bath the current density does not fluctuate, and polarization is at the minimum. Bartholow thus sums up the effects of the dipolar bath: In faradic baths of ten minutes' duration the electric sensibility is increased, whilst a distinct diminution of motor excitability takes place. The cutaneous sensibility to faradic stimulation is for a brief time increased, but afterward considerably lessened, whilst to the galvanic the diminution of cutaneous sensibility occurs at once, and is maintained throughout. At first, both in faradic and galvanic baths of moderate strength, the frequency of the pulse is lessened, after a time to return to the normal. With a powerful and long-continued current-action the frequency of the pulse increases during the bath, the tension of the vessels is elevated, and sometimes there is irregularity in the action of the heart. As respects the respiration in dipolar baths, galvanic and faradic, the number of the respirations is increased and in volume deepened, whilst in monopolar this effect is much less pronounced. The temperature is little affected in dipolar baths, but is lowered in monopolar. As respects the excretion of urea, the effect of the dipolar bath, galvanic and faradic, is much greater than the monopolar. All forms of electric baths stimulate the appetite, increase the digestive power, promote intestinal peristalsis, and affect agreeably the mental state; also sleep is promoted, and various functional nervous affections improved. The difficulties of administration of the various forms of electric baths are such that, unless they can be proven to enjoy marked therapeutic advantages over other forms of application of the current, they can never obtain much prominence in therapeutics; however, as they combine, to some extent, the advantages of hydrotherapy with electricity, they possess peculiar value for institutions in which the proper apparatus is at hand for the purpose.

Electricity in Medicine.—Electricity, as a therapeutic expedient, belongs to a division which is quite distinct from the ordinary classes of remedies. The various well-known forms of energy,—heat, light, motion, and electricity,—when considered as therapeutic agents, may be grouped together, for convenience, as "imponderables," or simply as "forces." The distinction is very marked between material substances, like **drugs,** which temporarily become a part of the human body, and during this time affect certain functions and produce disturbances of nutrition, which may or may not be ultimately beneficial, and **forces,** which directly act upon tissues and cells, exciting normal irritability of muscles and nerves, and, when properly and successfully used, aiding the functions of organs and strengthening vital powers. Electricity cannot, therefore, be considered as a department of the Materia Medica; it must be studied as a science by itself; but its application is an art which must be learned mainly by the bedside and from experience.

Different Effects Depending upon Various Modes of Application.—Electrical currents are applied through a greater or less extent of the body, according to the relative position upon the surface of the electrodes between which the force is technically considered as flowing. The effects vary according to conditions; they are classed as irritative (or excitant), electrolytic, thermic, cataphoretic, and catalytic. The latter word is rather uncertain in its signification; but it is a convenient term, under which may be included the actual, but not easily demonstrable, dynamic molecular action of the current, which has been already referred to in the preceding pages and which possesses a powerful influence in correcting perverted physiological processes and in restoring parts to a normal state. In ordinary medical applications of electricity,—as, for instance, in treating paralysis of certain muscles,—this dynamic or catalytic effect usually predominates over the chemical and electrolytic actions, the latter requiring, for their production, much more powerful currents than are ordinarily employed by physicians. The effects of the electrical current are, therefore, dependent upon the manner and method of its application. For instance, if we desire to obtain the electrolytic and cataphoretic effects of electricity we employ a galvanic current of low potential, as in treating urethral or other strictures by the method of Dr. Newman, of New York.* Here, moist mucous membrane being in contact with the electrode (negative), the energy of the current meets comparatively little resistance and becomes concentrated upon a very small area, where it produces decided electrolytic and chemical effects. On the other hand, in ordinary medical applications, where the percutaneous method is followed, the dry, horny layer of the skin offers great resistance to the passage of the current; hence the skin must be moistened, because moist tissues carry the current better than dry ones. When the current is diffused over a large surface by using large electrodes, it has its density greatly reduced, and the local effects are consequently less marked. Small electrodes, on the contrary, concentrate the effects. For the production of chemical changes, a degree of intensity of the current is required which is highly dangerous to the integrity of tissues, especially of the nerve-structures; therefore, measures are adopted for limiting the effects to the immediate neighborhood of the electrode. In the Apostoli method one very large, external, abdominal electrode is employed, which diffuses the current at one pole, whereas it is concentrated around the other pole by the use of a comparatively small intra-uterine electrode. Since, even in the Apostoli method, where heavy currents are used, no chemical changes in the blood or intervening tissues, except in the vicinity of the electrodes, have been noticed, it follows that chemical changes are not to be expected from the usual manner of applying this valuable therapeutic agent by currents used for medical purposes. Molecular or physiological change, however, does take place, as is shown by slight increase of temperature and improved nutrition and power in parts under treatment. This is explained by the hypothesis that the ultimate forms of matter—the atom and the molecule—represent force in perpetual action, and this motion takes place according to certain fixed laws. This is equally true of the molecules composing the human body, where the motion is also directed by physiological law. Now, the electrical current undoubtedly influences molecular motion, and produces polarizing effects which, within limits, are strictly physiological; for this effect we have no better term at present than to speak of them as the results of the dynamic molecular influence of the current, or " electrical

* See Clinical Lecture reported for the Medical Bulletin.

catalysis." The passage of a current of electricity, of either high or low tension, may be supposed to produce a tendency to polarization of molecules, all the electro-positive atoms, as far as possible, arranging themselves in series with the electro-negative bodies, so as to form a sort of chain of molecules of alternating electrical affinity, extending between the poles, when a portion of the human body is in circuit. As previously insisted upon, no actual flow of anything occurs, but successive waves of energy, when the circuit is closed, follow one another along the conductor, and from the positive electrode to the negative, through the tissues. These dynamic impulses, if sufficiently intense, or, in other words, if the current be strong enough, are capable of rupturing the bond between the molecules of the tissues and causing chemical change (**electrolysis**) and devitalization. In the latter case a blister and an eschar or slough (**electrocausis**) may be formed in the immediate vicinity of the electrodes and a burn of more or less depth result. Electricity of high pressure may also act upon the nerve-centres directly and cause death, as by a lightning-stroke, without producing lesions upon the surface of the body. Much lower degrees of electrical energy are employed in medicine, which, however, can be maintained within safe limits, and which produce only physiological and therapeutic effects.

Physiological Effects of Currents of Electricity.—A current of ordinary strength from a galvanic battery, passing along a motor nerve and muscle, causes contraction of the muscle at the time of making and breaking the circuit; but during the time the current is passing uninterruptedly no motion occurs. The nerve, at this time, is in a peculiar state or condition known as **electrotonus.** According to Pflüger, the portion of the nerve in contact with the anode (positive) loses its excitability and is in a condition termed **anelectrotonic**; the portion in contact with the cathode (or negative pole) has its excitability temporarily increased, and is said to be **catelectrotonic.** The anelectrotonus and catelectrotonus exist for a short distance from the point of contact of the poles, and are increased, with the augmentation of the current, up to a certain point, when they disappear. Bartholow accounts for this condition on the hypothesis that the chemical constituents of the nerve-trunk obey the laws of electrolysis, by which alkalies and hydrogen will appear at the negative pole and acids and oxygen at the positive, the effect upon the nerve being to a certain degree chemical. Where rapid reversals are made the muscles to which the nerve is distributed will be thrown into tetanic contraction (tetanus), and a similar condition occurs in certain morbid states from the application of faradic currents of moderate strength. This is especially likely to occur with the automatic, rapid interrupter, or rheotome, and this makes it necessary to have, for examination of such cases, a mechanism capable of making slow interruption of the battery-current in the primary coil, thus giving the muscle time to recover itself between the shocks. The faradic current is more irritating and stimulating than the galvanic; but when the interruptions are very rapid (from one hundred to two hundred per second) the faradic secondary current becomes sedative; and in many cases the anode relieves pain more quickly than the cathode. The very rapidly interrupted faradic current exercises an anæsthetic effect upon the peripheral nerve-endings, as lately demonstrated by Dr. Wm. F. Hutchinson, of Providence, R. I.

Methods of Electro-Diagnosis in Various Nervous Affections.—In studying the effects of brain-lesions and nerve disorders, proper apparatus is essential to determine differences in reaction and other evidences of departure from the normal standard. For electro-diagnosis we require each of the above-mentioned forms of current. The faradic coil should be constructed upon the Du Bois-Reymond pattern, in which the primary coil is of good size, and there should be at least two secondary coils,—one of fine wire and the other less fine,—and a scale in millimetres should be so placed as to indicate the position of the secondary coil, as related to the primary. The current is supplied usually by a single acid cell, of $1\frac{1}{2}$ or 2 volts, or two cells may be used of the Leclanché pattern. The external resistance being small, there is no advantage in having a larger number of cells, although, where a large coil is used for diagnostic purposes, two cells of the Law pattern are preferred by Dr. Walling,* who also points out that the dry cell is not suited for this work. In all faradic machines, when in use, the cell is on a short circuit; hence, the dry cell, having a tendency to rapidly polarize, soon runs down, and the battery will not again work until the cell has time to recover. The dry cell, however, is very convenient, in small, faradic batteries, for medical use, where the instrument will only be in operation for fifteen or twenty minutes at a time. To return to the large coil for diagnostic purposes, we find an advantage, as previously shown, in having the apparatus supplied with a slow, as well as a rapid, interrupter; and, for exact work, a clock-work rheotome is an advantage. With such an apparatus, muscular contractions may be obtained in some cases, in which no response will follow when the very rapid interruptions are made; or the latter may simply throw the muscle into tetanus, whereas, the slow interruptions permit the muscle to recover itself between the successive contractions.

As previously explained, in the induced current from the primary

* "Electro-Diagnosis in Brain and Nerve Injuries; Methods Used and the Apparatus Required." By W. H. Walling, M.D. Jour. Am. Med. Asso., vol. xvii, p. 764.

coil, the impulses follow each other in proportion to the rapidity of the interruptions; but they are all in one direction. That is to say, that they consist only of the currents set up by breaking the circuit, since those made by making the circuit are short-circuited through the cell. Therefore, there is a decided difference between the poles of the primary coil, and they may be marked anode and cathode, stronger contractions being obtained with the same strength of current when the cathode is placed over the muscle at the motor point, or on the nerve.

With the secondary coil, which furnishes the to-and-fro current, it is usually stated that there is no difference between the poles and no polarity. This is not strictly true, since the currents made upon breaking the circuit are more powerful than those set up when the circuit is closed; consequently, the current in one direction will be stronger than the other, and polar differences will be noted. Moreover, where the secondary coil is very long and the wire very fine, the resistance may be so great that the weaker current will not be able to pass through the additional resistance of the human tissues, and consequently we may get effects due solely to the stronger current, and the electrodes will then show anodal and cathodal differences, just as with the primary coil. The same result may be obtained from the secondary coil by the use of a commutator, as in the Ruhmkorff coil, by which both currents are made to flow in the same direction. Therefore, practical electricians who claim that there is a difference between the polarity of the electrodes from the secondary coil are quite correct, and those who maintain that there is no difference are in error.

The size of the electrodes is of importance. The indifferent electrode should be rather large, but the active electrode should be small. Erb prefers one of ten square centimetres; Stintzing uses electrodes of less than one-third of this size,—from one-third to one square inch of surface. The electrodes are provided with handles of non-conducting material and of convenient shape; they have their metallic extremities covered with leather, or, what is better, absorbent cotton, thoroughly wet with a saline solution, so as to favor the passage of the current through the skin. In order to obtain results for comparison, we not only note the number of millimetres of coil distance, but we also use the same electrodes, moistened to the same extent and applied to the same spots with equal pressure.

For general diagnosis, the patient, with as little clothing on as is convenient, is made to sit upon a stool, and a large, flat electrode (positive, or anode), covered with a wet napkin or absorbent cotton, is applied to the sacrum, or the patient may be allowed to sit upon it. If this is inexpedient, the feet may be placed in a basin containing warm water, in which the electrode is placed, connected with the secondary or primary coil of a faradic apparatus. The operator then applies the smaller (cathodal) electrode to the spine, commencing with a moderate current, and slowly carrying the electrode down the patient's back, upon each side of the vertebræ, noticing any effects which may occur, especially if tender spots are discovered. Anæsthesia or hyperæsthesia may be found, and, if so, the coil distance in each case should be recorded. Pain is not necessarily an indication of inflammation, nor of congestion, but these are common causes. When the electrode is passed over bony prominences pain may be felt; even the ribs are sometimes painful under the application, perhaps due to the effect of the current upon the periosteum or intercostal nerves. For testing cutaneous sensibility the wire brush is useful, or an electrode consisting of a bundle of fine, insulated copper wires, contained in a hard-rubber case. In this instance, one electrode is to be placed between the shoulders and the active electrode is placed alternately upon similar points on opposite sides of the body, when any change or difference may be noted. Paræsthesia, or diminution of sensibility, is a common symptom in many lesions of the brain, spinal cord, and peripheral nerves; but in the early stage of neuritis there is hyperæsthesia, which also may occur in hysteria and some reflex neuroses.

In using the galvanic battery for electro-diagnosis, we should have a sufficient number of cells (forty to eighty) to supply the proper potential for all required purposes, and the cells should not be too small for the work. The cells should be connected in series, and not in parallel. They may be connected with a pole-board and current-selector, or the current may pass through a controller, or resistance-coils, and a milliampèremeter, by which the strength of the current may be accurately measured. Where the potential is high, as in the Edison current for electric lighting, it has been claimed that, even though the current may be cut down by introducing resistance, the effects of the current are not identical with those from a battery supplying just sufficient potential for the work. The milliampèremeter may mark the same strength of current, but patients complain of more pain, and this is especially so in electrolysis, for removal of hair, small nævi, etc. As Dr. Walling says, "A painful and sensitive nerve quickly differentiates against voltage." Therefore, "when making a diagnosis, the meter, but not the controller, should be in circuit." De Watteville's method is to place the electrodes in position and commence with ten cells, then adding cell by cell, as needed, to get the reaction desired.

Attention has been already called to the physiological nerve and muscle reactions under galvanism and the reaction of degeneration.

(See page 124.) The following will show the method of comparing the electrical reactions of the muscles of the arms, one of which is supposed to be paralyzed. Having bared both arms and the chest of the patient, place a large, well-wetted sponge, or other, electrode upon the sternum, connected with the positive pole, and apply the cathode, or small negative electrode, to the motor points of the muscles of the sound arm first and note the reaction, following this by similar applications to the affected limb.

The currents should be only strong enough just to produce contractions in the healthy muscles, and the additional amount necessary to produce contraction in the paralyzed muscles, together with any alteration in the order of the normal formulæ, should be noted. The muscles should also be tested with the faradic current in a similar manner. The patient must allow the limb to be perfectly passive during the examination; if he will not do so, the muscles may be examined after the subject has been etherized. If, however, anodal closing contraction comes before cathodal closing contraction, and several trials confirm the observation, then degeneration may be positively diagnosticated. The relationship of this symptom to various lesions and diseases is set forth in the accompanying table, compiled after Adams, from Erb :—

Electrical Reactions.	Prominent Symptoms.	Seat of Lesion.	Pathological Conditions and their Location.
All normal.	Paralysis. No muscular degeneration.	Path of impulse from the brain (antero-lateral columns); or the brain itself.	Lateral sclerosis (idiopathic or from cerebral disease).
Nerve: Normal. Muscle: Qualitative and quantitative alterations. (Partial R. D.)	Paralysis. Muscular degeneration.	"Trophic centre" for the muscle, and also the path of impulse from the brain (antero-lateral columns).	Amyotrophic lateral sclerosis.
Nerve: At first normal; afterward diminished. Muscle: Qualitative and quantitative alterations. (Partial R. D.)	No paralysis at first. Muscular (afterward nervous) degeneration.	"Trophic centre" extending to multipolar ganglion-cells of the anterior horn of gray matter.	Progressive muscle-atrophy (of central origin). Bulbar paralysis. Mild acute poliomyelitis.
Nerve: } Reaction of de- Muscle: } generation.	Paralysis. Atrophy of muscles and nerves. Abolition of reflex actions.	Multipolar ganglion-cells of the anterior horn of gray matter.	Anterior poliomyelitis. Infantile paralysis. Lead poisoning.
All normal.	Paralysis. No degeneration.	Motor nerve-fibres.	Light form of rheumatic, traumatic, or pressure paralysis.
Nerve: Normal. Muscle: Qualitative and quantitative alterations. (Partial R. D.)	Paralysis. Muscular degeneration.	Motor nerve-fibres and path of trophic influence to muscle.	Middle form of ditto.
Nerve: } Reaction of de- Muscle: } generation.	Paralysis. Muscular and nervous degeneration.	Motor nerve-fibres, path of trophic influence to muscle, and path of same to nerve.	Severe form of ditto.
Normal, or diminution to maximum excitation.	Pseudo-paresis. Simple atrophy.	Muscular fibre.	Muscular wasting in phthisis, etc., and in diseases of the joints. Idiopathic myositis.

When a lesion is in the cord above the dorsal enlargement, as in some forms of **transverse myelitis,** all the nerve and muscle reactions, according to Dr. Walling,* will be normal for the parts below the trophic centre, except that, possibly, there may be some increase in readiness of response to electro-stimulation. If the lesion involve the dorsal enlargement, of course, there would be the reactions of degeneration. If the lesion affect the **basal ganglia** of the brain or the **hemispheres** there will be no change in the normal nerve-muscle formula unless the disease, in its progress, produces changes in the cord, thus also affecting peripheral nerves. In a **hemiplegia resulting from a clot in the corpus striatum** there will be no change in the reactions, except that in some cases the muscles respond more readily than normal to both currents. In old cases there may be a quantitative decline, due to degenerative changes, both in nerve and muscle. In **uncomplicated lateral sclerosis** the reactions are normal. In **amyotrophic lateral sclerosis** there will be both qualitative and quantitative changes in the muscles or partial reaction of degeneration. In **anterior poliomyelitis, infantile paralysis,** and in **lead-palsy** the reaction of degeneration will be present. It will also be found in **peripheral palsies** of traumatic, rheumatic, neuritic, or diphtheritic origin. It is absent in all **cerebral, hysterical, myelitic,** and **purely myopathic paralyses.**

In cases where the reaction of degeneration is limited to a definite, peripheral, neuro-muscular area the probabilities are in favor of the diagnosis of a peripheral lesion. When the degeneration phenomena are observed over a larger area a central (spinal) origin of the paralysis is rendered probable.

In **light forms** of rheumatic, traumatic, or pressure paralyses the reactions will remain normal, but in **severer forms** the reactions of degeneration develop themselves. In **muscular wasting** or **simple atrophy,** as in phthisis, in diseases of the joints, and in idiopathic myositis, the reactions are normal, or may be quantitatively reduced. When the reaction of degeneration, either complete or partial, occurs, we conclude that an alteration (degenerative atrophy) has taken place, either in the trophic centres or motor fibres going to the affected muscle, although Gessler claims that no such reaction is given unless the muscular structure has also undergone degeneration.

It should be borne in mind that it is the density of the current in the nerve which determines the amount of excitement, and not merely the volume of the current as registered by the milliampèremeter, and that this **density in the nerve** is controlled by the **size** of the active electrode and the **location** of the two **electrodes** (Adams), as well as the current

* Loc. cit.

intensity. Attention is no longer given to the **direction** of the current, so that no advantage is gained by placing the two electrodes on the skin along the course of the nerve. The indifferent electrode may be above or below the point of application of the **testing** or **active** electrode, as it is the action of the pole upon the part that is sought and not the direction of the current.

Clinical Electro-Therapeutics.—The clinical applications of electricity are partly deduced from the scientific data just given, and partly derived from experience. Although the essential identity of electricity from all sources is insisted upon, it is to be noticed that, under different conditions, and especially when supplied from different sources, the effects depend largely upon the conditions and methods of application. In practice, therefore, it is convenient to speak of electricity from the galvanic battery, the faradic coil, or the static apparatus, as if they were actually different kinds of electrical current. Indeed, it has been found that no one form is applicable to every purpose, and the physician, therefore, requires several forms of apparatus, and it needs some knowledge of the subject and some experience in order to determine which form shall be used. According to Rockwell, in nearly all cases where electricity is called for, each one of the forms—faradism, franklinism, or galvanism—might, at one time or another, possess positive value over the others. This authority gives the following differential indications for the use of dynamic and franklinic, or static, electricity: "Hemiplegia, accompanied by exalted muscular contractility, calls for a mild and rapidly interrupted **faradic current,** if for any form of electricity whatever. Indeed, this current is usually preferable, if the muscular contractions were only somewhat less readily called out than in the normal state. The **galvanic current** is indicated when there is very great diminution of electro-muscular contractility. In most cases of paraplegia, either complete or proximate, loss of farado-muscular contractility exists, at least, for a short time, and the galvanic current alone is applicable. The faradic current might be useful in attempting to improve impaired nutrition of the paralyzed members. The constant (galvanic) current is alone applicable for directly affecting the central nervous system.

"In the great majority of cases of neuralgia, where firm pressure over the affected nerves aggravates the pain, the galvanic current is indicated; if pain is not increased by pressure the faradic current should be used. Hysterical hyperæsthesia calls for the faradic current. While it is impossible, in many diseases, to say that a particular current is indicated to the exclusion of others, it is possible to name a variety of conditions where, as a rule, one method of treatment with one form of current is superior to others. The faradic current is indicated, for its tonic effects, in cases known as general debility. Not much is to be said of individual conditions which seem to demand the faradic current alone." Some few distinct organic or functional diseases in every phase of their manifestation, according to Rockwell, demand a single form of electricity. For instance, asthenopia, accompanied by hyperæsthesia of the retina and ciliary nerves, seems to require the faradic current. It is also useful in the paralysis following diphtheria, in which galvanism is of little service. Galvanism is particularly useful in special irritation or neuralgia, and in certain neuralgic sequelæ of cerebro-spinal meningitis; also, in treatment of exophthalmic goitre and in restoration of sense of taste or smell. It is superior to faradism in the treatment of skin affections. The form of electricity required in chorea varies according to the general condition of the patient: central galvanization in the well-nourished, and general faradization in those whose general nutrition is impaired. The same may be said of amenorrhœa; but in dysmenorrhœa the galvanic current is more frequently indicated.

"Franklinic electricity is less efficacious as a constitutional tonic than general faradization, but is a valuable supplement to the latter. The pain of myalgia (muscular rheumatism) is relieved by Franklinism sooner and more effectually than by other methods, and it acts best when applied by a roller. Franklinism is superior to either galvanism or faradism for relieving pain of a chronic character, confined to no special nerve-trunk or distribution, with no tenderness on pressure over the nerve. It is also most efficacious in treating the enlarged joints of sub-acute and chronic rheumatism; and in facilitating absorption in synovitis it is best employed in the form of sparks. It is often superior to other forms in old contractions and in cutaneous anæsthesia. It has, however, a far more restricted field than galvanism, and is less convenient than either of the allied forms of electricity." *

Central Galvanization: Cautions with Regard to its Employment.—The method of **central galvanization**, as practiced by Beard and Rockwell, when supplemented by skillful manipulation, has produced very striking results, but it cannot be considered entirely safe in unskilled hands, and probably should not be attempted by the average operator. "The object of central galvanization," according to the authority just quoted, "is to bring the whole central nervous system,—the brain, sympathetic, and spinal cord,—as well as the pneumogastric and depressor nerves, under the influence of the galvanic current. One pole (usually the negative) is placed at the epigastrium, while the other is passed over the forehead and top of the head, by the inner borders of the sterno-cleido-

* Philadelphia Medical Times, vol. xiii, p. 345.

mastoid muscles, from the mastoid fossa to the sternum, at the nape of the neck, and down the entire length of the spine." The application to the head is made by passing the pole (positive), from one temple to the other, over the forehead, using from two to six cells (about two to five milliampères), or increased until a sour or metallic taste in the mouth is experienced by the patient. The electrode is allowed to rest for a minute or two upon the cranial centre or vertex, because a current passing from this point to the epigastrium traverses the facial-nerve roots and others in the medulla, and also the sympathetic. A labile application or sudden interruption of the current may cause dizziness or mental confusion. During from one to five minutes, the electrode is next passed on both sides, down the neck, as above described, thus affecting the pneumogastric, as well as the ganglia of the sympathetic. A weak current only is permissible here. Proceeding next to the spine, an especial application is made over the cilio-spinal centre, between the first and seventh cervical vertebræ. Although recent observations make it very doubtful if the current actually reaches the spinal cord, there is no question about the effects upon the spinal nerves, and so the cord may be affected indirectly; and the same remark applies to the great sympathetic ganglia. The positive pole is carried the whole length of the spine, the application lasting from three to six minutes. The whole length of the sitting required for central galvanization should not exceed fifteen minutes. The disrobing required is simply, in a male patient, the removal of the coat and waist-coat and loosening of the clothing, so that access can be had to the epigastrium and the spine; and, in female patients, it is necessary to remove the corsets and to loosen the clothing at the neck and waist. The electrodes employed by Drs. Beard and Rockwell were a sponge- or flannel- covered, flat electrode (negative), having an insulated handle, by which it is held to the epigastrium by the patient himself. For the positive pole a flannel-covered electrode is used, having the disc parallel with the handle, so that it can be passed along the spine under the clothing. The battery should be a constant one, and furnished with a rheostat.

Objections to Galvanization of the Sympathetic in the Neck.—The best authorities speak of galvanization of the cervical sympathetic as a dangerous procedure, on account of the proximity of the pneumogastric nerve. Brown-Séquard remarked that he once tried to galvanize the cervical sympathetic of a friend in order to relieve him of a violent headache. "The effect was all we could desire against the headache, but the galvanic current (acting at the same time on the sympathetic and vagus, the simultaneous action of these two nerves cannot be avoided) produced such dangerous syncope that I would never again attempt to apply galvanism to the cervical sympathetic of man."

The galvanic current differs clinically from the faradic current in having much greater quantity with less tension or difference of potential, and hence produces greater dynamic and physiological effect than the latter, which, owing to very high tension, is apt to cause pain and excite muscular spasm, even with weak currents. It may be continuous or interrupted, and, as it is definite in its direction, it is capable of being reversed. Owing to its large volume or quantity, it penetrates the tissues more deeply.

The Medico-Legal Value of Electricity in Diagnosis.—Dr. W. B. Pritchard reports* a case of traumatic neuritis in which electricity proved of much value in aiding the diagnosis. "A man aged 49 received an injury to his shoulder under circumstances which would have entitled him to some compensation if any permanent damage had been done. When the swelling had gone down he complained of great pain in and around the shoulder, and of inability to raise the arm from the side. It could not at the time be determined whether this was due only to the pain, or whether there was loss of muscular power. There were tenderness and pain in the areas supplied by the supra-acromial branch of the cervical plexus and circumflex nerves, and some hyperæsthesia of this region. In the course of the next few months the pain and weakness remained much about the same, and it was then found that the circumflex nerve gave the reaction of degeneration. This set all doubt as to the existence of a traumatic neuritis at rest, and the patient succeeded in obtaining compensation without going into court."

Special Applications of Electricity in Clinical Medicine.—Disorders of the locomotive apparatus were probably the first to suggest the employment of electricity in medicine, owing to the fact of the contraction of the healthy muscular fibres when a current is made to traverse them, especially if the position of the electrode correspond with the entrance of the nerve into the muscle or the nerve-trunk itself. Paralysis, therefore, was the first condition to receive electrical treatment, and still is regarded as being especially amenable to the current. Pathological research and clinical observation have finally revealed the varied causes of paralysis, and clearly show the reason why a form of treatment so efficient in some cases is useless, or even injurious, in others. Paralysis of a muscle, or group of muscles, may be due to purely local causes; it may be due to a lesion of the nerve-trunk, or in its fibres of insertion or origin; it may also be due to a disorder of the centre in the brain or cord corresponding to the muscles affected, or to reflex irritation. Occasionally we see it caused by some remote or reflex cause which influences the nerve-centres, as in paralysis follow-

* New York Medical Journal, November, 1890.

ing intestinal inflammation, or in the form known as hysterical paralysis. When a morbid condition arises from such diverse cause as in the example just cited, it is very evident that the scientific treatment, which includes removal of the cause where it is possible so to do, would depend upon the diagnosis. The first principle of successful application of electricity, therefore, as already stated, is correct diagnosis, and a clear appreciation of the objects sought to be obtained by the current to be employed, and in some cases a combination of different forms of current will be necessary in order to attain the desired result. If to good diagnostic powers we add familiarity with the effects of electricity and skill in their applications to produce such effects in the living human body, we are in a position to employ this invaluable therapeutic agent with every prospect of success. In the following pages a review of some of the recent and more useful applications of electricity is presented, but for a complete exposition of electro-therapeutics we must refer to the systematic treatises of Beard and Rockwell, de Watteville, Liebig and Rohé, and the numerous monographs by Apostoli, Massey, Adams, Peterson, and others.

Effects of the Galvanic Current upon the Vitality of Disease-Germs.—From various experiments by Cohn and Mendelsohn and others, it has been ascertained that the vitality of bacteria may be destroyed by the passage of a current of electricity. Blackwood states that galvanism readily destroyed all varieties of germs, from twenty-five to one hundred and seventy-five milliampères being required. Strong currents, such as from ten to thirty-five ampères, not only killed the microbes, but caused them to disappear entirely. Quantity or ampèrage is the main essential: for low quantity under strong voltage was ineffectual, whilst high ampèrage under comparatively low pressure was efficient always. Blackwood states * that he has obtained satisfactory results in actual practice in a number of diseases, such as scabies, lichen, favus, etc. In typhoid fever, dysentery, phthisis, diphtheria, intermittents, and sporadic cholera he reports good results from the application of galvanism as above indicated. He suggests this field to other experimenters as a promising one for further investigation.

Electricity for the Relief of Pain.—Dr. W. F. Hutchinson † uses the faradic current by preference in **muscular rheumatism**, observing strictly the following precautions: A coil must be used which gives a fine, steady current, *i.e.*, one without jumps or sudden interruptions, and of adjustable force. Only so much ought to be used as produces a distinct

* W. R. D. Blackwood, M.D., "Has Electricity any Action as a Germicide?" Medical Bulletin, February 18, 1892.

† New England Medical Monthly, September, 1891, p. 622.

vibratory sensation without sharp pain. Before applying the electrode, see that the skin is thoroughly dried and well-powdered with a good conductor, and for this purpose starch is not so good as a mineral substance like powdered clay. The active electrode should be of polished metal,—a ball or rounded tube,—kept dry and warm; the passive may be a small sponge, held in the hand or at any indifferent point. Beginning with a force scarcely felt, slowly increase, keeping the active pole in constant motion over the painful muscles, observing carefully to avoid contracting a single fibre. If muscle contraction be produced no good results. All the force must be expended upon the skin; in other words, upon terminal nerve-filaments, which are alone the seat of pain in this annoying disease. Every inch of skin covering painful parts should be carefully gone over with the current, exercising a steady, slight pressure, for about a half-hour, and applications repeated twice daily until the case is well. It is unusual, he states, for a violent attack to persist more than two days with this treatment. De Watteville also recommends cutaneous faradization, and states that galvano-faradization may, with advantage, be sometimes substituted for it. He also says that the galvanic current may be applied: the current—moderate to strong—is passed for a few minutes, and the sitting concluded with a series of interruptions or voltaic alternatives, so as to excite the muscular tissue to contraction. We have obtained excellent results in pain confined to muscles—**myalgia, lumbago, stiff-neck**—by a resort to static electricity, which affords marked relief to the pain and does not require removal of the clothing.

The treatment of **articular rheumatism** by electricity is a novelty, and yet Dr. W. F. Robinson, of Albany, N. Y., reports excellent results from it.* Therapeutically, he divided cases of rheumatism into two classes: those in which only one or two joints are affected, which he always treats by means of galvanism; and secondly, those in which the rheumatic poison is more extended in its action, involving joints, muscles, fascia, etc., for which he employs static electricity. The electrodes, he writes, should be large and carefully made. If covered with sponge, this should be soft and free from gritty particles. In order to increase the conductivity of the skin, the sponges should be saturated with a hot solution of bicarbonate of soda. The caustic action and the electrolytic action of the electrical current are to be avoided in the treatment of rheumatism. The action of vital stimulation is to be sought; to obtain it the procedures of interruption and voltaic alternation must be adopted. Voltaic alternation is a still stronger stimulation

* Proceedings American Electro-Therapeutic Association, First Annual Meeting, Philadelphia, 1891. Medical News reprint.

than interruption, but it must be used with caution, for with strong currents the pain and irritation are very great. Joint-rheumatism, pure and simple, is almost powerless to withstand the direct application of the galvanic current. When the disease is more diffused, and involves various tissues and organs in different parts of the body, static electricity is indicated. The general charge is rarely used alone, and static electricity is usually given, by means of special electrodes, in the form of sparks. The applications may be made on alternate days. The usual length of the treatment is ten minutes, for about five of which sparks are drawn, the patient during the remaining five minutes simply sitting quietly upon the platform and taking the general charge.

Dr. Robinson states that electricity has a twofold action that meets all the indications of rheumatism: a specific action against the morbid process, and a general tonic action that tends to build up the system depressed as a result of the disease. Dr. Goelet, at the same meeting, stated that the sedative effects of galvanism could best be had by currents of short duration. He prefers a clay electrode, made of the consistency of putty, and maintains it so by keeping it moist. A flat pad is made by rolling it on boards, as if it were dough; it is gotten into shape, and, after having a metallic plate placed on the back, is covered with a layer of absorbent cotton, and is then sewed up in a gauze cover. On the back is placed rubber cloth, just as in sponge-covered hand-electrodes. To avoid the discomfort of a cold application, the electrode may be kept on a warming-pan, consisting of a flat tin or zinc jug filled with hot water. Dr. M. A. Cleaves also reported cases in which marked benefit followed the use of the galvanic current in **articular inflammatory exudations.** Stabile applications, of ten-milliampères strength, for fifteen minutes, with the anode at the sternum and the cathode applied over the affected joint, were followed by relief from pain, diminution of heat, and increased mobility. The current was used daily for a week, and then every two or three days, until thirteen *séances* were given, when faradism was applied to the muscles around the joint, with the cathode at the sternum and the anode applied successively to the motor points of the various muscles. The ultimate result was decided and satisfactory. Ankylosis, the result of chronic inflammatory processes, even with some osseous union, according to Dr. von Raitz, of New York, yields to the constant current, with the assistance of massage and passive motion. The various forms of **neuralgia** are amenable to electrical applications,—in all cases for amelioration, in most cases for cure,—in proportion as they are pure neuroses, and not the result of decided structural change. Electricity, says Dujardin-Beaumetz, is one of the most active agents in the treatment of rebellious neuralgias. Galvanic currents are preferred to faradic.

The negative pole is applied near the nerve-centre; the positive pole (which is the truly sedative pole) may be moved over the different painful points of the affected nerves. In **tic douloureux** the currents should be very mild,—not to exceed three to four milliampères. In sciatica much stronger currents are required (twenty or more milliampères). He agrees with Apostoli, in holding that the stabile applications should be continued until the pain disappears or some mitigation is observed. Duchenne preferred the use of faradism,—applying the wire brush over the affected area, and employing a very strong current with rapid interruptions. Electro-puncture, as practiced by Magendie, is no longer used.

Electric cataphoresis, as it is called, by means of which medicaments are carried through the skin under the action of electrical currents, is a new and valuable addition to our resources in the treatment of neuralgia. As shown some years age by Adamkiewicz, the wetting of the active electrode with chloroform leads to its local absorption. In the place of chloroform, we now use cocaine solution (10 to 20 per cent.). Aconitine may be substituted, or any soluble alkaloid. Anodic electrolysis in conjunction with cocaine cataphoresis, says Adams, gives great relief in neuralgias and other painful affections. If a considerable quantity of medicament is sought to be introduced, we may have the electrode in the form of a tube closed at one end with a porous partition (Du Bois-Reymond's conducting tube, stopped with a plug of clay), and since, according to Munk, the current should be occasionally reversed, it is necessary to have both electrodes charged with the substance used. Dr. Arthur Harries* prefers cocaine cataphoresis to hypodermic injections. He employs a large negative electrode wet with a salt solution, and the positive is small, covered with flannel, and wet with a 10-per-cent. cocaine solution. A continuous current of twenty-five milliampères is then passed for forty minutes, the electrodes being kept moistened with the solutions. Peterson† claims that "the anæsthesia produced by a 10- to 20-per-cent. solution of cocaine on the anode is sufficient for small operations, and affords distinct relief for from four to eleven hours in cases of severe neuralgia in superficial nerves." His method of securing accuracy of dosage, which is as follows, is ingenious: "It is necessary to use a flat, metal electrode, made preferably, but not necessarily, of platinum or tin. It may be of any convenient size and shape. A piece of filtering-paper or linen is cut to fit over the metal surface; this is soaked with a definite quantity of the solution to be used, and the electrode is then applied to the skin. A narrow soft-

* Lancet, October 25, 1890.
† Medical Record, January 31, 1891.

rubber rim at the edge of the electrode prevents any loss by evaporation. In order to have drugs ready for use at any time, discs of paper to fit the electrode may be charged with aqueous or alcoholic solutions and then allowed to dry, a drop or two of menstruum being added when they are to be used. The strength of current is regulated largely by the patient's feelings, but from five to twenty milliampères, or from ten to thirty cells may be used for five to fifteen minutes. The stronger the current, the shorter the duration of the sitting. The indications are: 1. To produce local anæsthesia for neuralgia, superficial pains, and cutaneous operations, a 10- to 20-per-cent. cocaine solution is used. Aconitine produces a deep analgesia, but it is accompanied by severe smarting around the edges of the anæsthetized area. Three or four drops of a 1-per-cent. solution of helleborin cause a deeper and more lasting anæsthesia than cocaine, without producing constitutional effects. Both ouabaïn and strophanthin, in doses of $\frac{1}{250}$ grain or more, are strong local anæsthetics. One or two drops of chloroform bring about a deep analgesia in a short time, but this is followed later by vesication. A mild solution of carbolic acid may also be employed as a local anæsthetic and analgesic. 2. For topical medication in various local lesions,—such as tumors, rheumatic, gouty, and other swellings; various skin diseases, syphilides, etc. In these cases iodine preparations, lithium, and mercuric salts may be used. 3. To induce absorption of medicines from baths. 4. For diagnostic purposes. Thus, if a pain were complained of in the region supplied by the trigeminus nerve, it should disappear under this treatment; if it did not, the lesion could be localized farther back, or it might lead to the conclusion that it was a hysterical pain."

In a communication to the American Electro-Therapeutic Association last year, Peterson stated that special forms of electrodes are no longer considered necessary, since ordinary sponge-covered electrodes will answer for solutions where accuracy is not specially required, and metallic ones for the more careful administration. The latter are supplied with a narrow rim of rubber to prevent evaporation, and a disc of cotton cloth, tissue- or blotting- paper may be cut to fit the surface, and upon this the desired number of drops of the drug in solution can be placed. Discs of filtering-paper containing a known quantity of the remedy may be kept on hand for this purpose. Cocaine employed in this way does not cure neuralgias. All that is claimed for it is that it affords relief without producing constitutional effects, and is, therefore, superior to any narcotic given internally. Where the cause of the neuralgia is deep-seated the improvement is much less evident than when the lesion resides in a superficial nerve, and Dr. Allen Starr calls attention to this valuable hint in diagnosis, as regards the question of surgical operation. If the pain be relieved temporarily by the treatment, the lesion is in the immediate neighborhood or peripheral to the anæsthetized area, and this would suggest the possibility of permanent cure by neurectomy or nerve-stretching. Dr. Fouveau de Courmelles, of Paris, presented a paper at this meeting of the Electro-Therapeutic Association, in which he stated that the pain of hepatic or renal colic may also be made to disappear by medicamental electrolysis or cataphoresis.

In various forms of neuralgia relief may be afforded from the action of galvanism by anodal diffusion over the painful spots. In no painful affection, says Bartholow, is the application of electricity more conspicuous for good than in **sciatica.** Large sponge-electrodes, moistened with hot water, are applied, both—labile and stabile—over the course of distribution of the nerve, using currents of twenty to forty milliampères. The applications should be made twice a day, if possible, or at least once daily. **Intercostal neuralgia** and **herpes zoster** also yield to galvanism, using small electrodes, applying one (usually the cathode) to the spine and the other to the distribution of the nerve in front; or, to place the anode over the painful points where the nerves become superficial, and the cathode on the terminals.

In **migraine,** in addition to the administration of remedies directed to the stomach, we apply galvanism, in the same manner as just indicated, to the supra-orbital nerve distribution. Galvanization of the sympathetic in the neck and of the pneumogastric, as practiced by Du Bois-Reymond, can only safely be practiced by an expert. Faradism, with very rapid interruptions and mild currents, may be used, in conjunction with gentle massage (the electric hand).

In **angina pectoris,** Eulenberg reports good results from galvanism administered in the intervals between the attacks.

Various forms of **visceral neuralgia** are amenable to galvanism. The applications may be entirely to the surface of the body, or one electrode may be introduced into the stomach, rectum, or vagina. Faradic electricity may also be used; mild currents and frequent interruptions for the sedative effects, and the electric brush, with stronger currents, to the skin as a counter-irritant.

In **gall-stone colic** with impaction, good results have been obtained by passing brief currents of high intensity, the electrodes being placed in the hypochondriac regions. The electrical stimulus produces contraction of the fibres entering into the common duct, and the consequence is that the stone is discharged into the intestine.

The Static Current in Neuralgia—Morton's Method.—For pain not accompanied by evidences of acute inflammation, perhaps no form of application can equal franklinism. Indeed, Adams states that "In all vasomotor disturbances, functional cerebro-spinal diseases, or neuroses, there is nothing, in the author's experience, which equals in value the diffused and the concentrated constant high potential currents from electro-static induction machines." As already explained, the diffused constant current or electro-static bath is where the patient is placed upon an insulated platform and charged with the current. The concentrated constant current is obtained by bringing an electrode near to any desired spot upon the surface, and thus drawing a shower of sparks from this locality. In the former case the circuit is completed at all parts of the body through the air, and in the latter by means of the spray coming from or going to a pointed metallic electrode which is in connection with the ground. By an ingenious device of Dr. W. J. Morton, of New York, contained in a peculiar-shaped instrument named, in consequence, the "pistol electrode," the current is tapped in the rheophore, and the electrodes may be placed directly in contact with the patient's body, just as in the application of the faradic current. In using this method of Morton, as practiced by Bartholow, one brass chain is fastened to the top brass knob of one condenser (the left one being the higher potential), and another brass chain is placed around the base, over the metallic coating of the other condenser, and to each chain an ordinary electrode (preferably a carbon electrode), covered with leather, is attached. The discharging rods are placed at a distance apart, which is determined by the effect to be accomplished, which consists in the faintest tingling when the rods are nearly together, or the most powerful muscular contractions when they are some distance apart. The same kind of irritation of the sensory nerves is caused by this interrupted current as that caused by the faradic; but it is softer. The most powerful muscular contractions can be produced without causing pain; and in this respect static electricity possesses distinct advantages over faradic. The interrupting handle of Morton is dispensed with in Bartholow's method; indeed, no special electrodes are required, and only as much of the current is taken as is desired.

Either electrization by sparks or by the Morton method may be employed in advantage in trifacial, intercostal, sciatic, and other neuralgias. General franklinization is especially useful in **hystero-epilepsy.**

Anæsthesia is very commonly functional and often a manifestation of hysteria. In such cases the anæsthetic area will, under a few applications of the faradic brush, rapidly recover its tactile sense. When the loss of sensation is due to inflammation, compression, traumatism, or other lesion, except actual loss of continuity of nerve-fibres, it will, as a rule, also be soon restored by electricity. When the galvanic current is employed the anode should be over the nerve-root and the cathode over the anæsthetic area, or the galvanic brush or faradic brush may be used. In **trigeminal anæsthesia,** Liebig and Rohé indorse transverse brain-galvanization; galvanization of the trunk and branches of the fifth nerve; the faradic brush to the anæsthetic surface, or to a small area of the forearm, as recommended by Vulpian. **Hemianæsthesia,** due to central or toxic causes, very frequently yields to the application of the faradic brush according to Vulpian's method. **Tabetic** and **traumatic anæsthesia** may be relieved, but not fully restored, unless the nerve-trunks can be made to resume a normal condition. **Anosmia,** or loss of the sense of smell, if not depending upon disease of mucous membrane, may be cured by faradization. In weakness of vision, amblyopia, amaurosis, **anæmia of optic disc,** and especially in tobacco-amaurosis (scotoma), electricity is of great value, the applications being made through moist compresses applied to the closed eyes,—the anode locally, and the cathode to the temple or the cheek. The strength of the current should not be greater than just enough to cause faint flashes of light, and the *séances* should last only a few minutes. Galvanism should also be directed to the cervical sympathetic and to the cilio-spinal region of the spinal cord. In anæsthesia of the auditory nerves, and in tinnitus aurium, Brenner, Erb, and others have conclusively proved the value of the polar method. The canal is filled with warm water; a special electrode may be used, or the ordinary small electrode may be dipped into the water and inserted into the ear. By the judicious use of this expedient, tinnitus aurium has been stopped after it had existed for years. In some cases, very marked improvement was noticed after the first application or after a few applications.

Electricity in the Treatment of Paralysis.—The favorable influence exerted by electricity over nutritive processes and cell-growth, especially in the form of galvanism, has made it the indispensable remedy in the treatment of various forms of paralysis, whether due primarily to nerve or to muscle. It is not judicious, in **hemiplegia,** to employ the electrical current too early, on account of the lesion in the brain; but after the first shock of the brain-injury is over, whether an extravasation or an embolus, and the parts are accommodating themselves to the condition and repair is going on, in a week or two after the attack came on, the electrical current may be used to keep up the nutrition of the muscles, employing both galvanic reversals and the faradic interrupted or labile applications. The precaution should be observed of only using a current strong enough to produce moderate contractions, and not continued very long (fifteen to twenty minutes for the entire *séance*). In various forms of **monoplegia** and paralysis of individual muscles, galvanization may show the reaction of degeneration due to local nerve or muscle changes;

but the systematic application of galvanism, at first stabile, followed by a few current reversals, and the faradic brush or static breeze or sparks, will cause the normal formula to be restored. Hygienic remedies must not be neglected, including massage, baths, and passive exercise. In **diphtheritic paralysis,** or **paralysis following typhoid** or other **exhausting** diseases, brain and spinal galvanization, with direct applications of both faradism and galvanism, should be resorted to. Static electricity is also useful here. In **lead-palsy, mercurial paralysis,** and similar toxic paralysis, the galvanic current may be applied to the affected groups of muscles, and the faradic to their opponents. **Paralysis of the laryngeal muscles** may be treated by intra-laryngeal applications of galvanism or faradism, with special electrodes, as practiced by Elsberg or by von Ziemssen. Equally good results, it is claimed, may be obtained by the method of Erb, in which the anode is placed under the occiput at the root of the neck, and the cathode applied to the front of the neck along the larynx and trachea. Faradism may be applied in the same way, but weak currents only should be used.

In **aphonia of hysterical origin,** the faradic brush or the static spark is promptly curative. In paresis accompanying neuritis and perineuritis, galvanism (anodic) is very useful, and farado-massage applied when the acute stage is over.

In **facial paralysis** due to inflammation in the course of the portio dura, the prognosis depends upon the extent of the lesion and its duration. In slight cases, the muscles may recover without any treatment; but this result will be attained much more rapidly under mild faradization. Where the reaction of degeneration is present, the patience of the operator and subject may be put under a considerable strain; but galvanism (cathodic) with current reversals and the faradic brush will, in most cases, bring about a cure in the course of time. If the diagnosis be made at the beginning and announced to the patient, it may save later disappointment on account of the apparent want of results from the treatment. **Facial paralysis of central origin** is more serious in its prognosis than the peripheral form. Recoveries are comparatively rare, but improvement may be expected from systematic electrical treatment; with galvanization to the head and neck, and polar applications to the affected muscles.

Spasms and contractures call for the sedative applications of the galvanic and faradic currents. Anodic applications in cases of **blepharospasm, convulsive tic, histrionic spasm, contractures following rheumatism,** are sometimes very successful; in others, complete failures. In the latter, the spasm may be due to some source of reflex irritation, such as latent hypermetropia, or myopia, dental caries, etc., which should receive attention before attempting treatment by electricity. In **hysterical spasm and contractures,** the faradic brush or static sparks are useful, especially if disagreeably painful. Spasm of muscles of deglutition may be due to a wisdom-tooth which is about erupting, and incision of the overlying gum will relieve it, perhaps assisted by a few applications of galvanism. **Hystero-epileptic** attacks may sometimes be broken up with the faradic brush or strong galvanic current. In **epilepsy,** Erb recommends diagonal followed by longitudinal brain galvanization to affect the motor area in the cortex; then subaural and spinal galvanization, limited to the cervical region, and general faradization for their reflex effects. This is to be practiced between the attacks, in combination with the usual remedial and hygienic treatment.

In **writers' cramp** and other forms of co-ordination neuroses, excellent results are afforded by rest and electro-massage. Erb lays down the rule that the entire cerebro-spinal nervous system should be subjected to systematic electrization. First galvanization of brain and spine, then of the peripheral nerves. Faradization of the affected muscles is combined with massage. By the method of Wolff, in which this is systematically practiced, a number of cures have been reported.

In **tetany,** galvanization of the spine and peripheral nerve-trunks and the anodal applications to the spine (Erb) have given good results. In **tetanus** proper, which is an infectious disease, not much can be gained by electricity, although spinal galvanization, with galvanization of the peripheral muscles, is said to have had a good effect upon the spasms. **Chorea** is benefited by weak currents, or by general franklinization or faradization. **Athetosis** is said to have been improved by brain, subaural and central galvanization, with currents from the spinal cord to the peripheral muscles (Liebig and Rohé).

Explanation of Production of Degeneration-Reaction Phenomena.— When discussing, on a previous page, the question of electro-diagnosis in paralysis, it was stated that there are important alterations in the electrical reactions. If a muscle be paralyzed by sectioning its motor nerve, or by the use of certain toxic agents which affect the nerve only and leave the muscular fibres healthy, we have a marked difference manifested in the behavior of the muscle under the electrical stimulus. For instance, instead of promptly contracting to the faradic current, we may find no response whatever when this (secondary or induced) current is used. With the galvanic battery, weak currents produce responsive contractions greater than in health, on making and breaking the circuit, or on reversing the current. With a stronger current, the muscle remains in a tetanic state of contraction while the current is passing, which is an abnormal phenomenon. Later, pathological changes occur, both in the nerve and in the muscle, due to removal of the influence from the trophic centres in the cord. When the lesion is destructive and irremediable, there is a gradual failure of galvanic as well as of faradic excitability of the nerve, ending in entire disappearance of the same in a few days. Before this is complete we have the following "degeneration-reaction":—

$$An\ Cl\ C > Ca\ Cl\ C > An\ O\ C > Ca\ O\ C.$$

This is well illustrated in a case of peripheral form of Bell's palsy, while the central or cerebral form of facial paralysis does not present this reaction.

Electro-Diagnosis in Paralysis.—We may summarize with advantage the results of the electrical examinations in cases of paralysis:—

Normal electrical reactions accompany diseases of the brain or spinal cord (white columns).

Abnormal electrical reactions, differing quantitatively from the physiological standard, usually accompany lesions of the gray matter of the cord or the peripheral nerve-trunks. The character and extent of the lesion may be judged by the promptness of response to the electrical current, and by the presence of the reaction of degeneration.

Increased electrical reactions may accompany general hyperæsthesia of the nervous system, and, if accompanied by reflex contractions of muscles in remote parts of the body, it suggests increase of spinal excitability, such as occurs in strychnine-poisoning, tetanus, hydrophobia, and other forms of disease. Should this phenomenon be restricted to a single muscle, or group of muscles supplied by a single nerve-trunk, the lesion is probably located in the afferent nerve. Dr. Haynes* sums up the diagnostic points in paralysis arising from disease of the gray matter of the cord as follows:—

"When the abnormal reactions are uniform, extending over an entire limb, the disease occupies a mass of its substance, as in the inflammation of the substance of the cord (**myelitis**).

"If they are confined to certain physiological groups of muscles the disease has generally been chronic and implicates the anterior roots of the spinal nerves, as in **progressive muscular atrophy**.

"If the degenerate muscles react in an irregular manner, neither according to distribution nor function, the disease has usually been the result of an acute inflammation of the anterior cornua, which has destroyed some of the nutritive centres and left others intact (**poliomyelitis anterior**).

"When a nerve is found deficient in response, and muscle normal,

* Electro-Therapeutics. C. M. Haynes, M.D., Chicago.

it shows alteration in the former, the latter remaining intact, as is sometimes seen in the early stage of **infantile paralysis.**

"The electrical reactions in peripheral paralysis indicate with exactitude the extent and distribution of the disease.

"When the electrical reactions are normal it indicates a paralysis of slight and temporary form; prognosis is favorable.

"Loss of response when either current is applied to nerve-trunks points to nerve-alteration, and this is in proportion to diminution of action.

"Loss of response to faradism, applied directly to a muscle, indicates changes in the intra-muscular nerves without necessary alteration of the fibres themselves.

"Loss of response with galvanism applied to the muscles shows a modification or destruction of the muscular tissue, and this in proportion to the physical changes induced."

The indications for the different forms of current are also well summarized by the same author:—

"Galvanism is indicated in those cases in which we wish to excite the nerves of the skin, to destroy the outer skin or mucous membrane, to produce an increase of warmth, to produce a chemical process, and also blood-coagulation.

"In certain peripheric palsies in which faradism fails, galvanism, probably in consequence of its uninterrupted duration, produces effects which cannot be brought about by the necessarily rapidly-interrupted faradic current.

"When a muscle has lost all power of responding to the stimulus of a faradic current, in many cases its sensitiveness may be restored by the application of a tolerably strong galvanic current.

"Faradism is indicated where we wish to excite either the motor or sensory nerves, to produce contractions of the blood- or lymphatic vessels, to effect certain organs supplied by the sympathetic nerve. To increase the volume of a muscle: This it accomplishes through exciting muscular contraction, which increases the temperature and at the same time improves the nutrition. To relax a tense muscle, or to loosen a peripheric contractor, single shocks from a strong faradic current are generally more useful than the galvanic.

"Galvanism not only acts as a powerful stimulant to nerves and muscles when interrupted, but during the time it is passing without interrution it produces a marked alteration in the nutrition. To this effect Remak gave the name 'catalytic action.'"

When paralyzed muscles exhibit the reaction of degeneration they are more sensitive to galvanism than faradism; therefore, the former should be selected to improve their nutrition. With this exception, faradism is a more powerful agent in the direct treatment of paralyzed muscles than galvanism.

According to Dr. Rockwell, in paralysis of one side of the body, or **hemiplegia,** when the muscles contract more readily under the influence of electricity than in health, electricity, if used at all, should be in the form of a very mild **faradic** current; even though the muscular contractions are not excited quite so readily as in a normal condition, the faradic is still to be preferred. On the contrary, when the contractility of the muscles is very greatly diminished, the **galvanic** current is indicated, the faradic current being only employed after the muscles begin to contract under its influence. In most cases of paralysis of the lower half of the body, or **paraplegia,** there will be found, after a short time, more or less complete loss of farado-muscular contractility; the galvanic current alone is useful in these cases to restore nerve-excitability, although the faradic may be usefully employed to improve the impaired nutrition of the paralyzed members.

Paresis, or a condition of partial paralysis, is frequently materially benefited by electricity, both galvanism and induced currents being employed. Here we may again caution against the use of too strong currents and too prolonged administration. The contractions of the affected muscles should be slowly produced, so as not to fatigue the muscle or cause discomfort to the patient. In **constipation** owing to defective peristalsis, often due to a paretic condition of the muscular tissue in the intestinal wall, very prompt effects can be obtained by either faradism or galvanism. In using the former a sponge-covered electrode, well moistened, is placed over some indifferent point upon the surface, or it may be held in one hand; the other (similarly prepared) electrode is passed around the abdomen in the direction of the large bowel, commencing at the right side, just over the cæcum, and gradually following the ascending, transverse, and descending colon to the sigmoid flexure. This may be accompanied by kneading the abdomen, or percussion (abdominal massage). For the application of galvanism an olive-shaped electrode may be passed into the rectum, the other being placed on the surface of the abdomen, in the form of a flat sponge. A moderately weak current, not strong enough to cause burning or other disagreeable sensation to the patient, is now passed, and the current broken and reversed several times a minute. If the constipation be simply due to inertia or paresis the effect will be prompt, pleasant, and highly satisfactory to both patient and physician. The treatment of **enlarged prostate** is conducted in much the same manner, with a specially-constructed electrode introduced into the rectum. When the middle lobe is especially implicated, we may obtain very satisfactory results from the use of an insulated electrode introduced into the urethra. In the treatment of **Graves's disease** "Cardew (*Lancet*, July 4, 1891) advises * a galvanic current, two to three milliampères, to be applied three times a day, six minutes to be taken in each application. The anode should be placed at the nape of the neck; the cathode should be moved from the mastoid process along the course of the great nerves. The electrodes are flexible metal, covered with wash-leather, three and a half inches in diameter for the anode, and one and a half inches in diameter for the cathode. Four Leclanché cells or three bichromate cells will suffice. Six Scholl's chloride-of-silver cells (dry) will be enough, and can be used by the patient in his home. The following directions are given: Thoroughly moisten the electrodes with warm water. Apply the anode to the nape of the neck, making firm pressure; apply the cathode to the mastoid, and move it up and down slowly along the sterno-cleido muscle. Each application should last six minutes. Instructions can be written out for the patients, and they can apply the current at home. The author has used this means of treatment in a large number of cases, and believes it to be of great benefit in the vast majority of cases of Graves's disease. He has had failures, but it has been successful where other means have failed."

Electricity in Gynæcology—The Apostoli Method.—The convenience, cleanliness, and efficiency of electricity have combined to make it an indispensable adjunct to other therapeutic measures in various uterine and pelvic disorders, and, indeed, in some it has proved to be **the** remedy **par excellence.** In the reaction from the ultra-mechanical measures of a preceding generation and the ultra-surgical tendency of the present, thoughtful physicians have welcomed the treatment of many diseases of the uterus and adnexa which was introduced and practiced with such brilliant results by M. Georges Apostoli, of Paris. He first directed the attention of the profession to the treatment of endometritis by the use of galvanic currents of a strength previously unheard of in medical annals. By means of what he termed the "chemical, galvano-caustic current," of from one hundred to three hundred milliampères, he succeeded in checking hæmorrhage, relieving pain, removing chronic inflammatory products, producing involution and restoring normal function and condition. The method can best be explained in discussing its therapeutical applications. The principal peculiarities of this method have already been alluded to, and they are well illustrated in the following brief statement of its applications:—

* The University Medical Magazine, September 1, 1891.

In **endometritis** attended by much hæmorrhage or other discharge, Apostoli uses a metallic sound insulated, except at its termination in the uterus, by a celluloid sheath or cannula. The active portion of the electrode is of platinum or of gold, so that it will not be corroded by the decomposing fluid when used for the positive pole. Dr. A. H. Goelet, of New York, has devised a set of graduated, interchangeable, non-corrosive steel tips for this purpose, which are durable and comparatively cheap. Dr. Walling has used gas-carbon tips, which are easily replaced if broken; they are made from the carbon points (such as are used in the ordinary arc lights), and are affixed to a stout copper wire, which may be insulated with rubber varnish or by melted shellac. Dr. Andrew F. Currier, of New York, employs vaginal and uterine electrodes of aluminium with a cylindrical, removable tip of platinum, the shaft being covered with thin rubber tubing. These possess the advantage of lightness, flexibility, and comparative cheapness. The second electrode of Apostoli is a large flat surface of moist clay, which admits of accurate molding to the abdominal wall. If it is not snugly fitted, under the effects of high currents it may cause pain and even blistering of the skin. The objections to Apostoli's clay electrode are, that it is heavy, awkward to handle, and dirty. This may be obviated to some extent by the plan of Dr. Goelet, of New York, in which the clay is made into the consistence of putty and rolled flat; it is then enveloped in a layer of absorbent cotton and covered with linen crash; finally, a sheet of rubber cloth is fastened to the back, by means of which it may be handled and the patient's clothing kept dry. The metal contact-plate is pressed into the clay underneath the cotton, and a binding-post extends through the back, by which the apparatus may be connected with the appropriate cord. Another device for the same purpose has been adopted by Dr. Franklin H. Martin, of Chicago, and is now manufactured by the McIntosh Company, of that city. It consists of a concave, metallic, nickel-plated electrode, the lower surface of which is a sheet of membrane surrounded by an insulated rim to prevent the plate from coming in contact with the skin. When used, about a pint of warm water is poured into the interior through a central opening in the plate, which is then closed with a screw-cap. The transudation of the water through the membrane produces a moist surface for contact with the abdominal wall. This apparatus is cleanly, and it is claimed by Dr. Martin to be capable of transmitting very heavy currents without pain or local action upon the skin. The strength of current employed by Apostoli should not be maintained long,—the duration will depend upon the character of the case; usually it lasts from three to ten minutes, and not repeated oftener than once a week or every ten days. For several days after the application more or less sanguinolent and serous discharge may occur from the uterus, but unless antiseptic precautions have been neglected fever is not likely to be manifest. The number of sittings required for a cure will vary very greatly according to the chronicity and condition of the case.

Hæmorrhages from the Uterus.—Apostoli calls the positive electrode "the hæmostatic pole," and in persistent hæmorrhages he employs positive electrization by the intra-uterine sound, the negative being connected with the abdominal large-plate electrode. Dr. G. Betton Massey reports several cases in which currents of from forty to fifty milliampères were curative in a few applications. When heavier currents are used, he advises having two flat electrodes, one on the abdomen and one at the back of the patient, both connected with the same electrode, thus very much reducing the liability to production of pain. The applications may be made every two or three days. There is, probably, no agent of the Materia Medica which will check hæmorrhage so effectively and promptly as the positive pole; and it is far preferable to the ordinary mineral or vegetable astringents or styptics. Even in cases of myoma or cancer, the effects of the positive pole have been highly successful, while in ordinary menorrhagia, due to pathological conditions of the mucosa, it is curative after a few applications, both of the hæmorrhages and the **chronic leucorrhœa.** In such cases, swelling currents to two hundred or two hundred and fifty milliampères are employed.

For the relief of a **painful condition of the uterus or ovaries** the positive pole is used as above, but the current need not be more than twenty to thirty milliampères, rarely as high as fifty milliampères. The applications, however, should be more frequently made,—every day at first,—*séances* lasting from five to eight minutes. In some cases, this expedient will gain time and afford temporary relief while the patient is being prepared for surgical operation. On the other hand, if an operation have been performed and the ovaries removed, pain may still persist, and here electricity will meet the indication better than any other resource.

Uterine Cancer Treated by Electricity.—The good effects Apostoli had in the treatment of myomata with electricity led Dr. Wernitz,* of Odessa, to use it in carcinoma of the uterus. He reports four cases of carcinoma of the uterus in which he employed the galvanic current. The results he reports are the following :—

1. Complete cessation of pain. Patients who could only be eased with strong narcotic remedies enjoyed, after a few applications, complete freedom of pain, good appetite, and sound sleep, in consequence of which their general condition improved.

* Berliner klinische Wochenschrift, September 22, 1890.

2. The discharges were decidedly reduced in quantity and hæmorrhage ceased.

Whether a complete cure or cessation of the cancerous processes could be expected after a long-continued application of the galvanic current, Dr. Wernitz does not venture to state. The favorable results so far gained by electricity he ascribes to the chemical and electrolytic action of the current.

Sterility may result from many causes. If it result simply from imperfect development or defective nourishment of the uterus and ovaries, or to catarrhal endometritis, electricity is of decided value. In the former case, faradism, systematically applied, twice or three times a week in the intermenstrual periods, will stimulate development, and, in the latter, galvanic currents of mild strength will remove the cause.

Dysmenorrhœa may also be caused by defective development, and faradism systematically applied will afford marked relief. Where mechanical causes exist, the discovery of their nature may suggest other expedients, but the intra-uterine negative electrode, with weak galvanic currents, will produce excellent results as regards the relief from pain and discomfort. **Inflammatory exudation,** the result of peritonitis, may incarcerate the uterus and ovaries and make them immovable. This is capable of amelioration, or cure, through absorption of the exudate, according to the Apostoli method. In **subinvolution,** which may be attended by pain, sterility, and menstrual disorder, or hæmorrhage, faradism is very useful, but weak galvanic currents (twenty to thirty milliampères) will materially assist in restoring the organ to a normal condition. In all cases of hypersecretion from the uterine mucous membrane, the positive galvanic pole is promptly efficient in overcoming this condition.

It is, however, in **uterine myoma** (or **leio-myoma**), **myo-fibroma,** and **fibroma,** that the Apostoli method comes in direct opposition to the practice and teachings of the surgical gynæcologist. It certainly should be borne in mind, throughout the discussion of the therapeutics of this form of neoplasm, that its life-history is not well known. The original cause of the growths has not been discovered; they may remain for years of about the same size and then suddenly take on renewed growth, or they may undergo involution and become the seat of degenerative changes. In many cases, especially if small, they may cause but little discomfort, and may be quite accidentally discovered during life or post-mortem; in others they are, without reference to their size or number, accompanied by congestion, hæmorrhage, and various symptoms of disorder calling for relief. The submucous variety tends to become polypoid, and readily admits of detection and removal; the intra-mural and subperitoneal forms, on the contrary, are less easily recognized, and require a more serious operation for their relief. These growths are now scientifically treated by the method of Apostoli, which has the indorsement of some of the best authorities, such as Sir Spencer Wells, Keith, and many others equally well known as competent to decide upon the relative merits of electricity and laparotomy. A very temperate summing up of the present subject of controversy may be given in the words of Massey :—

1. A properly-conducted electrical treatment of solid fibroids is harmless, will remove the irritation and pain due to their presence, arrest further growth, and almost invariably cause a gradual diminution in their size.

2. Bleeding fibroids may be entirely cured of the hæmorrhagic tendency and pain, arrested in growth and gradually lessened in size.

3. It is possible for the diminution in the size of the tumor to end only in its complete disappearance.

4. In small intra-mural fibroids surrounded by unimpaired uterine tissue, the current applications tend to promote their disengagement from the uterine stroma and extension either into the uterine or peritoneal cavity. In the former case a complete cure may result by delivery of the tumor, and in the latter case a lessening of its symptomatic importance.

5. The time necessary for a satisfactory shrinkage should not be too sparingly measured with the slow cases. Quick symptomatic cure and slow shrinkage are often associated in the same case.

6. In fibroid tumors that have undergone cystic degeneration a treatment by strong currents may do harm, being apt to set up changes in the liquid contents of the cavities that may result in septicæmia.

A uniform result in Massey's experience is, that the first two or three applications, even if strong ones, do not usually cause an appreciable diminution in the size of the tumor, but a striking and almost inevitable consequence is a prompt disappearance of any tenderness about the mass. If this does not occur, it will be found, as pointed out by Apostoli, that some pronounced disease of the appendages co-exists. Fetid or too abundant leucorrhœa is promptly relieved after a few applications. There is also a marked improvement in the general physical health of the patients under this treatment; the abdominal walls increase in adipose, the appetite and digestion improve, the bowels become more regular, and the chronic invalid finds herself restored to health and usefulness.

It is proper to state, however, that some observers have not had as happy results with electricity as those just named. Dr. John Homans, of Boston, communicated last year* his results in thirty-four cases of

* Provincial Medical Journal, June 1, 1891, p. 362.

uterine fibroma, in only two of which had the size of the tumor diminished. The general health had improved in fifteen cases, had been worse in two, and one death was attributed to the treatment. Profuse hæmorrhage had been diminished to a normal or bearable degree in nine, had been increased in six and unchanged in nine. Locomotion had been made easier in sixteen cases and more tiresome in five. Pain was lessened in six cases, increased in two, and unaffected in five. The menopause occurred in four cases after treatment had been begun. In consequence of such unsatisfactory results, Dr. Homans discontinued the use of electricity in this class of diseases in favor of abdominal section. It is well known that Lawson Tait is an outspoken antagonist to the Apostoli method. It is impossible to reconcile the conflicting reports as to the relative value of these two radically different plans of treatment; but it may be admitted by both parties to the dispute that electricity can never be practiced successfully by the general practitioner, unless he knows more about electrical science than the average physician does. Just as special skill is required to perform an abdominal section for removal of the uterus and appendages successfully, so we may acknowledge that treatment of uterine fibroma requires special skill and knowledge. We also may conclude that at present the data are wanting which would enable us to say, at the beginning of treatment, which cases require surgical interference and which are proper subjects for electrical treatment. It is claimed by Joseph Price that, in cases which come ultimately for operation after a more or less prolonged course of electricity, the operation is rendered more difficult, and that adhesions result directly from the treatment. Just here there is irreconcilable antagonism between the advocates of the two methods. Apostoli claims good results upon diseased conditions of the uterine appendages. A recent writer,—Dr. Willis E. Hallowell,*—advocating this treatment, says: "When we find the tubes and ovaries alone inflamed, excepting for the present, at least, those cases in which they contain pus or other fluid, hydro- and pyo- salpinx, ovarian abscess, and cystic ovaries, we have in galvanism a very efficient curative agent. I have seen a number of tubes about the size of the little finger, more or less hard and very tender, become of normal size, consistency, and sensibility; and likewise ovaries, variously enlarged, prolapsed, and exquisitely tender, become of normal size, and, in many cases, return to their normal position."

The advice of this writer is much to the point. If pus or other fluid be present and its infective character be made probable by recency of occurrence, by fever, or by repeated attacks of pelvic inflammation, laparotomy is indicated, and at once. He further declares that if we can

* Northwestern Lancet, 1891, p. 85.

satisfy ourselves by good evidence of the existence of a closed collection of fluid, even though we have no evidence of its virulence, it is advisable to remove it by operation. Laparotomy may even find an ally in electricity. The good effects of the latter upon the general health and nutrition may place a patient in better condition to pass through the ordeal of a capital operation; on the other hand, an operation may fail in its good results owing to cellulitic exudation, which can be removed by subsequent electrical treatment. He concludes by the statement of his "conviction that we have in electricity an agent which, with careful study of what is already known and future investigations, will become, in the hands of a good electrician and a thorough gynæcologist, one of the most important weapons in the struggle against disease in woman, though it can hardly become the panacea which many of its advocates have claimed it to be."

Just what is claimed by the advocates of electrical methods may be learned from a communication read by Dr. Apostoli at the last International Medical Congress, of which the following summary presents the leading points:—

1. The constant galvanic current is indicated principally in gynæcology, in endometritis and fibroma; of paramount value in vascular derangements and pain (amenorrhœa, dysmenorrhœa, and metrorrhagia); it is also a potent means for arresting the growth of benign neoplasms, and promoting the absorption of peri-uterine exudations. It exerts a very salutary resolvent action in peri-uterine phlegmasias, and in some cases of catarrhal ovaro-salpingitis; but it is inefficient and even does harm in high dosage, especially if the negative pole is used in the uterus, in suppurative phlegmasias of the appendages. This variable intolerance, which is increased by an inflammatory condition of the appendages, proves a valuable means of diagnosis in determining the existence and character of peri-uterine, liquid effusions (sanguinolent or purulent), which have been unknown or merely suspected, and hastens in these cases a delayed or refused operation.

2. The effects of the constant galvanic current are polar and interpolar. The trophic and dynamic interpolar action, which increases as the square of the given intensity, is distinct from the polar action; this action, as Apostoli has shown us, differs according to the pole used, giving us the calorific action produced by the passage of the current (to increase interstitial circulation), and, finally, the antiseptic action of the positive pole, the experimental demonstration of which has been given us recently by Apostoli and Laguerrière.

3. Galvanic applications in high dosage, used in varying amounts from fifty milliampères upward, dependent upon the tolerance of the

patient or the clinical indication, are the fundamental basis of Apostoli's method, and present the following points in their favor: (*a*) The utilization of vascular drainage, a direct effect of the calorific action due to the resistance to the passage of the current, and in direct proportion to the square of the intensity. (*b*) The antiseptic or microbicidal action, which increases with the given intensity. (*c*) The rapidity and efficacy of the results produced, which are in proportion to the square of the electrical energy, the formula for which is analogous to that of the measure of the energy of other natural forces: $Q = \frac{1}{2} m V^2$. (*d*) The general applicability of this method to refractory cases (painful and subperitoneal fibromata, fungous endometritis, etc.), and to young women. (*e*) The infrequency of relapses, which, all things being equal, are least apt to occur when the strongest currents have been employed.

4. If the vaginal application of the galvanic current (which is the method proposed by Chèron for fibromata alone, and used since by A. Martin, Brache, Ménière, Onimus, Carpenter, Mundé, etc.) gives any results, they are very inferior to those of the intra-uterine application, which should always be the method of choice: (*a*) Because it utilizes the maximum of the given current and its energy. (*b*) Because it utilizes the antiseptic action of the positive pole, which is entirely local, and is not present in the interpolar circuit or at the negative pole. (*c*) Because it adds the derivative and caustic action of the intra-uterine application, treating thus at the same time the simple endometritis, or the secondary endometritis, which so often complicates fibromata and peri-uterine phlegmasiæ, thus insuring a more rapid, complete, and permanent cure. (*d*) Because it is more effectual than the vaginal application in relieving pain and in producing a tolerance for higher dosage, and, by thus allowing the use of currents of increasing intensity, the vascularity is increased and the best results are attained.

5. Vaginal galvano-punctures, two to five milliampères (one-twelfth to one-fifth of an inch) in depth, made with a filiform trocar of gold, insulated throughout except at the point, are a very useful complement to the intra-uterine treatment proposed by Apostoli, by better localizing the galvanic action, and by increasing, in some cases, the efficiency of small and medium doses.

The innocuity of his intra-uterine applications is proven: First, by the parallel innocuity of the chemical and other harsh methods of intra-uterine treatment; secondly, by the statistics gathered from all parts of the world, and particularly by his own statistics:—

From July, 1882, to July, 1890, he made 11,499 galvanic applications, which are classified as follows: 8177 positive intra-uterine galvano-cauterizations; 2486 negative intra-uterine galvano-cauterizations; 222

positive vaginal galvano-punctures; 614 negative vaginal galvano-punctures. He treated 912 patients during this period, comprising 531 fibromas, 133 simple endometritis, and 248 secondary endometritis, complicating peri-uterine phlegmasiæ. He has had three deaths following operations (two galvano-punctures, one of which was for a subperitoneal fibroma, the other for an ovaro-salpingitis, and one galvano-cauterization for an ovarian cyst mistaken for a fibroma). He has observed thirty cases of pregnancy after intra-uterine applications had been made.*

Details of Operation.—The apparatus required are a good battery or source of electrical energy, capable of maintaining a current up to two hundred and fifty or three hundred milliampères when the body of the patient, a rheostat, and a milliampèremeter are in the circuit. The electrodes have already been sufficiently described. It may be stated, however, that for applications of less than one hundred milliampères the clay abdominal electrode may be substituted by towels wrung out of hot water or wet absorbent cotton laid upon the surface, upon which the lead plate to which the electrode is attached may be placed. The intra-uterine electrode, as pointed out by Massey, should be insulated nearly to its extremity, leaving only about two and a half inches exposed, so that it shall not cauterize the cervical canal and thus induce subsequent stricture. This electrode should be so constructed as to permit of thorough cleansing and boiling for several hours before it is used.

The battery should be tested prior to operation and the milliampèremeter examined. This is done by placing all the cells in action and gradually turning on the controller, while watching the effect upon the meter. The controller should then be reversed until the current is entirely cut off, when the apparatus is ready for use in the operation. The conducting-cords should be carefully examined, so as to detect any possible break. Determine the proper size and curve of the sound, and properly disinfect it. The curve is best made with the aid of an alcohol-lamp, and, while the sound is heated, the insulation may be secured by applying gum-shellac in such a way as to cover all breaks and weak spots. Arrange the gynæcological table or couch so that it will be convenient to hold the sound in place with the left hand, leaving the right hand to manage the current-controller.

The patient should be informed of the character of the operation and of the necessity of keeping absolutely still, so as to avoid shock or disarranging electrodes or wires. The application should not cause pain beyond a slight burning, and the patient should at once inform the operator if the current causes more pain than this, when the current can be promptly diminished by the controller. The bowels should be evacu-

* The Satellite, Philadelphia, December, 1890.

ated by a purgative, followed by an enema, and the vagina should have a preliminary irrigation with an antiseptic solution shortly before the operation. If there should be any pimples or abrasions on the surface of the abdomen they should be covered with small pieces of waxed paper, or paper smeared with vaselin or lard upon the surface next to the skin. The details are further described as follows (abbreviated from Massey) :—

Placing the Electrodes.—1. Apply the clay (or the Martin) electrode smoothly upon the abdomen, and attach to the binding-post the cord of the plate which is desired to be indifferent.

2. Attach a disconnected conducting-cord firmly to the intra-uterine electrode, and insert it as any other sound is inserted, using all the precautions recommended in the passage of this instrument. At first it may only be possible to introduce a filiform, flexible instrument, but after a positive cauterization subsequent introductions will be easier, and larger instruments may be used. A speculum, as the rule, is not needed, as the sound should be guided by the finger alone in its introduction ; it should be held firmly in place by the left hand during the passage of the current, the finger being in the vagina.

3. After seeing that the connections are all right and the controller at zero, the cord of the intra-uterine electrode should be attached to the binding-post of the pole that is to be active. The patient now being ready, the current is slowly turned on, until thirty or forty milliampères are shown by the meter. After resting at this point for a few minutes ten or twenty milliampères may be added ; but, as the rule, forty or fifty milliampères will suffice for the first treatment, especially if the patient be nervous. The meter should be constantly watched, as well as the patient's countenance, and on the first sign of pain the current should be reduced by the controller. The active electrode may be moved, so as to bring it in contact with all parts of the endometrium, care being taken not to perforate the fundus. The current is maintained at its maximum from two to ten minutes, and then gradually lessened. When heavy currents are used (two hundred or three hundred milliampères) the time should be shortened, except in tumor cases. The decrease of current should be gradually produced by slowly reversing the controller until the needle of the meter falls to zero. The sound is then removed, and the abdominal plate taken away. It is best to have the patient rest awhile before going home, particularly if she is obliged to walk. Massey insists that, in every case where at least a hundred milliampères have been used, the patient should lie down immediately upon reaching home, and remain inactive during the remainder of the day, so as to avoid inflammatory reaction. There will be sanguineous, followed in twenty-four hours by

a purulent, discharge, and there may be some colicky pains, but the recumbent posture, with antiseptic vaginal irrigation twice daily, will soon cause these to subside. For the treatment of many cases of endometritis, unaccompanied by hyperplasia, currents of twenty to thirty milliampères are quite sufficient, while the heavy currents are especially required in tumors, large hypertrophy, or inflammatory exudation. Three times a week is as often as the operation can be performed with safety; in many cases twice, or even once, a week will suffice.

Dr. Massey gives the following contra-indications to operations under the Apostoli method :—

1. The presence of the menstrual flow.
2. The existence of acute metritis or perimetritis.
3. The co-existence of abscess anywhere in the pelvis.
4. Pregnancy.

Faradism in Gynæcology.—Apostoli uses the faradic current in acute inflammatory affections of the uterine and peri-uterine tissues and appendages. No stage of the inflammation, even the most acute, contraindicates the employment of the current. The bipolar vaginal electrode may be used, applied in the neighborhood of the severest local pain. (Liebig and Rohé.)

In **amenorrhœa** both galvanic and induced currents are employed. It is not necessary to apply the electrodes locally to the uterus or ovaries, since experience has shown that electricity applied to a distant portion of the body will increase the menstrual flow, or stimulate it if arrested (except in pregnancy). The faradic current is employed in general faradization, dorso-abdominal with the dry brush to the abdominal walls, the inner sides of the thighs, and also to the soles of the feet.

In **obstructive dysmenorrhœa** Apostoli uses faradization with a bipolar electrode, the strength being regulated by the feelings of the patient. **Congestive dysmenorrhœa** may be relieved by weak currents, either intra-uterine (Apostoli) or with the wire brush to stimulate the cutaneous circulation over the abdomen, while galvanism from the cervix to the spine (anode to cervix, cathode externally) may be combined with advantage. The same treatment is advised for painful ovaries and **nervous dysmenorrhœa**; also, for non-periodic or constant pains in the pelvis. Daily, or even twice a day, is not too often for the application of faradic currents, which should be extremely rapid and perfectly smooth, in order to obtain the sedative effects.

In **threatened abortion** an insulated vaginal electrode may be placed against the os and a soft-sponge electrode applied over the hypogastrium or lumbo-sacral region for ten minutes at each sitting, using mild, smooth currents. Dr. W. T. Baird, of Texas,* used it in three cases, in which he succeeded in arresting hæmorrhage and preventing the expulsion of the ovum, the patients afterward going on to full term. To arrest hæmorrhage after abortion, owing to a relaxed uterus, the same current may be employed, either in the same manner, or by using a double uterine electrode, by means of which the current can be definitely localized in the uterus and produce more forcible contraction (Liebig and Rohé). Even in **placenta prævia** the faradic current is recommended, as strong as can be borne, in order to produce strong equable contractions of the muscular fibres. Dr. Baird claims that **during parturition** faradism is a valuable agent for relieving suffering, and may take the place of chloroform. He uses the mediate method, one electrode being placed over the patient's sacrum, the other being attached to a wristlet upon the operator's arm; he then passes his hand over the patient's abdomen during the pains. **Premature delivery** may be brought on by very strong currents, either faradic or galvanic.

Agalactia, or **deficient secretion of milk** after delivery, yields promptly to faradic stimulation of the mammary glands. Dr. Fry reported a case of suppressed lactation in which galvanism was employed with complete success, only two applications being required. The active electrode (cathode) was made of sheet-lead, three by five inches, molded so as to fit over the breast, and covered with absorbent cotton. The anode was placed at the back of the neck. An average current of ten milliampères was passed for eight minutes through each breast.

Involution of the uterus after labor is hastened by faradization, according to Apostoli and Tripier. Septic infection is thus prevented by securing contraction of the organ. The lumbo-abdominal method is usually sufficient, with daily sittings for a fortnight, or longer if necessary.

In disorders of the male genito-urinary organs electricity is largely used with marked success. In paralysis, hyperæsthesia, stricture, functional impotence, all three forms of electricity may be employed locally.

Paresis or **paralysis of the bladder** resulting from various causes, with retention or incontinence of urine, is often markedly relieved. An insulated urethral electrode is passed into the bladder, the other electrode being placed over the perineum, hypogastrium, or lumbar region, and a current passed as strong as the patient can bear, gradually increasing the length of the sittings, though not exceeding ten minutes. The bladder should be partly filled with a weak borax solution, so as to diffuse the current during its passage; and if there should be decomposition

* American Journal of Obstetrics, April, 1885, p. 341.

of urine with cystitis, irrigation of the bladder should be practiced once or twice daily with mild antiseptic solutions.

In **nocturnal incontinence of urine** faradism is very successful, one electrode being placed in the lower dorsal region of the spine and the other over the pubes; or, an insulated urethral electrode may be introduced as far as the neck of the bladder.

Functional impotence, spermatorrhœa, and **frequent nocturnal losses** may be relieved in a similar manner to that just indicated for nocturnal incontinence of urine. In addition, the wire brush may be applied to the external genitalia and to the inner side of the thighs, especially in functional impotence and feeble erections. Mild galvanic cathodal applications to the neck of the bladder will also markedly reduce irritability and arrest the discharges in spermatorrhœa.

In **hypertrophy of the prostate** Tripier recommended an insulated sound in the urethra and one in the rectum, with the faradic current. An electrode of special shape for the rectum has been made, at the suggestion of the author, for application to the base of the bladder and prostate, the neutral electrode being placed over the abdomen.

Electrolysis in Medicine.—In cases of stricture of the urethra, rectum, or œsophagus, due to cicatricial stenosis, the application of the method as practiced by Dr. Neumann, of New York, to stricture of the urethra, will serve to illustrate its usefulness in all such conditions. It should be understood that this is entirely different from cauterization such as seen in the Apostoli method. Much milder currents are employed, and the principal object in view is to cause the absorption of the inflammatory exudate, or scar-tissue, which softens under the electrolytic influence of the current; but there is no charring of tissue and no subsequent sloughing. Insulated urethral sounds are used, terminating in an exposed olive-shaped bulb, which should be a little larger than the calibre of the strictured urethra. After being made thoroughly aseptic, this is passed down to the tender spot in the urethra and the negative cord attached; the other electrode, covered with sponge or cotton of the usual shape, may then be applied to the thigh; the current is then gradually turned on until four or five milliampères are passing. The sound is then gently guided through the stricture, allowing it to make its own way until the stricture is passed; the circuit may then be opened and the electrode withdrawn. The sittings should be twice a week, and should not exceed five minutes each. After each operation, the parts should be bathed with hot water containing boric or carbolic acid. Some bleeding and increased tenderness may be noticed after the first few applications, but these become less, and in from ten to twelve sittings the cure is complete. In many cases, though, no positive prediction can be made as to the time required.

In **new growths, tumors,** etc., electrolysis promises to be of great service. In connection with the introduction of various remedies through the skin,—**electro-cataphoresis,**—some remarkable results have been obtained by Adamkiewicz, Peterson, and others. The fact that medicines may thus be introduced into the body has already been mentioned, and it seems evident that this new method is capable of very valuable applications. The medicament is carried directly to the diseased cell, and thus produces a more marked effect than if it were diluted by the circulating fluid. Moreover, electrolysis of fluids and solids tends to occur in the vicinity of the poles, thus liberating remedies in nascent form, which is one of special activity. Dr. Woodbury treats syphilitic new growths with lithium-iodide solution, using absorbent-cotton electrodes, and urges a similar treatment of various tumors in the same manner. The success of Dr. A. C. Garrett, who reported one hundred and fifty-seven cures out of one hundred and eighty-six cases of tumors (indurations?) of the breast, by means of direct application of the galvanic current; and the favorable experiences of Dr. J. Inglis Parsons in four cases of cancer, in which the progress of the disease was arrested by strong currents (ten to six hundred milliampères with intensity of one hundred and five volts), the tumors being transfixed with fine insulated needles, should encourage further experiment in this direction. "There is reason to believe," says Dr. Rohé, "that the limitations of electrical treatment of malignant tumors have not yet been reached." It was suggested by Woodbury* that various chemical agents might be tested, until one be found which has a special inimical influence to the cancer development, and that the prospects then would be favorable for the successful treatment of malignant tumors by the introduction of such agents by means of electro-cataphoresis directly into the interior of the growth.

In **goitre** the galvanic current may be used percutaneously, but better results are obtained by the use of needles with negative electrolysis. Dr. Jas. Hendrie Lloyd† uses three gold-plated needles well insulated to within one-third of an inch of the point, connected by a branching cord so that all were attached to the negative pole. The needles were inserted well into the goitre, far enough to protect the skin by the insulating material. The positive pole, a large flat sponge, was applied to the nape of the neck. The greatest strength was twenty-four milliampères, but this could not be kept up; the average was about

* Paper read before the Philadelphia College of Physicians, "On the Employment of the Cataphoric Action of the Galvanic Current for the Removal of Syphilitic New Growths. A Contribution to the Medical Treatment of Tumors." Medical News, June 21, 1890.

† "The Treatment of Goitre by Galvano-puncture." By Jas. Hendrie Lloyd. University Medical Magazine, December, 1890.

fifteen to eighteen milliampères. The *séance* lasted twenty minutes. Patient was cured by fourteen applications.

In **enlarged lymphatic glands,** when suppuration has occurred, the galvano-cautery affords an ideal method of opening glands. The wire-point cautery may be employed to make punctures into the substance of enlarged glands, the gland-structure being partly destroyed and partly condensed or absorbed under the action of the negative electrode (five to twenty milliampères twice weekly). Strong, frequently interrupted **faradic currents** have also been found useful in enlarged lymphatic glands.

In **orchitis,** after the acute stage has passed, percutaneous galvanization, followed by faradization, reduces swelling and promotes absorption. In **atrophy of the testicle,** faradism with the dry brush and descending galvanic currents to testicle and spermatic cord will increase the circulation and favor nutrition. In **hydrocele,** percutaneous applications of both forms may be practiced, but the effect is more prompt, according to Liebig and Rohé, if the sac be punctured with a needle-electrode (cathode), using a current of twenty to fifty milliampères to produce electrolysis.

Application of Electricity in Dermatology.—Various morbid conditions of the skin are susceptible of marked amelioration under the action of the several forms of electricity. Only a few of the principal applications can be mentioned here.

Various nervous disorders, pain, hyperæsthesia, anæsthesia, œdema, urticaria, and neurotic bullous eruptions are successfully treated by galvanism or faradism. General electrization (electric baths, static "breeze," etc.) is valuable in neuroses with cutaneous manifestations. **Itching, or pruritus,** which is such an annoying accompaniment to various lesions, is promptly, if not permanently, relieved by swelling faradic currents. Raynaud's disease (local asphyxia), it is claimed, may be checked and the angio-spasm permanently arrested by a strong faradic current. In a similar manner **chilblains** or **pernio** may be benefited. In either, if trophic symptoms are present, the combined treatment with galvanism and faradism is useful.

In various forms of inflammation of the skin, electricity may be judiciously employed, especially in the more chronic forms. In **eczema,** the author sees the best results from the faradic current applied by a metallic-ball electrode. Anodal galvanic applications also give good results in acute forms, while in the chronic form with much infiltration the cathode is preferable. In **herpes zoster,** galvanism gives better results than faradism. The anode to the spine and the cathode along the distribution of the affected nerve, with mild currents, generally relieve the pain and check further eruption. It is also valuable in the treatment of the resulting intercostal neuralgia.

In **alopecia,** the dry faradic brush over the bald spots is often beneficial. The drawing of sparks with static apparatus is recommended by Ranney and others. **Acne** may be similarly treated with the faradic current, or galvanism may be applied with anode to back of neck and the cathode to the seat of eruption. In **rosacea,** Dr. Hardaway practices electro-puncture: introducing a delicate needle into the enlarged veins and connecting it with the cathode, a current (of one or two milliampères) is passed through the needle, causing coagulation of the blood and occlusion of the vessel. Multiple galvano-punctures of the hypertrophied skin will greatly promote resolution.

In **keloid, hypertrophied scars, cicatrices,** etc., the same authority has obtained the best results from galvano-puncture. **Warts, moles,** and **small fibromata of the skin** yield readily to the same treatment without leaving disfiguring scars. Currents of two to six milliampères are used. Small **nævus telangiectasis** is successfully treated in this way, the negative needle being thrust in various directions through the base of the growth. **Cavernous angiomata** and **vascular nævi** are less amenable to this treatment, but with judicious management and patience complete success may follow the application of this method. The galvano-cautery may be used in removing such a growth, either by the use of a loop or the various flat burners which are used as knives.

Removal of Superfluous Hair—Hypertrichosis.—Electrolysis is now very generally employed in destroying hair-bulbs and removing hair growing in abnormal situations. First employed by Dr. Michel, of St. Louis, in **trichiasis** with successful results, the method was afterward extended by Dr. Hardaway to the removal of superfluous hair in any situation. When properly used this method causes neither pain nor disfigurement, but permanently removes the source of the trouble. The method is easy and the instruments are few in number: a battery capable of yielding a current of from one-half to two milliampères, a needle-holder armed with a No. 12 sewing-needle of steel or alloyed platinum (the latter being preferable because flexible), and a sponge electrode are all that are required. It is convenient to have the patient sit in a chair with a good head-rest during the operation, and the operator may find it necessary to use a good hand magnifying-glass to enable him to introduce the needle directly into the hair-follicle by the side of the hair. The needle being attached to the cathode, the current is made to pass by the patient touching, with his disengaged hand, the sponge of the electrode held in his other hand. The effect of the current will be immediately observed; the tissues around the needle will be slightly raised up and froth will issue from the mouth of the follicle. In about half a minute the hair should be gently pulled with the tweezers or cilia forceps; if it does not immediately come away the current should be passed a short time longer. The circuit is broken by removing the hand from the sponge, which gives less pain than if it be broken or closed with the needle. A sitting should last not longer than fifteen minutes, and the hairs destroyed should not all be from one spot; otherwise there may be some inflammatory reaction, or even sloughing and production of scars. After the operation a mild astringent lotion is ordered and applications of hot water directed to be made several times daily to reduce hyperæmia. If the operator has been successful in destroying the papilla the hair will not return, but in a certain proportion of cases the papilla escapes destruction and the hair is regenerated. This may be due to a twist in the hair-shaft in its passage through the skin, and partly to inexpertness on the part of the operator. Some hairs may require repeated removal before the papilla is finally destroyed. In young persons, especially, new hair-papillæ are constantly developing in the skin, and the appearance of new hairs after operation does not, therefore, mean that the operation was a failure. Such patients it is necessary to warn before operating that new hairs may appear though the older ones were destroyed by the operation. In young individuals the process may have to be repeated several times before the operation is finally crowned with success. The needle-holder of Hardaway is a good instrument, but one has recently been devised by Leviseur which is a decided improvement. In this instrument the needle can be held either directly projecting in a straight line or at an acute or obtuse angle with the handle. The operator holds the instrument like a writing-pen, with the needle at the proper angle to enter the follicle with the greatest readiness.

Electricity for Preventing the Loss of the Hair, Premature Grayness, Calvities.*—The object of treatment is to promote nutrition of the scalp and hair-bulbs. This is promoted by the practice of massage, the use of hot, alternating with cold, douches, by the shampoo with either hard or soft soap, and, above all, by electricity. Both galvanism and faradism have been employed, and both are efficacious. The uninterrupted current should in the beginning be a mild one, not exceeding three or four milliampères. It may be applied by moistened sponge electrodes, the hair also being moistened and parted at intervals. An excellent mode of administering the current is through a brush with

* See article by author on the "Hair with the Toilet. Care in Health and Treatment in Disease." Medical Bulletin, Philadelphia, April, 1892.

metallic bristles. Faradic electricity is conveyed in the same way through a wire brush, the patient holding the moistened sponge electrode. The brush is to be passed over the scalp slowly until the skin becomes quite red.

Removal of Foreign Bodies from the Eye with the Electro-Magnet.— One of the neatest applications of practical electricity to medical purposes is seen in the removal of pieces of iron or steel from the interior of the eye with the electro-magnet. Several forms have been devised since the instrument of Professor Hirschberg, of Berlin, was first introduced, in 1855, varying in slight details, but all consisting essentially of a fine insulated wire coil with a core of soft iron, to which is attached a tip, also of soft iron. After closing the circuit, the current being furnished by a single galvanic cell, the point of the instrument is brought to the edge of the wound, or, if the foreign body be deeply imbedded in the eyeball, it may be necessary to puncture the sclerotic and introduce the point of the magnet until the substance is attracted by it and removed from the eye, the current not being broken until the instrument is free from the eye. Of course, only particles of iron and steel can be removed by the magnet, but, as they frequently find their way into the organ, it is an admirable contrivance, since the foreign body may be removed without causing further irritation.

Dr. Casey A. Wood, of Chicago, recently reported a case of electro-magnetic extraction of a piece of steel from the vitreous chamber of the eye, with preservation of sight. The magnet used is known as Snell's, manufactured by Meyrowitz Bros., of New York. With this he prefers a small two-volt storage cell, which is more portable than the ordinary acid cell, and is very efficient. The details of this case are quite instructive. Atropine solution had been instilled into the eye, shortly after the injury was received, by the attending physician, and Dr. Wood saw the patient seven hours after the accident. There was a penetrating wound of the cornea and iris, and the anterior chamber contained blood. No clear view could be obtained of the fundus. It was decided to wait until the effused blood had undergone absorption. The conjunctival sac was thoroughly disinfected, more atropine instilled, and the eye dressed with boric-acid powder and a bandage. Three days later a wound in the lens could be plainly seen through the dilated pupil. Two clots were seen in the vitreous; only portions of the fundus could be seen. It was decided not to attempt removal of the foregn body through the original wound. Four days after the accident, "the patient was anæsthetized and a straight equatorial incision (eight millimetres long) was made with a Graefe knife through the sclera, about a centimetre behind the limbus, at the lower outer quadrant of the hemisphere. Another wound of the same length, but at right angles to this, was first carried through the conjunctiva and Tenon's capsule, so that when both wounds were closed the vitreous chamber was effectively shut off from the outside air. A bent and flat needle was carefully introduced into the vitreous, and, after several re-introductions and 'fishing' about, a small bit of steel was withdrawn, attached to the tip of the magnet-end. Little or no vitreous was lost. A few stitches were put through the conjunctival flaps, and the eye was again dressed with boric-acid powder. The greatest care was observed as to the use of antiseptics, and the wound healed without the least difficulty." The extracted metal weighed 17.7 milligrammes.*

The electric probe of de Wilde consists of two insulated wires contained in a flexible sheath, the ends being brought out at the extremity of the instrument. As soon as the wires touch a metallic object the circuit is complete, and a small electrical bell or "buzzer" indicates the fact. This instrument requires actual contact with the foreign body in order to produce the signal. The **electrical induction balance** is an ingeniously constructed apparatus, which will indicate the presence of a bullet or other metallic body when buried in the tissues. Several varieties have been constructed, but they are essentially the same, and depend upon the principle of better conduction of the galvanic current, and hence greater induction in a secondary coil, when the metallic object is included in the field or interpolar region. Dr. Kummer† recorded a case where a needle having become buried in the knee, its precise location was detected by an ordinary galvanometer, and also by a freshly-magnetized needle. Dr. Addinell Hewson‡ claimed that in a similar way he had been enabled to detect, by means of a small pocket compass, the presence of a bullet imbedded in the muscles of the back. Unless the projectile were of iron or steel this experiment would not succeed with such simple instruments. The electrical induction balance and the electric probe, however, will detect the presence of any metallic substance capable of conducting the electrical current. Dr. A. B. Kirkpatrick§ reports a case of gunshot wound, in which the electric probe was used with excellent results.

In **nose and throat diseases** the galvano-cautery has been extensively used, and, in the opinion of some, greatly abused. The chief advantages over the knife and cold-wire snare are: the ease and convenience of the apparatus, its perfect asepsis, and the counter-irritant and stimulating effect to be obtained by minute points of cauterization. In skillful hands it warrants all the praise bestowed upon it, because its use is then limited

* American Journal of Ophthalmology, April, 1891, p. 127.

† Revue Médicale de la Suisse Romande, October, 1890.

‡ Proceedings American Medical Association. Surgical Section. Newport Meeting.

§ Proceedings Philadelphia County Medical Society, October 14, 1891.

to appropriate cases; while in unskillful hands it is indiscriminately employed, and sloughing and necrosis caused by injudicious application. The source of power is now almost universally the storage cell, although the cautery battery, as devised by Seiler, is quite sufficient for all ordinary purposes; when the time of actual use is very brief, polarization does not have time to occur.

Nasal hypertrophies of mucous membrane are readily reduced by a touch of the galvano-cautery. The platinum knife or probe should be inserted in a universal handle, bearing a spring switch, so that the current does not pass until the instrument is in place and can be instantly discontinued. If the instrument adheres, it should not be abruptly withdrawn, or it will tear off a portion of mucous membrane and cause bleeding and an open wound. On the contrary, if the instrument is permitted to remain for a moment or two the natural secretions will be restored and it will easily drop out. In applying the cautery to posterior hypertrophies the rhinoscopic mirror should always govern the application, so that the operator can see just what he is doing.

In **granular pharyngitis** of singers and public speakers, accompanied by thickening in bands and bunches of enlarged follicles, excellent results follow the galvano-cautery. Enlarged papillæ at the base of the tongue can be reduced by cautery punctures, or removed without pain or hæmorrhage by the wide platinum snare.

As the rule, the wire should be heated to a cherry-red heat, and in nasal work it is often of advantage to use a shield, such as an ordinary metal aural or nasal speculum, or Shurley's ivory-blade speculum. It is a powerful hæmostatic and resolvent; and, when used as a destructive agent, its action is perfectly under control, and is limited to the area operated upon.

Recently, the galvano-cautery has been advocated as an application to the throat in **diphtheria**; but, while we are in possession of such antiseptics as peroxide of hydrogen and chlorine and such solvents of false membrane as papoid and lime, it is not likely that this plan will receive much favor. In **chronic enlargement of the tonsils** the use of the galvano-cautery is often productive of decided diminution in bulk.

In keratitis fascicularis and ulcerations of the cornea, galvano-cauterization gives good results; and Darier * reports excellent effects in the treatment of two cases of **purulent ophthalmia.** Antiseptic douches with instillations of iodoform followed each cauterization.

Direct Electrization of the Stomach.—Owing to the inconvenience of the use of the stomach-tube, Kussmaul's stomach-electrode, introduced in 1877, was never a practical instrument for local or direct electrization

* Journal American Medical Association, November 29, 1890.

of this organ. Recently, Dr. Feinhorn * has constructed a novel form of electrode, on the principle of the stomach-bucket, and gives it the name of the "Deglutable Stomach-Electrode." It consists of a hard-rubber capsule (about one and one-quarter inches in length) perforated with numerous openings, this cage serving to protect the metal knob within from direct contact. The connecting wire runs through a fine, flexible-rubber tube. The capsule is readily swallowed and tolerated by the patient, and contact is secured, as in Bardet's electrode, by water in the stomach. The faradic current has been generally employed, and in all cases the degree of acidity of the stomach has been markedly increased. The author makes a preliminary report, which goes to show that most decided results have been obtained in cases of dilatation and in grave cases of chronic gastric catarrh. Two cases of pure gastralgia showed an amelioration after use of the constant current. The majority of cases of hyperacidity were improved, but required the administration of alkalies in the usual way.

Electricity in Intestinal Occlusion.—Where intestinal occlusion is due to transient intestinal paralysis through defective innervation, Semmola has recently pointed out that the constant current has a truly marvelous effect. He reports a case of diarrhœa, followed by acute constipation and colicky attacks, with obstinate vomiting and retention of urine. The positive electrode, olive tipped, was inserted into the rectum as far as the sigmoid flexure; the negative pole, moistened with salt water, was moved about over the abdomen in various directions, especially along the colon. A current of ten milliampères was used. Each application lasted about ten minutes, and was used three times a day. At the end of the third application the retention of urine ceased, the paroxysms were less severe, and the patient had visibly improved, but it was not until the ninth application, at the end of the third day, that the bowels were moved. The treatment continued two days longer, and the patient recovered.†

Action of Constant Current upon Microbes.—According to reported experiments by Apostoli and Laguerrière,‡ the action of the constant galvanic current upon cultures is in direct relation to the intensity of the current estimated in milliampères. A current of three hundred milliampères and above, applied constantly for five minutes, kills charbon bacteria, while lower degrees of intensity of current merely attenuate the culture and render it less virulent. The positive pole alone produces this effect; the interpolar action and negative pole are indifferent. The gen-

* Medical Record, May 19, 1891.

† Communication to Section of Medicine, British Medical Association. British Medical Journal, February 20, 1892.

‡ La Tribune Médicale. American Lancet, December, 1890.

eral conclusion is, that the continuous current in ordinary medical dose (fifty to three hundred milliampères) has no action *sui generis* upon microbe cultures in a homogeneous medium, and that its unique positive polar action should be referred to the liberation of acids and of oxygen.

Gonorrhœa, which is known to be of infectious origin, offers a field for the use of the antiseptic effects of galvanism; but, unfortunately, the urethra is too sensitive in the male sex to permit the use of the high currents required; yet, in women good results have been reported by Prochownik.* He treated ten cases of acute gonorrhœa with very rapid recovery. The gonococci were absent from the secretions after the fourth application, and all the morbid phenomena disappeared after the ninth application. The positive pole was carried into the uterus, and a current strength of one hundred and twenty milliampères was used from eight to ten minutes. The necessary precautions of cleaning the vagina and vulva and using no other instruments than the electrode were scrupulously observed. The same author attempted to treat gonorrhœa of the urethra in the same way, but patients could not endure currents stronger than thirty to forty milliampères, while a current strength of from eighty to one hundred milliampères is essential to the destruction of the gonococci.

Electric Illumination in Medicine and Surgery.—Czermak (in 1858) first called attention to illumination of the larynx by transmitted sunlight, and subsequently this method of illumination was greatly advanced and improved by Voltolini, by whom the electric light has been utilized for this purpose. Dr. W. Freudenthal presented an instrument containing an Edison lamp, which is applied closely to the larynx externally, while the laryngoscopic mirror is used in the usual way.† The instrument is made by Reynders & Co., New York. It appears to have special value for illuminating the subglottic region of the trachea. This method was discussed at the meeting of the American Laryngological Association last year, but did not receive much endorsement.

For descriptions of electric otoscopes, laryngoscopes, gastroscopes, urethroscopes, and others of similar scope, the reader is referred to special works on electricity and to the illustrated catalogues of the instrument-makers and electricians. Their chief interest lies more in the direction of diagnosis than therapeutics.

* Centralblatt für Gynækologie, and Pac. Rev. of Med. and Surg., November, 1891

† Medicinische Monatsschrift, N. Y., November, 1889.

KINESITHERAPY; MECHANOTHERAPY; MASSO-THERAPEUTICS. MASSAGE AND REST-CURE.

History.—Kinesitherapy (*κινησις*, motion), or the treatment of disease by mechanical means, is a well-established therapeutic resource. The high esteem in which gymnastics was held by the ancients for maintaining health and vigor led inevitably to the employment of modified, and especially passive, exercises in the treatment of appropriate diseases. Herodicus became so famous for his application of gymnastics to the improvement of health that Plato is said to have accused him of doing an ill service to the State by keeping alive people who ought to die, because, being valetudinarians, they caused more expense than they were worth to the community. In many places in the writings of Hippocrates we encounter expressions of his high opinion of the value of systematic and scientifically-directed massage. For instance, "It should be kept in mind that exercise strengthens and inactivity wastes." "Friction can relax, brace, incarnate, attenuate: hard braces, soft relaxes, much attenuates, and moderate thickens." "The physician ought to be acquainted with many things, and, among others, with friction." These extracts are from the Sydenham Society's translation of the genuine works of Hippocrates; in Littré's translation the last sentence is more appropriately rendered, "The physician should possess experience in many subjects, and, among others, of massage."

The term massage (*μασσειν*, to knead or rub) is applied to the employment of pressure, strain, and other peculiar manipulations of the soft tissues of patients with the view of bringing about physiological and therapeutical effects. Known and practiced by the Chinese from the earliest period, by the ancient Persians, and later by the Greeks and Romans, its use, in one form or other, is almost universal at the present day, not only among civilized nations, but also among the aboriginal inhabitants of Africa and the South Sea Islands. Among the natives of Tongo and the Sandwich Islands, for instance, a crude though elaborate system of shampooing is practiced, which is essentially a form of massage. During the Middle Ages, the nations of Europe lost appreciation of this important handmaid of therapeutics, which was permitted to sink into oblivion by the medical institutions. However, it continued to be practiced by the laity, who often associated it with superstitious forms and observances, which brought it into still further scientific disrepute. It is to the French that we are indebted for the rediscovery and rehabilitation in medicine of this valuable therapeutic agent. Toward the latter part of the eighteenth century, Tissot (1780) and Meibom (1795) laid the medical world under obligation by their writings;

the subject, however, attracted very little notice, until at a comparatively recent period Mezger, of Amsterdam, and his pupils Berghman and Helleday (1873) gave it a scientific foundation. The enthusiasm of a Swede, Peter Henry Ling, was necessary to popularize mechano-therapeutics, and in this he was so successful, particularly in his native country, as to be regarded, by many, as the creator of the modern movement cure. His leading physiological idea was that the nourishment and development of the muscles depended upon their use and amount of active movements they perform. The peculiar merit of Ling, according to Schreiber (who has given us an excellent "Manual of Treatment by Massage and Methodical Muscle Exercise"*) lies in the fact that "he re-established the gymnastics of the ancients on a scientific basis, and, using the then known results of skilled German gymnasts, penetrated still deeper into the writings of ancient nations, and became one of the first to elaborate a complete system on an anatomical and physiological basis."

Technique of Masso-Therapeutics and Mechanotherapy. — The mechanical treatment of disease presupposes acquaintance on the part of the operator with regional anatomy and with the teachings of human physiology. It is true that in the hands of uncultured persons, who practice massage in an empirical manner, excellent results have been obtained, but this is due to the fact that ignorant people are often shrewd observers and are not modest in proclaiming their successes, while their failures are kept in the background. The so-called art of bone-setting, by which stiffened joints are restored to motion by systematic mechanical treatment, as practiced in this way, often is successful, and such cases are widely published; whereas, if the treatment was a failure, the result would not be sufficiently rare or interesting to be noticed.

In acquiring the art of massage, it is of great advantage to have a skilled instructor to teach the various manipulations and their applications, and at the present time such experienced practitioners are to be found in many of our large cities. In Philadelphia, a thorough course is given under the direction of Dr. Benjamin Lee, who has devoted his life to the study and practice of mechanotherapy. It is, however, a manual art and cannot be acquired either from written instructions or demonstrations, but by actual experience. This being admitted, we may agree with Schreiber that "the necessary knowledge and skill can very well be mastered without an instructor, if, with each manipulation, the final end, namely, the physiological effect, be kept strictly in view," provided that

*Translated, with the author's permission, by Walter Mendelson, M.D., of New York. Philadelphia: Lea Bros. & Co. 1887.

this be confirmed and established by sufficient personal knowledge of pathological and therapeutical processes.

In his "Art of Massage" (translated, with notes, by Benjamin Lee, under the title of "Tracts on Massage"), Reibmayr has very much simplified the nomenclature and the multitudinous procedures of Ling and the French writers particularly. He distinguishes the following principal methods of application:—

1. **Introductory massage.**
2. **Massage proper.**

The divisions of massage are those of Mezger and his pupils, Berghman and Helleday, and are now generally adopted by scientific writers and practitioners:—

1. **Stroking.**
2. **Friction.**
3. **Kneading.**
4. **Percussion.**

1. **Stroking** is done with the whole palm, with the radial border of the hand, or with the thumb or ends of the fingers. The pressure may be as light as possible, and vary gradually from this to as much weight as can be borne, the operating hand being re-inforced by pressure made upon it with the other, or the weight of the upper part of the body may be called into play to give sufficient force to the stroke. The direction is nearly always venous (centripetal, or toward the heart), but in rare cases it may be arterial (centrifugal, away from the heart).

2. **Friction** consists in more or less forcible, circular rubbing of a surface, with the palm of the hand usually, or with the fingers or final phalanx of the thumb. During the manipulation the remaining fingers of the hand, or, it may be, both hands, clasp the limb which is under treatment, making it a point of support. It is advisable to begin at the border of the pathologically altered tissues, and work out the exudate into the surrounding healthy tissue in all directions, always concluding, however, with centripetal strokings.

3. **Kneading.**—This is what is meant by "massage," which, however, as an English word, is now used, in a comprehensive sense, to include all the manipulations employed in manual mechanotherapy, and is applied to such treatment, even though kneading proper be not included in the prescription. The restricted application of this term is to the method of picking up or grasping a certain portion of muscle or other tissue with the fingers of one hand and subjecting it to pressure between them, or upon a hard substance, such as a surface of bone. Dr. Douglas Graham, of Boston, who is especially skilled in massage, recommends that, in kneading, "each group of muscles should be systematically worked

upon, and, for this purpose, one hand should be placed opposite the other; or, when the circumference of the limb is not great, one hand may be placed in advance of the other, the fingers of one hand partly reaching on to the territory of the other, so that two groups of muscles may be manipulated at the same time, with grasping, circulatory, spiral manipulations, one hand contracting as the other relaxes, the greatest extension of the tissues being upward and laterally, and on the trunk, forearms, and legs, away from the median line. . . . It is well, first, to go over a surface gently and superficially before doing the manipulation more thoroughly and in detail." For instance, to take up a limb of considerable size, such as the leg, he finds three divisions of surface necessary: the posterior and lateral aspects will form one; the stretching of the perineal muscles from those of the anterior tibial region will make another; and for the third a rolling of the tissues will be made away from the crest of the tibia. "In large muscular masses we seize them, in successive portions, with both hands, and squeeze in all directions, as one would squeeze water out of a sponge," says Reibmayr. At the moment of making pressure a certain amount of longitudinal traction may be practiced, which adds to the value of the manipulation. Another, but much less effective, form of kneading consists in rolling the limb between the palms of the hands. The movements here are very rapid and pressure is less important, the principal effect being produced by the frequently recurring stretching and forcible separation of the individual muscles, fasciæ, and nerves. Dr. Benjamin Lee judiciously sums up the characteristic features of this method in the following words: "Kneading is the procedure by means of which, above all others, we act upon the circulation of the deeper-seated tissues and profoundly modify the processes of absorption, assimilation, and destruction; in short, of tissue-metamorphosis,—in other words, of life. Hence, our aim should be, to as great an extent as possible, to avoid allowing any motion between the hand and the surface of the skin,—that is to say, friction or stroking,—and to compel the integuments following the motion of the hands and fingers to describe the desired movements over the underlying tissues. We thus not only act upon the circulation of the blood in the muscular and visceral capillaries, but accomplish the very desirable objects of increasing the elasticity of the skin, opening the areolar lymph-spaces, sundering pathological adhesions between the inferior layer of the skin and the tissues beneath, and stimulating the flow of the areolar fluid. Just to the extent that we allow rubbing do we lose the essential virtues of kneading."

Vibration is a form of massage, the alternate pressure and relaxation being made with great rapidity. It is generally performed by means of a mechanical contrivance, by which any portion of the body or limbs may be thrown into vibrations at a rate of several hundred per minute.

4. **Percussion** may be performed either with the border of the hand, the tips or knuckles of the fingers, the closed fist, or with some instrument constructed for the purpose. The shocks should be rapidly, but not forcibly, delivered,—usually from the wrist only. For this purpose various instruments have been invented, such as Bennett's percussion-hammer, Granville's percuteur, or electrical percusser; also, Klemm's or Ruebsam's muscle-beaters. The latter are useful for self-flagellation, but the hand remains the best instrument for accurately controlling the amount of force exerted. After massage has been performed **active and passive movements** of the neighboring joints are usually resorted to, especially in case of diseased joints and in chronic cases with stiffened articulations. In the north of Europe massage has been systematically combined with Swedish remedial gymnastics (so-called movement-cure) with great advantage. In this method various kinds of gymnastic exercises are resorted to, and peculiar forms of apparatus are provided to meet various requirements of treatment.

Electro-Massage.—A massage-electrode, in the form of a small roller, affords an excellent means of combining the effects of electricity and massage. It is usually connected with the faradic apparatus, but in cases of paralysis or of exudation it might be very advantageously used with galvanism. Owing to its powerful effects this form should be applied personally by the physician, or, at least, it should be used in his presence and under his direction, in order that the rules already laid down for the administration of electricity shall be duly observed.

The Roman bath is the term used to denote the use of some unguent, such as cocoanut-oil, codliver-oil, or butter, in conjunction with massage.

Physiological Effects of Mechanotherapy.—As might be inferred from the above description of the methods of massage, its physiological effects are very obvious, though complex. They may be considered as mechanical, thermal, electrical, and vital; the latter term being applied to the force or forces which resist disease and oppose death. The mechanical effects are immediate and most important. Under the movements there is a stimulation of the exchange of cell-contents, an increased activity in the movement of the areolar fluid, and noticeably in acceleration of the blood-currents and contents of both blood-vessels and lymph-channels. The glands behave in a similar manner, although they are unaffected by mild electrical currents; "every mechanical impression, such as stroking or pressure, whether over healthy or inflamed glands, causes the escape of large quantities of contained lymph." Von Mosengeil injected a thick solution of finely-levigated, black, India ink into various joints in rabbits. Some were treated by massage; others were let alone for control experiments. Upon subsequently killing the animals, "In the cavities of the joints which had been kneaded no trace of India ink was found, while in those which had not been so treated it was observed in considerable quantities, mixed with synovia. On examining the thighs, numerous and widely-scattered deposits of India ink were found in the areolar tissue in those limbs which had been manipulated. These were entirely wanting in the others. . . . Well-marked deposits of the coloring matter were discovered in the intermuscular connective tissue. The crural muscles were also stained black. The thighs of the unmanipulated limbs were not in the least colored, the muscles being of a clear red. The glands of the manipulated extremities which were situated above the joints were stained intensely black, and the lymphatics leading to them could be detected by the naked eye as two black cords. In the untreated limbs ink deposits in the lymphatic system were entirely wanting." Absorption is, therefore, stimulated by massage, and this holds good in the synovial lining of joints as it does elsewhere, the process taking place principally through the lymphatic vessels. In the blood-vessels stroking and kneading caused increased rate of blood-movement; this being assisted in the veins, as also in the lymphatics, by the pressure of valves in the inner walls. Randolph and Dixon * found, upon examination of the fæces of persons receiving inunctions of codliver-oil with massage, that there was a notable increase of fat in the discharges, thus proving absorption of the oil in 80 per cent. of the cases.

The temperature of a limb, and very commonly of the whole body, is slightly increased by massage. Arrested motion and friction give rise to thermic effects in the body as in the physical laboratory. Owing to physiological causes, the whole of the heat thus developed in a body under massage treatment is not made manifest by the thermometer, but is probably transformed into other forms of energy, such as electricity or cell-force. Heat, electricity, chemical action, motion, and life-force are intimately connected, and experiment and observation prove that properly-directed massage elevates temperature and improves nutrition, partly mechanically and partly through increased cell-activity. The vulgar notion that the operator directly transfers electricity or so-called animal magnetism from his own body to that of the patient has no other basis than this: Although a certain class of operators make capital for themselves by pretending to confer health or magnetism, their claims are either due to ignorance or to a deliberate attempt at deception. What passes from the operator to the patient is motion and, to a slight degree, heat. The operator feels the result of exercise of his muscles

* Transactions of the College of Physicians of Philadelphia.

and becomes fatigued, not because he has parted with any mysterious force, but simply because massage is rather hard work.

Schreiber divides the physiological effects into two groups:—

1. **Primary** (purely mechanical) effects, *i.e.*, the removal of lymph, exudations, transudations, and extravasations; the destruction of exudations by pressure, the removal of vegetations by friction, and the solution and removal of adhesions.

2. **Secondary effects,** which act by increasing the circulation by stimulating the muscular and nervous systems, by setting up molecular changes, and producing consequent changes in sensation, and by effecting alterations in the process of general nutrition.

Pain in an inflamed area being caused by the pressure of some exudation upon sensory nerves, relief will be produced by removal of this pressure under the effects of mechanotherapy. **Analgesia** is, therefore, obtained by massage. Inasmuch as manipulation causes an onward flow of the contents of the lymphatics and blood-vessels, massage has an **antiphlogistic action.** This is further demonstrated in its power of causing resorption of inflammatory products. It may also be regarded as an **alterative** on account of its effects upon effused fluids and its power of restoring healthy action in diseased parts. It is likewise a local **stimulant** and **counter-irritant.**

Neuralgia, or pain unaccompanied by inflammation, is usually the result of some lowering of the general nutrition, or the effect of a poison such as malaria. It may or may not be associated with any local lesion which acts as an irritant. Massage is especially serviceable in the first class of cases, owing to the improvement of local and general nutrition; but any source of irritation—such as eye-strain, caries of teeth, indigestion, etc.—should receive attention and be corrected if possible. The secondary effects of massage are included under the general heads of stimulation of vasomotor nerves and arterioles, with, in consequence, increased absorption and nutrition, and muscular contraction with increase of heat. Mechanical stimulus bears a strong resemblance to electrical stimulus in its effects upon the human body. According to Schreiber, "Any source of energy conveyed to a nerve from without first expends itself in producing molecular change, and this is again converted into energy, manifesting itself through the various forms of innervation." Hence, it follows that, as far as its effects upon the nerve-tissue are considered, it may be regarded as identical with electricity, with certain limitations. The proper appreciation of this is of much importance in mechanotherapy and is of daily practical application, especially in the treatment of neuralgia. The normal functional activity of the nervous system, according to Heidenhain, Hallstein, Tigerstedt, and others, consists of a species of wave-motion. The communicated motion or stimulus is converted, in some unknown manner, into the form of motion peculiar to nerve-substance. How molecular change is transformed into nervous force is a physiological problem which has not yet been solved; but this hypothesis of Tigerstedt is at least plausible, that nervous energy itself is a form of wave-motion among molecules, and analogous, therefore, to light and heat. Douglas Graham sums up the action upon the nervous system in the following enthusiastic terms: "Upon the nervous system, as a whole, massage most generally exerts a peculiarly delightful, and at the same time profoundly sedative and tonic, effect. While it is being done, and often for hours afterward, the subjects are in a blissful state of repose; they feel as if they were enjoying a long rest, or as if they had just returned from a refreshing vacation, and quite frequently it makes optimists of them for the time being. An aptitude for rest or work usually follows, though generally those who submit to this treatment feel gloriously indifferent, and needless apprehensions are dispelled. I have never known any one to take cold or suffer from exercise in the open air after general massage when ordinary care was observed. . . . Through the medium of the central nervous system even local massage is radiated or reflected throughout the body, thus acting at the same time as a nervous and vascular revulsive, or physiological counter-irritant, if one may be allowed the expression. One of the best examples of this, perhaps, is the relief from headache from manipulation of the back and shoulders. It has long been known that stroking the limbs often induces sleep. . . . The transmitted and reflected influences of massage must evidently be as numerous as the distributions and connections of the sensitive nerves that are accessible to its impression. Briefly, it may be said to act on distant parts by sympathy, by reflex action, and, as a variety of the latter, by inhibition." "Furthermore, massage excites and awakens the **muscular sense** in an agreeable and beneficial manner, such as nothing else does, restoring idiomuscular contractility and extensibility; and we know that the state of our muscles indicates, and often determines, our feelings of health and vigor or of weariness and feebleness." Estradua* sums up the effects of massage in similarly enthusiastic expressions of opinion. "I think that this happiness, this quietude, this respiration more free, these ideas so pleasing, are the result of the equilibrium which at this time reigns over all the functions. The nervous system, no longer requiring to exert herself against obstacles to respiration, to circulation, and to nutrition, enjoys a tranquility almost equivalent to repose, and then this

* Quoted by Graham in his Practical Treatise on Massage. Wm. Wood & Co., New York, 1884, p. 79.

state of oblivion, *de la vie expectative*, in some manner leaves the imagination to dwell upon the ideas of beatitude which come in multitudes to occupy the nervous centres, and these now have no need to concentrate a certain part of their activity to control the functions,—to subdue some and to stimulate others."

Massage is the hand-maid of medicine, in a literal sense, since the absorption, diffusion, and assimilation of remedies is favored by general massage,—at the same time that the emunctories are stimulated and the excretion of effete material by all the channels of excretion is encouraged.

Therapeutic Applications.—At the present day no physician can be considered well equipped for his duties unless he is acquainted with at least the fundamental principles of massage, and understands how to apply them in practice. It is by no means necessary that he should himself be an expert in the art of massage,—although this would be a consummation devoutly to be wished for his patient's sake,—but he should know how to prescribe massage as intelligently as he prescribes medicine, and should know whether or not the work is properly done, so that his patient may receive the greatest amount of benefit. It is too often the case that massage is "tried" in a case, and left entirely to some amateur masseur, who lacks tact and experience, and, after one or two *séances*, it is abandoned, and massage is brought into discredit. The physician owes it to himself and to his patient to see that the treatment is properly administered, and carefully adjusted to the strength of the patient. Some cases are benefited by ten minutes of massage, but would be completely exhausted by the full hour, which is the usual standard of service rendered among the lower class of operators. The golden rule in massage is, that the operations should be conducted in such a manner and for such a period of time as will afford the greatest benefit to the patient, without being followed by any sense of fatigue; but, on the contrary, as stated on the preceding page, he should feel rested and invigorated after each treatment.

Neurasthenia and Hysteria.—Massage occupies an important place in the so-called "rest-cure" of Dr. S. Weir Mitchell. It must be remembered that the subjects for this combined treatment of physical and mental quietude, diet, electricity, and massage, are either broken-down, chronic invalids or hysterical subjects, whose energies apparently are in a state of hibernation, or, at all events, in an abnormal condition as regards their response to the requirements of the mind and the body. Such patients are too weak for bodily exertion, often paretic, certain groups of muscles being affected more than others; there may be, and often is, great emaciation, due to want of exercise, and frequent pains and aches, owing principally to deficient nourishment of nerves and defective innervation of organs. Cases which have been bedridden for years have been cured by Mitchell, Playfair, and others, by enforced rest, improved nutrition, and electro-massage. The psychological factor in the Weir-Mitchell treatment is certainly a valuable adjunct. He insists upon isolation of the patient, forbidding all visitors, especially members of the family, absolutely confining the patient to the company of the nurse and the doctor during the period of treatment, and, in some cases, even interdicting all private correspondence. "Rest," says the author of this treatment, "means with me a good deal more than merely saying, 'Go to bed, and stay there!' It means care that letters bring no worrying news; that they are brief, and of such kind as a nurse may read aloud. It means absence of all possible use of brain and body. It means neither reading nor writing, at least for a time, with exceptions in cases where, as is rare, there is no asthenopia. If the nurse can read to the patient, and reading be borne without fatigue, let it be used, at first, for only a few minutes at a time. If this wearies, then let the nurse try to cull the bits of interesting news from the papers, and, as she glances over the columns, talk this to the patient in place of formally reading aloud. . . . If you are disposed to smile because I say let the nurse feed the patient, you will not if, lying supine, you make the experiment of using your own hands in the act of feeding. . . . I believe that I have done something to make rest fashionable among physicians as an essential to the treatment of spinal maladies, and, both in them and in the treatment of neurasthenia and hysteria, it is well that you clearly comprehend what it is that I mean by rest. Your trouble will be, always, that the patient will desire to lie on a sofa, or to make some such compromise, but in bad cases—and it is only of these I speak—all this is but mere trifling, and you had better, on the whole, make an error in the direction of a too absolute rest." * The fact is, that in many of these patients there is a long history of domestic tyranny by the querulous and exacting invalid, and the first battle to be fought is to establish the authority of the physician. Unless he can secure an unconditional surrender, so as to be master of the situation and have his directions obeyed, both in letter and spirit, he had better retire from his charge of the case, and refuse to accept any responsibility as to the results of treatment, in order to protect his own reputation. After he has secured the co-operation of those in authority, he is in a position to dictate the plan of treatment. The rest-cure consists essentially in keeping the patient passive, in the recumbent posture, for a certain length of time,

* Lectures on Diseases of the Nervous System, Especially in Women, p. 227. Philadelphia, 1881.

—generally, about three months,—keeping up nutrition by frequent feeding and the daily application of electricity and massage. The moral influence of the association with the trained nurse is of great advantage to the patient, as is also the knowledge that the term of treatment depends altogether upon the rate of improvement. In many cases this knowledge and the irksomeness of unaccustomed restraint combine to awaken an ardent desire to get well, which has a very happy effect upon the results of the treatment.

In hysterical paralysis, whether monoplegic or paraplegic, or in **hemiparesis,** the treatment by rest and massage, as above indicated, is of the greatest service, although in the lighter cases it may not be necessary, these being the patients who are likely to be benefited by the static current. Weir Mitchell, in the work already quoted, warns against allowing a convalescent, hysterical, paralytic patient to overtax her strength, or the original difficulty may return in an aggravated form. As regards the dietetic treatment, this is not the place for its discussion, but it is proper to observe that many fat patients are really thin-blooded and anæmic, and the first step toward improvement is a decline in weight. Mitchell reports one case of a paraplegic woman, weighing one hundred and seventy pounds, who was put to bed, and allowed a milk diet mixed with a little rice-water or barley-water, the milk being gradually reduced to less than a quart a day; when she showed signs of weakness beef-soup was added to the diet for a day or two. In one month, under this regimen, her weight was reduced some twenty-four pounds. Massage and induced currents, with a good diet, now turned the scale; she gained in color and in flesh, and at the end of another month she could walk without much trouble.

Dr. Benjamin Lee points out a possible abuse of the rest-cure, and considers that the treatment in other hands than the author's is capable of producing injury rather than benefit. He regards the movement-cure as the essential agent in the restoration of these nervous invalids, and the enforced rest, apart from its influence upon the *morale* as a means of subduing the perverse will of a spoiled child, simply as an accident of the massage and the acto-passive exercise necessary, to a certain extent, to reap the full benefit of the method, not necessarily remedial in itself, and, without the other means, as likely to do harm as good. **Overfeeding**—which is insisted upon—is only made possible by the mechanical treatment, and, in its effects, may really be undesirable and pernicious, by overloading the emunctories to a degree entirely beyond their capability to take care of assimilated material forced upon them in order to build up adipose tissue. It is possible that this fat may be deposited in abnormal situations, as in the liver or in the walls of the heart. He holds that, in these cases of impaired nutrition, hydrated blood, degenerated tissue, and depressed nerve-force, our object should not be to overload the economy with carbon and lay on layer after layer of adipose tissue, but to create a demand in the tissues farthest from the centre for healthy blood, by breaking down and forcing out the dead-alive cells, with their accumulations of morbid deposit, and sending them to the emunctories to be excreted, and, as this demand begins to be felt, supplying it cautiously,—principally with nitrogenous elements,—and not in excess of the assimilating organs to manage it. It is evident that the results of the so-called rest-cure will not be equally good in the hands of all who attempt to carry it out, and, where it is practiced, the greatest attention should be given to all the details in each individual case.

Massage in General Medical Practice.—Headache due to hyperæmia is relieved by neck-massage,—stroking the tissues upon each side of the larynx and trachea downward, thus accelerating the venous current in the numerous superficial veins. Its operation is analogous to that of blood-letting upon the cerebral vessels; the stroking, therefore, should be gentle, especially at first, and not too frequently repeated, or it may cause syncope. Massage of the muscles of the back, also, often relieves headache. **In congestions of the brain or membranes,** whether active or passive, the intra-cranial circulation may be diminished in this way, preparatory to the employment of slower derivative agents, such as purgatives. **In sun-stroke** Reibmayr is so convinced of its good effects that he says it should always be instantly resorted to. **Hemicrania,** of the congestive form, may be relieved promptly in the same manner. In the anæmic form of **hemicrania,** or **migraine,** massage of the neck does no good; but firm stroking of the frontal and temporal regions, with the eyes closed, usually brings relief. As such patients are readily hypnotized by gentle stroking of the head, this method should be employed with circumspection, unless it is desired to produce hypnotic sleep. **Nervous headaches** and some neuralgias are benefited by stroking and friction. Norström, of Paris, finds neuralgias of muscular origin, which are accompanied by centres of induration in the muscles of the neck, and often by tenderness along the nucha. These he attributes to chronic inflammatory processes, and that the removal of their indurations by massage is invariably accompanied by complete cure of the neuralgia.

In **tabes dorsalis,** or locomotor ataxia, good results have been reported by Schreiber and others following the use of massage. The annoying symptoms of this disease are undoubtedly relieved by mechanotherapy and the progress of the morbid lesions possibly delayed; but it cannot be said as yet that the therapeutic problem in this interesting malady has been solved.

It is in **sciatica** especially that the most brilliant results have been reported from the movement cure. In sciaticas of rheumatic origin strong stroking alternating with percussion along the course of the affected nerve is usually successful in producing a cure in a short time. If pathological changes in the course of the nerve have caused the sciatica, the success of the treatment will depend upon their discovery and their removal, either by local massage or by other means. When tumors, or pathological changes deep within the pelvis, have caused the pain, massage may fail and, in fact, may aggravate the suffering. In uncomplicated cases cure may be hastened by combining massage and electricity. Painful points, especially along the spine, are frequently met with, especially in women. As such points are in some cases the point of departure for hysterical or epileptiform convulsions, it is important to relieve or remove them early by local massage.

In various neuroses of occupation, professional neuroses, of which **writers' cramp** is a familiar illustration, massage is the only agent capable of affording permanent relief. The method of Wolf in treating writers' cramp has already been mentioned under Electricity; it is a combination of stroking and friction, with both the galvanic and faradic currents. In cramp of the calf of the leg, the toes should be strongly adducted, so as to twist the muscle, while friction is applied with the palm of the hand.

Chorea is a disease which is rapidly controlled by massage and gymnastics, as pointed out by Blache and Bouvier.* The treatment is by light stroking of both upper and lower extremities and the chest, the patient being held by attendants. The muscular masses of the back, especially at the neck and along the spinal column, are also masséed. The treatment, lasting for about an hour, should be repeated daily for three or four days. "After each treatment the irregular muscular contractions become less violent, and the patient gives it to be understood that he feels more comfortable. Sleep, which had been completely interrupted during the continuance of the most violent contractions, is gradually re-established, and speech begins to return. For several subsequent days the light stroking and friction must be persisted in, and the masseur may then begin very regular rhythmical, passive movements." Following these, acto-passive movements are encouraged for the next eight or ten days, when the patient may be encouraged to try to walk alone. As soon as he is able to accomplish this, active gymnastic exercises of simple character are superadded. By systematic training and encouragement the control of the will over the muscles is gradually established, while at the same time there is an improvement in the chlo-

* Use of Gymnastics and Massage in Chorea. Dr. Blache, Paris, 1854.

rotic condition, and the heart and arterial murmurs disappear. This method of treatment, according to its originator, Dr. Blache, is not followed by relapses, and the patients apparently are permanently cured.

In **rheumatic paralysis,** or peripheral paralysis of a motor nerve as a result of exposure to cold, and also in **lead paralysis,** massage is an invaluable adjunct to the electrical and other treatment, and a tendency to degeneration of the muscles and nerve may thus be overcome.

In **infantile spinal paralysis** and **club-foot due to paralysis,** massage, systematically practiced, improves nutrition of the parts and is often curative if early resorted to. Erb considers it of service as an adjunct to electrical and other forms of treatment. It is often impossible for parents to bring their children to be treated daily with electricity, and they can be taught by the physician to employ massage at home. In **central paralyses** the nutrition and circulation of the palsied parts can at least be improved by massage.

Dr. Murrell reports a case of recovery from **chronic** myelitis in a man 35 years of age, as the result mainly of massage.

In **acute catarrhs** of the mucous membrane of the upper air-passages, in **coryza, tonsillitis, pharyngitis, angina, laryngitis,** massage of the neck is highly serviceable. In **croup** Weiss employed this method with remarkable success. In a child with croup a single sitting relieved the most urgent symptoms; the short, wheezy respiration, accompanied by the most painful tension of the respiratory muscles, soon became more free, easy, and deep; the aphonia gave place to a voice which, although still hoarse, was no longer mute, and the child became more tranquil and willingly underwent the massage, inasmuch as it brought him such manifest relief. **Bronchial catarrhs, asthma of the pure nervous type,** and even **angina pectoris** are benefited by stroking, friction, and percussion with the palm of the hand until the skin becomes intensely reddened.

In **torpid liver, semi-paralyzed condition of the intestines,** and **constipation** abdominal massage is capable of accomplishing much toward overcoming the morbid state. As stated by Reibmayr,* we shall bring it into use in all those affections in which we desire to regulate the peristaltic movements of the stomach and bowels; to exert a favorable influence on the circulation of the blood and of the lymph so closely dependent upon those movements, and hence, secondarily, on the secretion and excretion of the digestive juices; to expedite the absorption of exudations, and, finally, to dislodge obstructing fæcal masses in the intestinal tube by direct mechanical action. Massage may, therefore, be practiced in **acute** and **chronic gastric** and **intestinal catarrh, dyspepsia, cardialgia, dilatation of the stomach, intestinal obstruction** (**ileus**), **tympanites** not

* Tracts on Massage. No. iii. Translated, with notes, by Benjamin Lee, Philadelphia, 1887.

dependent upon inflammation of the peritoneum, **ascites,** and, finally, all the sequelæ of peritoneal inflammation,—such as firm peritoneal or extra-peritoneal exudations, swellings, and adhesions,—always provided that the inflammatory process is completely at an end. All inflammatory affections of the peritoneum, malignant tumors, and deep ulcerations of the stomach or intestines contra-indicate its employment. "For **habitual constipation,** especially in persons of sedentary habits, abdominal massage, combined with pelvic gymnastics, constitutes the most desirable, sure, and efficient remedy that we possess," in the opinion of Benjamin Lee.

In **hepatic congestion with jaundice** local massage over the liver with general abdominal massage for fifteen minutes daily are used, combined with gymnastic exercises for pelvic muscles.

Chlorosis and **anæmia,** as recently suggested by Sir Andrew Clarke, are often associated with and dependent upon constipation. Abdominal massage to overcome the latter condition, combined with general massage of the entire surface, will render most favorable results.

In **local œdemas** and **congestions** stroking, friction, and passive movements are rapidly curative.

Rheumatic gout, or, more correctly, **chronic rheumatoid arthritis,** is, according to Dr. Graham, amenable to massage, provided that the treatment commence before the pathological changes in muscle, tendon, bone, and surrounding tissues are too far advanced. Frequent visits and arduous work are required, but in the end amply repay both physician and patient for the time and trouble expended. He obtained gradual improvement from the use of massage in five out of six cases of well-marked rheumatic gout; and, by keeping up the treatment, four patients regained tolerable use of the affected limbs, and in one recovery seemed to take place. Berghman and Helleday, Courfield, Balfour have reported cases similar to those of Graham, where marked improvement resulted from the treatment. His method was deep manipulation, without friction or inunction; passive motion as far as pain would allow, and sometimes farther; and resistive motion as soon as it could be done. . . . If pain last for several hours, and increase after subsequent efforts, the treatment must be modified or suspended. Kneading with one hand, so as to break up indurations or disperse effusions, while the other hand pushes along the circulation in the veins and lymphatics above the joint, will often lead to absorption of products not too firmly organized. Massage of the adjacent area acts as a physiological derivative, and improves nutrition. The inutility of any other form of treatment makes massage the only resource in this disease.

In **heart disease,** when valvular disease has resulted in insufficiency and the compensatory hypertrophy is commencing to fail, at a time when there is slight œdema, fullness of the venous system, symptoms of hyperæmia of the liver, etc., general massage affords marked relief. The œdema disappears, the circulation improves, and the digestive organs perform their duties in a more satisfactory manner under the influence of properly-applied massage.

In **weak heart,** due to deficient innervation or to lowered tone in the muscular tissue, following certain fevers, such as typhoid, influenza, diphtheria, etc., the daily performance of general massage, with passive exercises, will gradually restore vigor and tone to the debilitated organ.

In **diseases of women** massage, on account of its corroborant power, is a valuable emmenagogue. It diminishes the suffering attendant upon dysmenorrhœa, and may be instrumental in restoring such normal relations as will overcome sterility. In malpositions and flexions of the uterus, with or without prolapse, the application of pelvic massage after the plan of Thure Brand, of Stockholm, has proved very successful. It consists in (1) raising the womb; (2) massage of the organ and its ligaments; (3) forced abduction and adduction of the knees; (4) percussion of the lumbar and sacral vertebræ. This method favors absorption of exudations, cicatricial bands, adhesions, etc., and was indorsed by A. Reeves Jackson, of Chicago. With regard to the correction of womb troubles, Weir Mitchell offers the following rules in connection with the rest-cure: "In the case of married women I make, or cause to be made, a thorough examination, to begin with. If there be only congestive states and their consequences, I trust to the general treatment for cure. If there be marked displacements or excessive menstruation, I like to correct the one and have the uterus well searched for possible causes of the other. Should there be grave fissures of the neck of the womb or perineal rupture, I prefer to have them relieved at once. Misplaced ovaries cause, in my experience, a great deal of trouble, but both Professor Goodell and I have seen a number of cases in which this annoying complication righted itself spontaneously during treatment by rest."

In **skin diseases** extended experience has only confirmed the favorable opinions expressed by the author in 1884, in papers which he read before the Section of Dermatology and Syphilis of the Eighth International Medical Congress, at Copenhagen, and before the American Medical Association (1883), on "Mechanical Remedies in Skin Diseases," as to the practical value of massage in this special field. He regards it as one of the most helpful agents at his command. To consider a few of its applications, we may commence with seborrhœa capitis. Gentle massage is here of great service in restoring perfect capillary circulation, promoting absorption, and imparting a healthy tone to the tissues. It prevents falling out of the hair, and favors a healthy new growth by improving the nutrition of the hair-bulb. In **acne indurata** and in glandular swellings in the skin massage opens the clogged absorbents, causing the lesions to disappear and rendering the skin soft and elastic. Many skin disorders are the result of disturbed digestive processes and constipation, and the application of massage to the abdomen, by kneading and percussion, is of excellent service in removing the cause of the unhealthy condition of the skin. Excess or deficiency of pigment may be remedied by massage, owing to its dispersing power and tendency toward restoring normal action. In **psoriasis** and **scrofuloderma,** general massage is used to increase nutrition of the skin and promote the formation of blood-corpuscles and consequent oxidation. In the **itching** of chronic or acute eczema, massage is directly beneficial, and patients may be instructed to use it in place of scratching with the nails, which produces secondary lesions and aggravates the original condition. Many **trophic disorders** of the skin are influenced favorably by properly-administered movements.

Infiltration of the skin, accompanied by roughness and scaliness, is a condition in which ordinary methods fail, but which will yield to massage. In simple cases of rough, thick, and leathery skin, where it is desired to enhance the beauty of its texture, its fairness, softness, and elasticity, there is no agent so powerful as massage. Frequent warm bathing, an occasional Turkish bath, and daily shower baths are very valuable in stimulating the cutaneous circulation, and should be supplemented by friction and kneading. The well-recognized benefits of friction with a coarse towel are feeble imitations of the results of skilled massage, such as gave suppleness to the muscles and health and beauty to the skin of the ancient Greeks.

Massotherapy is the best means in our power for rendering old, infiltrated, exudative material amenable to the action of the absorbent vessels. In **elephantiasis arabum** deep kneading has led to excellent results. In the intervals of the application the limb may be compressed by a bandage, preferably of rubber. Very decided diminution of bulk has followed this treatment. **Ecchymoses** of the face or other parts of the body, due to bruising and consequent effusion of blood under the skin, are very disfiguring for the time; they may be rapidly dispersed and absorbed by rotary friction, stroking, and gentle kneading. **Hæmatoma** of the auricle, frequently occurring in the insane, is believed to arise frequently from direct injury. At all events, it gives rise to considerable deformity, and should be treated with massage applied in the same manner. In **furuncle,** before suppuration has occurred, gentle friction—first of the neighboring vascular area and finally of the lesion—will relieve pain and promote resolution. The pain of **herpes zoster** is said to be decidedly lessened by well-directed local stroking over the affected nerve. In **hyperidrosis** and other disorders of the perspiratory glands good results may often be noticed after general massage, and the consequent improvement of the general health. In **sycosis** we have had excellent results from general massage combined with local measures. **Ecthyma** being an expression of faulty nutrition, massage similarly promises good results by improvement of the general condition. **Impetigo** is similarly caused and similarly benefited. In **lichen planus** and **lichen scrofulosus** massage is of service, and it is calculated to counteract the constitutional depression attendant upon **lichen ruber. Scrofulous** and **syphilitic lesions** of the skin, especially occurring in weak patients or those of feeble constitution, or debilitated by intemperance, sexual excess, insufficient food, poor clothing, and bad air, are rapidly benefited by general massage and proper hygienic management. **Cicatrices** and **hypertrophied scars** may be softened and caused to disappear by persevering applications of friction and kneading, especially if codliver-oil be used locally, by inunction, at the same time.

Morbid growths of a benign character, hypertrophied tonsils, chronically-enlarged glands may disappear under general and local massage; and inflammatory thickening and indurations very constantly are removed in this manner.

In **chloral poisoning, alcoholic coma,** or **opium narcosis,** as suggested by Dr. Murrell, massage of the extremities is useful in maintaining the circulation until antidotes have time to act.

Synergists.—Hygienic measures of all kinds assist massage in bringing the body to its highest state of physiological perfection. Pure air and exercise are powerful adjuncts; bathing, especially sponge and shower baths, are too much neglected; affusion, or pouring, of either hot or cold water, or each in turn, is a decided stimulant to the nerves and vessels of the part treated; and, in fact, massage is greatly aided in producing the desired results by these and similar means. Proper clothing, both at night and during the day, will assist the treatment. During massage the clothing should be loosened, or of such character as to permit the required manipulations. In the use of apparatus, as in the Swedish system of mechanotherapy, and, in fact, in the drill, either with or without appliances, a gymnastic suit of flannel, with a belt at the waist, is indispensable. Intelligent supervision should be given to the daily food of the patient, in order that the best results may be derived from the movement-cure. The diet should be plain, nutritious, and, unless in special cases where the contrary would be required, it should be sparing. The object to be kept in mind by the patient should not be the gratification of the palate, but the needs of the system. The advice to exercise not for strength, but for health, may be accompanied by the admonition not to eat for enjoyment of the pleasure of the table, but to keep the body well.

Electricity is closely allied to massage in its effects upon the muscular system, as it produces contraction and commotion in the body of the muscle by acting upon the muscular fibres and end-organs of the nerves. As previously indicated, a combination of these valuable agents is used by means of the roller electrode, using either faradism or galvanism. The hand of the manipulator may also be made to act as an electrode and communicate a current to the tissues operated upon. In delicate patients and children this is the best manner of administering electricity, as they are re-assured by the knowledge that the current must pass through the body of the attendant before reaching them. In the rest-cure faradic electricity is employed to produce contractions of individual muscles, and, in effect, it serves as a means of making passive motion. The massage is performed either before or after the application of the electrical current, but generally before.

Some drugs are of great value in assisting a course of massage. They would generally be classed as nerve-tonics and restoratives, but it is often necessary to regulate the action of the digestive organs and get them into a normal condition before getting the best results of the massage treatment. If digestion is feeble, it may be judicious to give digestive ferments for a time, until the improved nutrition enables the glands to secrete a better quality of gastric juice and other digestive fluids. Where the liver is performing its duties poorly, the administration of a good cathartic will hasten the effects of massage, and in cases of constipation the use of a large warm-water-and-soap enema, or the injection of a small quantity of glycerin into the rectum, will assist the manipulations in moving scybalous masses. At the same time, it is observed that cases of constipation which come for treatment by massage are generally those which have been through the list of purgatives, and pills and potions have lost their effect, owing to an atony of the bowel-wall or paresis of the nerves causing peristaltic movements. As already intimated on a previous page, feeding is to be regarded as of more importance than drugging, and a judicious regulation of the dietary will often make remedies superfluous, especially if abdominal massage be properly practiced, in many disorders of digestion.

Tonic remedies proper or nerve-tonics, of which strychnine may be taken as a representative, have been greatly abused in the treatment of neurasthenic patients, who require massage and good hygienic treatment. Drugs very poorly substitute gymnastic exercise and fresh air. If patients should have their exercises regularly prescribed for them, and obey the directions of the experienced physician in regulating their periods of work and rest, the supposed necessity for tonics would often disappear entirely from the therapeutic problem. Owing to the great faith which patients have in the mysterious virtues of remedies and the power of habit, they do not feel satisfied unless they have a magistral prescription, and are taking the regulation "teaspoonful three times a day." It is, perhaps, a pardonable weakness, perhaps a shrewd and judicious procedure, to concede something to the prejudices of the patient and prescribe, if not a placebo exactly, at least a mild stomachic; something bitter,—but not too bitter,—that he may satisfy his sense of propriety with while he permits the massage and electricity to do their perfect work. The good results will be apt to be ascribed to the medicine, but as our object is to cure the disorder this undue exaltation of one part of the treatment must be suffered and ascribed to its proper source,—the ignorance of physiological processes on the part of the patient.

Contra-indications.—Many cases of confirmed invalidism have drifted into the habit of taking comparatively large doses of various narcotic remedies, with which they stupefy themselves, and thus pass their lives in a more or less intoxicated condition. It need scarcely be said that the use of drugs which lock up the secretions, benumb the nerves, and lessen motility of the muscles is entirely opposed to the objects for which massage is practiced, and that such drugs must be abandoned if improvement of health is expected under mechanotherapy. Fortunately, as Murrell has pointed out, massage aids in overcoming the opium and chloral habits, and, if the patient wishes to escape from the physical and intellectual degradation which their constant use entails, no better way has been devised than a course of treatment of this kind. For many reasons, it is preferable that such patients shall be taken away from their friends and customary surroundings and treated in an institution directly under the supervision of the skilled physician in charge. The treatment must be mental as well as physical, and the first step to be taken is to secure the co-operation of the patient, and make him sincerely and earnestly desire to throw off the evil habit and to be restored to a normal state. If this be not secured the result will not be permanent, even if massage and gymnastics are faithfully performed, because a relapse will be inevitable as soon as the opportunity of indulgence is again presented. It is evident, therefore, that unless the patient pledge his honor to abstain in the future, massage will be only of temporary benefit and will be brought into undeserved disrepute.

While massage may relieve pain in carcinoma and other forms of malignant disease, it is considered inadvisable, since it favors the absorption of the cancer-cells and their introduction into the neighboring glands and systemic infection. In aneurism the suffering may be relieved by light friction, but kneading or pressure must be avoided. In ulcer of the stomach, massage should not be practiced. It is considered injudicious, in atheroma of the cerebral arteries and in softening or tumor of the brain, to perform general massage; but gentle massage of the neck may be permitted, in order to assist the return of blood from the brain.

In recent apoplexy, hemiplegia, or monoplegia, and effusions into the spinal cord, it is better, for the first week, to abstain from massage. Subsequently, light friction may be used, in order to maintain nutrition of the limb by urging onward the lymph and blood in their respective vessels. If local softening of the brain should occur (red softening), anything like active or passive movements of the affected limbs should be avoided as completely as possible. In chronic myelitis it is generally considered that massage is of little value, but Murrell reports a remarkable case, which has already been referred to, in which it produced almost a complete restoration of motion in the paralyzed limbs. In recent neuritis the use of massage is interdicted, as the rule, although a skillful operator will be enabled to afford relief from pain and diminution of hyperæmia by progressive massage.

How to Prescribe Massage.—The usual method of prescribing massotherapeutics is to personally interview the masseur or **masseuse** (male or female operator), and indicate verbally, and, perhaps, by demonstration, exactly the character and duration of the movements desired. This is the best way, because the physician can remain and see the operations performed, and have a demonstration of the manner in which his ideas are carried into practice. Where the physician has his own trained nurses, who fully understand his directions and can be trusted to carry them out, this inspection on the part of the physician may be dispensed with, as it involves considerable loss of time. For his notes of cases, it is also desirable that there should be some abbreviated form of indicating the exercises. In the German and Swedish works on mechanotherapy these directions are given in terms which, to the uninitiated, are entirely meaningless, especially in the system of Ling and his immediate followers. Instead of indulging in such an expression as this, for instance, "Left—rest—right—extended—gait—left—side—support—standing," it would greatly simplify the matter if a code of arbitrary signs were adopted, as in the transmission of messages by the Atlantic Cable. For instance, in regard to massage, the nurse may be supplied with a card, on which may be printed the following:—

No. 1.—Massage.*

A.	All over,	30 minutes.
B.	All over,	45 "
C.	All over,	60 "
D.	Head-massage,	5 "
E.	Over the chest,	5 "
F.	Over stomach and bowels,	5 "
G.	Over the throat,	3 "
H.	Over the spine,	5 "

No. 2.—Fomentations, with Wet Compresses.

A.	Hot on back of neck and head, with ice-cold compresses over nose,	15 minutes.
B.	Hot between shoulders, with ice cold compresses over lungs,	15 "
C.	Hot between shoulders, with ice-cold compresses over lungs,	20 "
D.	Hot between shoulders, with ice-cold compresses over lungs,	30 "
E.	Hot behind stomach, with ice-cold compresses over bowels,	20 "
F.	Hot behind stomach, with ice-cold compresses over bowels,	30 "
G.	Hot on sacrum, with ice-cold compresses over bladder,	20 "
H.	Hot on sacrum, with ice-cold compresses over bladder,	30 "

No. 3.—Fomentations, Alternating with Compresses.

A.	Alternate hot and cold, four changes, to dorsal vertebra,	15 minutes.
B.	Alternate hot and cold, four changes, to dorsal vertebra,	20 "
C.	Alternate hot and cold, four changes, to dorsal vertebra,	30 "
D.	Alternate hot and cold, four changes, to lumbar vertebra,	15 "
E.	Alternate hot and cold, four changes, to lumbar vertebra,	20 "
F.	Alternate hot and cold, four changes, to sacrum,	15 "
G.	Alternate hot and cold, four changes, to sacrum,	20 "
H.	Alternate hot and cold to cervical vertebra,	15 "
I.	Alternate hot and cold to cervical vertebra,	20 "
J.	Alternate hot and cold whole length of spine,	10 "
K.	Alternate hot and cold whole length of spine,	15 "
L.	Alternate hot and cold whole length of spine,	20 "
M.	Alternate hot and cold to painful part,	15 "
N.	Alternate hot and cold, six changes, to painful part,	30 "

No. 4.—Ten-Minute Fomentations.

A.	Over stomach and liver,	140°,	two applications.
B.	Over spleen,	140°,	" "
C.	Over bowels,	140°,	" "
D.	Over bladder,	140°,	" "
E.	Over right lung,	140°,	" "
F.	Over left lung,	140°,	" "
G.	Over both lungs,	140°,	" "
H.	Over throat and bronchi,	140°,	" "
I.	Behind stomach,	140°,	" "

* Massage of the head is not included in A, B, or C; so that where this is desired in addition it should be designated by adding D to the prescription.

J. Behind bowels,	140°,	two applications.
K. Behind lungs,	140°,	" "
L. Back of neck,	140°,	" "
M. On sacrum,	140°,	" "

No. 5.—Fifteen-Minute Fomentations.

A. Over stomach and liver,	140°,	two applications.
B. Over spleen,	140°,	" "
C. Over bowels,	140°,	" "
D. Over bladder,	140°,	" "
E. Over right lung,	140°,	" "
F. Over left lung,	140°,	" "
G. Over both lungs,	140°,	" "
H. Over throat and bronchi,	140°,	" "
I. Behind stomach,	140°,	" "
J. Behind bowels,	140°,	" "
K. Behind lungs,	140°,	" "
L. Back of neck,	140°,	" "
M. On sacrum,	140°,	" "

No. 6.—Twenty-Minute Fomentations.

A. Over stomach and liver,	140°,	two applications.
B. Over spleen,	140°,	" "
C. Over bowels,	140°,	" "
D. Over bladder,	140°,	" "
E. Over right lung,	140°,	" "
F. Over left lung,	140°,	" "
G. Over both lungs,	140°,	" "
H. Over throat and bronchi,	140°,	" "
I. Behind stomach,	140°,	" "
J. Behind bowels,	140°,	" "
K. Behind lungs,	140°,	" "
L. Back of neck,	140°,	" "
M. On sacrum,	140°,	" "

No. 7.—Thirty-Minute Fomentations.

A. Over stomach and liver,	140°,	two applications.
B. Over spleen,	140°,	" "
C. Over bowels,	140°,	" "
D. Over bladder,	140°,	" "
E. Over right lung,	140°,	" "
F. Over left lung,	140°,	" "
G. Over both lungs,	140°,	" "
H. Over throat and bronchi,	140°,	" "
I. Behind stomach,	140°,	" "
J. Behind bowels,	140°,	" "
K. Behind lungs,	140°,	" "
L. Back of neck,	140°,	" "
M. On sacrum,	140°,	" "

The prescription-blank would be as follows :—

Prescription Card for Treatment of

Name ________________________________

Address ________________________________

Prescribed by ________________________________ M. D.

	M.	T.	W.	T.	F.	S.
No. ________						
No. ________						
Followed by No. ________						
No. ________						
At same time No. ________						

The masseur is requested to continue this treatment until otherwise directed, unless obvious change in the condition of the patient renders desirable an earlier consultation of the prescribing physician. The time of day may be indicated if desired.

The above is actually in use in this city, and its practical value demonstrated. The masseur or masseuse stands in the same relative position as the druggist to the physician, and simply carries out his directions as indicated by the prescription.

[NOTE.—In the foregoing pages an attempt has been made to indicate the characteristic features, physiological effects, and a few of the applications, of mechanotherapy. On account of the extent of the subject and the limitation of space, it is evident that only the most general conclusions could be communicated, and that many of the details of treatment are omitted. At the same time, it is exactly the details which should be scrupulously observed in order to obtain the most satisfactory results in an art like massage. It is, therefore, urged upon the attention of students and physicians that the physiological effects of mechanotherapy being what they are, and its results such as have been demonstrated, the subject should be intelligently and carefully studied by consulting such text-books as Douglas Graham's "Practical Treatise on Massage" (second edition), Murrell's "Practice of Massage," or Schreiber's "Treatment by Massage and Exercise," where the instructions are more explicitly given, and with a wealth of illustration and detail which is impossible in a general work on therapeutics. As Murrell remarks, massage is a therapeutic agent of the first rank, which will yield good results in a host of diseases other than those which have just been summarily reviewed. At the present day the intelligent practitioner cannot afford to be ignorant of the advantages and applications of massage, which is now employed by the leading specialists in nearly every field of medicine, with excellent results. Indeed, a proper understanding by the physician of what the Chinese call "the body-regulating art" will lead him to apply it to his own case,—obeying the injunction of "Physician, heal thyself!"—in order to maintain his own health and vigor amid the various disturbances to which he is subject in the pursuit of his arduous avocation; more especially if he live in a crowded city, amid the turmoil and excitement that keeps the nervous system in a constant state of tension, which is interpreted as the need for drugs, such as bromides, opium, and alcoholic stimulants; but which is better treated by massage and due regulation of bodily exercise and rest.]

PNEUMOTHERAPY AND PNEUMATIC DIFFERENTIATION.

Pneumotherapy, **atmiatria,** or pneumatic medicine, considers the administration of gases and remedies in a gaseous condition in the treatment of disease. The effects of changes in density and of the use of remedies under circumstances increasing or decreasing atmospheric pressure have recently received so much attention that they will require separate discussion. The subject, therefore, will be divided into :—

1. The administration of remedies in a gaseous form: **Pneumotherapy.**

2. The administration of such remedies under altered conditions of atmospheric pressure, or in a more or less condensed or rarefied form: **Pneumatic differentiation.**

A strict construction of the term "pneumotherapy" (*πνεῦμα*, air or breath, and *θεραπεύω*, to heal) would restrict it to the consideration of respiratory disorders, but it may also be employed as applied to treatment by the use of air or gases. An ancient medical sect, known as pneumatici, or pneumatic physicians, founded by Athenæus, held that an immaterial principle or element existed, upon which depended conditions of health the excess or diminution of which caused disease. Previous to the revelations of the microscope and the advent of modern pathology and chemistry, this was about as far as hypothesis could be expected to carry us toward the discovery of the true nature of many diseases, but there is no good reason for the existence of such a medical theory in the nineteenth century.

In proceeding to consider the therapeutic employment of certain gaseous substances, it is proper, in the first place, to devote a few words to a gaseous compound known as **atmospheric air,** its composition, and the effects upon the human system of alterations in the proportion of its constituents and the results of its contamination. Air is a universal and indispensable gaseous food. It is not a chemical compound, but simply a mixture of oxygen (about one-fifth) and of nitrogen (about four-fifths) with variable, but usually small, quantities of carbonic acid, ammonia, watery vapor, dust, etc. We cannot dwell here upon the physiological facts in connection with the effects of increase or decrease of carbonic acid or the presence of certain contaminations, especially the various forms of microbes and disease-germs. We may, however, in passing, point out, in a very general way, the difference in the rate of growth and development of children who have a plentiful supply of fresh, pure air as compared with those who lead a sedentary life in house or school. The subject of the ventilation of sick-rooms and apartments where many persons are crowded together, as in schools, factories, and work-shops, has been fully investigated of late years, and the breathing of foul air is now regarded as one of the principal causes of ill health.

Conversely, in many patients the first therapeutic step to take is to secure for them a greater quantity of pure air than they have been accustomed to having. In modern treatises upon the practice of medicine, great stress is usually laid upon the importance of the ventilation of living-rooms, and also of exercises in the open air. Drs. Trudeau and Sternberg found that the mortality from consumption, in rabbits inoculated with tubercle virus, was very much greater among animals confined in crowded, ill-ventilated hutches than among others which were allowed to run out and live in the open fields. Heated air has been employed in therapeutics not only in the form of the Turkish bath, but also used simply by inhalation. The effects here being simply those of elevation of temperature, they will be considered under the head of heat. The effects of differences of atmospheric pressure will be discussed in the present section, under the title of "Pneumatic Differentiation." The effects of breathing rarefied air are closely connected with those attending residence in elevated localities, where atmospheric pressure is less than at ordinary levels. This deserves careful study, as upon it often depends the decision as to the proper sanatorium to send an invalid. It may be accepted as an axiom that patients suffering with advanced disease of the heart, lungs, or kidneys are injured by removal to a high altitude, as their systems do not readily become accustomed to the increased labor of breathing necessarily required by the rarefaction of the air. This, however, will be considered, more in detail, under the subject of "Climatology." Under this head, also, will be considered the effects of the presence in the air of moisture, and the differences between marine and mountain airs and places.

The presence of ozone in the air, and its consequences, will be hereafter referred to in discussing oxygen. When present, it is an important witness to the purity of the air and its freedom from organic contamination. Where great numbers of people live in crowded communities, ozone is never present. If the fact is borne in mind that the expired air from the lungs contains more or less excrementitious organic matter, it will be understood why crowd-poison or re-breathed air may be the cause of disease. Besides the increased quantity of carbonic-acid gas and the diminished proportion of oxygen, the expired air further varies from the standard of pure air, in that it has an excess of moisture, which contains odorous particles, and frequently bacilli and other forms of bacteria. Atmospheric air, however, except in special locations on the tops of mountains, may also contain many varieties of bacterial forms, and also organic material, in the form of dust, which may be of a very irritating character. The expectorations of tuberculous patients in the streets become dried, and tubercle bacilli have been shown by actual experiment to be present in street-dust, as well as in the confined air of the consumptive wards in a hospital. Manifestly, therefore, persons who, by heredity or acquired predisposition, are liable to suffer from phthisis, should live in a neighborhood where they can breathe pure air, as free as possible from all irritating matters, and especially pathogenic substances, and they should carefully avoid crowded vehicles or public halls. Consumptive nurses should never be allowed to contaminate the air that young children breathe by fondling and kissing them, infants being particularly liable to infection from this source. Operatives who work in overcrowded rooms, such as cigar-makers, cloak- and dress-makers, especially where there is much dust in the air, show the effect of privation of fresh air in their pallid faces and wasted frames, and they are also very subject to pulmonary affections from inhaled particles, which act as irritants. The first prescription for a cough, under such circumstances, would be fresh air, as pure as can be obtained. One of the principal beneficial effects of the movement-cure and massage is seen in the increased activity of the respiratory function which follows physical exercises; but increased respiration will not be of great benefit unless, at the same time, provision be made to supply a sufficient quantity of pure air. The report of the English Army Sanitary Commission, published in 1858, is conclusive in its proof that "the excessive mortality from consumption among soldiers, and in particular regiments, was due to overcrowding and insufficient ventilation. Previous to that inquiry, the cubic space per soldier in the barracks of the Foot Guards only amounted to three hundred and thirty-one cubic feet, and the phthisis mortality was as high as 13.8 per 1000. In the Horse Guards, on the other hand, with a space per man of five hundred and seventy-two cubic feet, the mortality from phthisis did not exceed 7.3 per 1000. It was found that phthisis prevailed at all stations, and in the most varied and healthy climates, the vitiated air in the barracks being the only condition common to all of them. In consequence of this excessive mortality, the Commissioners recommended that the cubic space allowed per man in barracks should be increased and the ventilation improved, with the result that, from the time their recommendations were acted upon, the number of phthisical cases occurring at all these stations has materially diminished. Similar evidence is afforded by the statistics of the Royal Navy, and notably as regards the civil population, in the report of the Health of Towns Commission, published in 1844. Indeed, it has been fully established that not only phthisis, but other lung affections, such as pneumonia and bronchitis, are generated, to a large extent, under like conditions, and the same may be said of such diseases as scrofula, and others of an adynamic type." *

The announcement of the discovery of the tubercle bacillus by Koch, in 1882, has not invalidated the above observations. On the contrary, these observations are highly valuable, since they serve to explain the problem of susceptibility, or predisposition, by means of which some individuals acquire phthisis, while others, under similar circumstances of exposure, successfully resist the inroads of the bacilli. In fact, while the effects of constantly breathing vitiated air may not be at once manifested, or cause severe pain or discomfort, other than frequent headaches or feelings of malaise, the consequences, in undermining the health, appear slowly, and are cumulative, but not the less injurious. This is now universally recognized as among "the most potent and wide-spread of all the predisposing causes of disease" (Wilson). Following the dictates of sound judgment and experience, civilized nations have steadily improved the ventilation of dwellings and work-rooms, and systematically remove from cities garbage and filth which poison the air by undergoing fermentation and putrefaction, and giving off poisonous vapors and disease-germs. Especially in hospitals has attention been paid, of late years, to this essential point, in order to secure an aseptic atmosphere for the sick. By the use of forced ventilation, the supply of pure air is maintained, which is now generally acknowledged to be an important element in the treatment of both sick and wounded.†

*Hand-book of Hygiene and Sanitary Science. George Wilson. London, 1877. Third edition, page 65.

† For further elucidation of this subject, see recent work by John S. Billings, U.S.A., on Hospital Construction.

In the treatment of many chronic disorders, especially pulmonary affections, respiratory gymnastics, having for their object greater expansion of the chest and an increase in the tidal air, are of acknowledged value, and have been already referred to in the preceding section. In the treatment of asphyxia from coal-gas, carbon dioxide, or hydrogen sulphide, fresh air is absolutely necessary, as it is also in syncope and suffocation by drowning. As already intimated, many cases of cholera infantum are due to local poisoning of the air, and can be cured only by a change to a purer atmosphere. During the prevalence of yellow fever, cholera, small-pox, and other epidemic diseases, it sometimes becomes necessary to remove a whole community to a more sanitary locality, the best disinfectant being pure air, and plenty of it.

Since the famous experiments of Dr. Priestley, there have been many attempts made to render air more curative by adding to it various substances, either in gaseous form, or as a vapor, spray, or impalpable powder. The latter forms will be separately considered later, and in another part of the work will be given a number of useful formulæ for medicaments to be used by inhalation. Air may be made to carry not only gaseous substances, but liquids and solids in minute subdivision. An excess of watery vapor is present in the Russian bath. It is also useful for inhalation by means of a croup-kettle or steam-atomizer, after operations for tracheotomy, and also in cases of catarrhal inflammation of the throat and bronchial mucous membrane. Various volatile substances may be added to the water, such as oil of eucalyptus-leaves, compound tincture of benzoin, iodine, and carbolic acid. Smoke from burning nitre-paper, diffused in the air, gives marked relief in asthma, or pyridine may be volatilized for the same purpose. Tar, cresylic acid, phenol, and other substances may be also administered in this way in pulmonary affections, and often with marked effect. Among the gaseous substances proper, chlorine has been used, largely diluted, as a bronchial stimulant, in narcotic coma or hydrocyanic-acid poisoning. Nitrogen is inert, and the results of its inhalation are due to deprivation of oxygen from the system. Hydrogen produces a peculiar squeaking voice, but otherwise is negative. The effects of oxygen are so important that they will be considered in a separate section. Modern surgical anæsthesia depends upon the mixture of a certain amount of vapor, of chloroform, ether, or ethyl bromide, with the respired air. This will be considered in detail in the volume devoted to drugs, under the individual headings of the articles in question (such as chloroform, ether, etc.). Nitrogen monoxide, or laughing-gas, will be considered under its own title.

Claude Bernard discovered that, under certain conditions, general anæsthesia could be produced for the time, by directing a stream of carbon-dioxide gas directly into the throat and larynx, but this observation has not yet been utilized in practical medicine. Bergeon some years ago brought out a system of treatment for chronic pulmonary disease, the principal feature of which consisted in the injection into the large bowel of a mixture of carbon-dioxide and hydrogen-sulphide gases, with a view to their absorption into the circulation and excretion by the lungs. Some good results in the way of lessened expectoration, reduction of cough, and temporary improvement of the physical condition have been noted after the clinical trial of this method, but, as it is impossible for it to exert any antiseptic action upon the tubercle bacilli, and the bodily improvement is only transitory, the practice has fallen into disuse. If it had succeeded in accomplishing all that was claimed for it by its enthusiastic advocates, it would have afforded some support to the theory of Beddoes that there is an excess of oxygen in the tissues of consumptives, and that they are benefited by breathing air containing a considerable proportion of carbon dioxide.

Attempts have been made to destroy septic matter in the air, or, technically, to "sterilize" the air, in order to prevent infection of wounds during operations. The antiseptic method of Sir Joseph Lister, as first formulated, required a spray of carbolic-acid solution, so that the operation should be performed in an atmosphere charged with this antiseptic. It was found that this was not only inefficient and failed to fulfill the purpose, but it also was objectionable, and in some cases caused symptoms of carbolic-acid poisoning. Mr. Lister has since acknowledged his mistake, and the spray has disappeared from the operating theatre. Experience has shown that, if everything else coming in contact with the wound—the surgeon's hands, the instruments, and all the dressings, and the wound-surface itself—is rendered aseptic by proper solutions, under ordinary circumstances the air may be disregarded, except when contaminated by special poisons like diphtheria or scarlatina. Dr. David Prince, of Illinois, however, has devised a very complete aseptic operating chamber, in which all the air is forced through antiseptic solutions before coming into the apartment. Where the air of a hospital is so contaminated as to require such a chamber, it would be safer to remove the patient, if possible, to more sanitary surroundings.

Oxygen.

Although not yet admitted to the United States Pharmacopœia, oxygen is a remedy of considerable therapeutic value, and, as an antidote to certain forms of poisoning, in some cases is indispensable to the recovery of the patient. It is administered in its purity or combined with other gases, such as nitrous oxide, nitrogen, or with atmospheric air. Oxygen is a colorless,* odorless, and tasteless gas, nearly sixteen times as heavy as hydrogen, a little heavier than atmospheric air (specific gravity, 1.1057), of which it constitutes 20.81 per cent. by volume, or 23 per cent. by weight, of dry air, in which it exists simply as a mixture with nitrogen and not combined. Under certain conditions, it appears under the allotropic forms of **ozone** and **antozone**, in which it acts with peculiar energy. Under ordinary circumstances, oxygen is a non-condensible gas, but Pictet has succeeded, by cold and pressure, in making it assume the form of a liquid apparently containing solid particles. Water (H_2O) is a combination of oxygen with hydrogen (8 to 1). Peroxide of hydrogen is also a liquid; clear, colorless, syrupy, and of a specific gravity of 1.453, it is a bleaching agent, and slightly caustic and somewhat irritating to mucous surfaces. It evolves oxygen at a temperature of 70 degrees or above, the ordinary commercial solution claiming to yield fifteen times its bulk of oxygen gas.

Preparation of Oxygen.—Among the several methods of preparing oxygen in the laboratory only those can be employed in medicine which are convenient and which yield a pure gas fit for inhalation. The most available method is by heating the solution of peroxide of hydrogen, but where a considerable quantity is required this method would prove too expensive. The usual method is to heat potassium chlorate, so as to drive off some of its combined oxygen; and, in order to do this safely and to obtain the gas in steady volume, the potassium chlorate is intimately mixed with manganese dioxide, which does not enter into the reaction, but simply acts mechanically. The gas obtained in this way is passed through several wash-bottles containing dilute caustic alkali, and it is then collected in a receiver (gasometer) and kept over water. Oxygen is now made on a large scale, commercially, directly from atmospheric air, and is sold at a very low rate, being delivered in steel cylinders, generally condensed so that a cylinder containing from one hundred to two hundred gallons is of a convenient size for handling. From such a holder or reservoir the gas is drawn into a rubber bag or a gasometer for ordinary office use or individual administration. If the extemporaneous plan of making oxygen is employed, care should always be taken to see that the binoxide of manganese is pure and clean. If it contain coal-dust or charcoal as an adulteration a serious explosion may result. It is, therefore, recommended to gradually heat some of the mixture (four of potash to one of manganese), in a glass test-tube, up to

* In the liquid form, Olszewski, a Polish chemist, finds that oxygen has a bright, sky-blue color. This is of interest not only as accounting for the blueness of the atmosphere, but also in point of view of the absorption spectra of oxygen.

a red heat. If it should explode, the small quantity would do very little damage, especially when compared with that which would result from the explosion of several pounds of the same mixture. For each gallon of oxygen, about 214 grains (or nearly ½ ounce) of potassium chlorate will be required.

Physiological Effects.—When inhaled, pure, oxygen is capable of causing considerable irritation in the air-passages, and small animals immersed in it perish in a few days with highly-congested lungs. Ordinarily, when a moderate amount is inhaled in health, no irritation occurs. The gas, even when pure, is pleasantly respirable, and from four to eight gallons can be inhaled without any other obvious effect than a slight increase of activity of the circulation and some nervous exhilaration. Slight giddiness may be experienced for a few moments, but vertigo and headache are absent. In addition to the quickening of the pulse, there is evidence in the lips and finger-nails of increased oxygenation of the blood, and cicatrizing wounds, with granulation tissue, have been observed by Demarquay to become more ruddy. The expiration of carbon dioxide is increased, and, according to some observers, is doubled in amount. Uric acid is lessened in quantity, according to Kollman, owing, probably, to the fact that a greater quantity is oxidized in the system. The digestion and appetite improve, and there are evidences of increased assimilation and resulting enhancement of physical strength.

Therapeutic Applications.—As has probably been inferred from the preceding paragraph, the chief application of oxygen is to conditions of asphyxia and dyspnœa from any cause. Thus, in poisoning by coal-gas, sewer-gas, hydrogen sulphide, carbonic oxide or dioxide, oxygen inhalations, promptly used, are followed by immediate good effects. In dyspnœa attending pneumonia, morbid growths in the larynx, or other grave disturbances of respiration, oxygen is of great service. In various chronic cachectic conditions, the systematic administration of oxygen is often of value in improving assimilation and building up the system.

Thus, in anæmia and chlorosis, in chronic ulcers, and in strumous affections oxygen inhalations are practiced in one, two, or three daily sittings, using from one to four gallons at a time, either pure or mixed with atmospheric air or other gas, such as nitrogen monoxide. When a stream of oxygen-gas is directed upon a granulating or gangrenous surface it is said that healing is accelerated. When there is some impediment to the respiratory function, as in stenosis of the larynx, croup, diphtheria, or emphysema, asthma, heart disease, œdema, or marked congestion of the lungs, the dyspnœa is greatly relieved by oxygen inhalations. The cyanosis of pneumonia is overcome by its means. In chronic pulmonary affections with reduced breathing capacity, we are now in a position to pass the same quantity of oxygen into the blood as is normally required, and thus put the patient on a more favorable footing for his ultimate recovery. As an illustration of its value, the following remarkable case of pneumonia successfully treated by its aid is worthy of study. It was reported in the Boston *Medical and Surgical Journal* (No. 21, 1890): "The patient was a lady aged 37, of neurotic tendencies, who suffered at first with ordinary lobar pneumonia at the base of the right lung. The general symptoms were very strongly marked, and, after the first few days of ordinary treatment, the disease spread to the upper part of the same lung, and alarming and excessive dyspnœa set in rather rapidly. Energetic stimulation and counter-irritation appeared to relieve the condition to some extent, but it recurred and showed itself less amenable to treatment. Inhalations of oxygen were given, the gas being simply conducted to the patient's mouth, after having been passed through a wash-bottle and diluted with 10 per cent. of nitrous oxide. Very decided relief was given for a short time, but again and again the dyspnœa returned, each time being staved off by the inhalation. At last it became necessary to keep up constant inhalation. The supply of gas began to fail, and before a fresh store could be obtained the patient was moribund. The gas was then given by artificial respiration, and the patient rallied once more. Constant inhalation was then kept up for one hundred and six hours without intermission, and at the end of that time the breathing was easy and natural, and complete recovery followed without further incident. The temperature fell during the long-continued inhalation, the average amount of gas being two hundred gallons in each twenty-four hours." Dr. Blodgett states that the effect of the gas was "almost as pronounced and evident as is that of a ligature in hæmorrhage." Dr. Lauder Brunton and Dr. Prickett report a case of pneumonia (*British Medical Journal*, January 23, 1891), where the patient was unconscious, livid, and almost moribund; but, after the inhalation of oxygen and the hypodermatic injection of strychnine, he recovered his consciousness and his normal color, and expressed himself as feeling comfortable and well. Twenty-four hours afterward, however, breathing again became embarrassed, and, notwithstanding a somewhat freer use of oxygen, he died in a few hours. Dr. Skerritt, in the same journal (February 6), says: "I have never seen such an extraordinary effect upon cyanosis produced by any other means, and, for the future, in any case of acute respiratory affection threatening to prove fatal, I shall not consider that everything practicable has been done unless a fair trial has been given to oxygen."

Another writer suggests that, even where cases are manifestly *in* *articulo mortis*, they may be temporarily improved so as to sign or execute legal papers by its aid. On the other hand, cases have been reported where inhalation was begun and the patient promptly died (Colton: *Brooklyn Med. Journal*, August, 1891, p. 528). It is probable that the addition of 10 per cent. of nitrous oxide, by Dr. Blodgett, to the oxygen, contributed materially to the successful result. The question of details of administration will be again referred to shortly. In cardiac asthma, it has been shown that the condition of the heart-muscle and the aorta is often an active or predisposing cause. The change in the aorta may be small and those in the heart considerable, or just the reverse. The aorta is more or less the seat of atheroma. The change in the heart is a chronic myocarditis; the coronary arteries are also diseased.

In the diagnosis according to Dr. Heitler,* if the organic lesion be overlooked, and a good prognosis given, it may be falsified by the patient dying suddenly from heart-failure. The most valuable sign is accentuation of the second aortic sound. For the dyspnœa and cyanosis of cardiac insufficiency, Dr. Heitler says the combined use of morphine and ether subcutaneously, with inhalations of oxygen, will cut the attacks short. In the opinion of Dr. Catlin,† oxygen is pre-eminently the remedy for profound shock, either from hæmorrhage or nervous drain, where the vitality is at too low an ebb to take up the intricate history of assimilation and repair. He reports a case of profuse hæmorrhage at the sixth month of pregnancy, followed by miscarriage. The prostration was absolute, with shock and constant vomiting. Continuous oxygen inhalations (mixed with air?), and the patient immediately improved and made a good recovery. He also reports cases of prostration during typhoid fever. in which oxygen was inhaled with marked benefit.

Professor Tarnier has used oxygen inhalations in the treatment of very young children, and Bonnaire (*Journal de Médecine*, June 28, 1891) has employed it in the newborn, especially the premature infants who are placed in a "couveuse," or incubator. He gives the following suggestions:—

"1. Whenever there is insufficient pulmonary hæmatosis, either from obstruction of the respiratory passages or from weak action of the mechanical apparatus of respiration, or from want of excitation of the respiratory nerve-centre, oxygen administration is indicated. Apparent death in the newborn is, therefore, the first indication, though this does not exclude efforts at artificial respiration; besides, oxygen is not

* Centralblatt für die Gesammte Therapie, October, 1891.
† Brooklyn Medical Journal, August, 1891, p. 521.

always available as soon as required. But if the first dangers of asphyxia have been overcome, and respiration is still ineffectual, or pulmonary disease imminent, with general asthenia, oxygen will be found a valuable recourse.

"2. Oxygen is also indicated for disorders in the interstitial circulation, of which scleroma in premature infants is one of the most common manifestations.

"3. Changes in the blood, of infectious origin, like that which takes place in the hæmaturic bronze disease, of which mention was made." (It was used in several infants suffering with bronzing and hæmaturia, —a disease resembling pernicious anæmia. It was administered for two hours daily, and was successful in several cases in the first stage of the disease.)

"4. Conditions in which there is decided depression of the temperature. Athrepsia, in its acute and chronic forms, is the type of such conditions."

Neumann (*Therap. Monatsheft.*, October, 1891) speaks in high terms of the administration of air containing a high percentage of oxygen, under increased pressure, for which he employs an apparatus of his own devising. By using a mixture with air, he avoids the irritation caused by the pure gas, and the slightly increased pressure facilitates absorption. The pulse, at first quickened, is ultimately slowed. No unpleasant head symptoms arise. There is no palpitation; in fact, the heart's action is regulated. Sleep is often induced, even in men. In many patients, the night's rest has been improved, the breathing rendered easier, and there has been induced a feeling of increased strength. In three cases of tuberculosis, treated at the same time with Koch's method, the fever disappeared in two and was lessened in the third. The action of iron, when given for chlorosis, may be increased by oxygen inhalation. Neumann has treated very severe cases of anæmia, convalescence from pleurisy, phthisis, sepsis, and diabetes with good results. He thinks that it also may be of service in gout, as it diminishes the proportion of uric acid in the urine.

Dr. Francesco Valenzuela has published a paper, in *El Siglo Medico*, on new methods of administering oxygen, with especial reference to the treatment of senile pneumonia. He administers the gas by the rectum, and also by injection hypodermically. He reports that in every case of senile pneumonia, with dyspnœa, in which oxygen enemata were given, dyspnœa was decidedly and permanently relieved. The ease and rapidity with which the gas was absorbed by the intestine were remarkable; indeed, it seemed to be as readily taken up by the intestine as by the lungs, four injections, of five litres each, being absorbed in an hour.

Thus, the intestinal mucous membrane may be regarded as a valuable adjunct to the lungs in the function of respiration. In employing oxygen subcutaneously, Dr. Valenzuela believes it important to introduce the gas in a nascent state. The arm was selected for the injections, and the quantity of gas introduced varied from half a litre to a litre. Cellular emphysema was, of course, produced, and a sensation of heat was complained of, but both disappeared within a few hours. There was no calmative action or slowing of the respirations, but there was marked stimulation of the heart,—a desirable result in the collapse that follows pneumonia and fevers of a typhoid character, and cerebral congestion and asphyxia. No mention is made of the temperature of the gas that was administered,—a point which, according to Dr. B. W. Richardson, of London, is of great importance.

Dr. G. Thompson,* from a review of the therapeutic value of oxygen, arrives at the following conclusions: (1) In dyspepsia, the gas controls the subjective symptoms; (2) it is effective in cyanosis, by diminishing the frequency of the respiration and relieving the subjective dyspnœa; (3) oxygen is of value in the partial inflammation of the lungs due to various causes; (4) it is especially useful in the dyspnœas of chronic Bright's disease, uræmia, pneumonia, capillary bronchitis, asthma, catarrhal bronchitis, congestion of the lung, and of the first period of œdema.

Apparatus and Technique of Administration.—Samuel S. Wallian attributes the failures observed from the use of oxygen to various causes, and to many conditions under which the gas may be devitalized (?) by the imperfect processes employed to evolve, store, and use it. He insists that the oxygen should be freshly prepared and washed before using. Except in special cases of narcotic poisoning, asphyxiation, syncope, and other serious emergencies, the gas should be well diluted. The undiluted gas may be given in quantities of eight hundred to one thousand cubic inches at a sitting, once or twice daily. It is more economical to dilute it with air, since a comparatively small portion only is utilized at each inspiration. If nitrogen monoxide be combined with it (oxygen, 2 parts; nitrogen monoxide, 1 part), as they are synergistic, better results are obtained. Dr. Wallian also insists that patients should be instructed or made to inhale the gas properly. The person being erect, and the chest thrown a little forward, the lungs are then filled to their utmost capacity, and the gas held as long as possible, then expired through the nasal chambers. The respiration should be deliberate, and not hurried. Better results can be obtained if patients are taught chest gymnastics,

* Norsk Magazin for Lægevidenskaben, Christiania, p. 274. Annual of the Universal Medical Sciences, 1891, vol. v, p. A-117.

so as to develop the muscles of respiration and increase the capacity; imperfect habits of breathing, tight clothing, awkward position of the body, and sedentary occupations are to be avoided, as far as possible. Oxygen may also be administered internally, by charging water with it under pressure, and Wallian recommends the mixture of oxygen and nitrous oxide, as above, which are dissolved in the water under a pressure of one hundred to one hundred and fifty pounds to the square inch. Oxygen-water has already been used in the Paris hospitals by Dujardin-Beaumetz, with some good results, in dyspepsia, debility, and chronic pulmonary or digestive disorders. It has been highly extolled in the treatment of infectious diseases, like small-pox, scarlatina, diphtheria, etc., and in many forms of skin disease.

For inhalation, the gas is supplied ordinarily in iron or steel cylinders, containing forty and one hundred gallons, under pressure. Attached to the cylinder is a cloth-covered rubber bag, which serves as a reservoir and enables the quantity taken to be accurately measured. A bottle partly filled with water is also attached, so that the gas from the reservoir passes through it, and is then received into the bronchial passages in the form of moist oxygen. A small gasometer may be attached, for the purpose of administering the gas under pressure, or for use when it is desired to introduce it into the rectum. The gas may also be injected into the bowel by an ordinary Davidson syringe connected with the rubber bag containing oxygen. In order that absorption may be facilitated, it should be of the same temperature as the interior of the body, or a little higher than the surface temperature.

Ozone and Hydrogen Peroxide.

Attention has already been directed to an allotropic condition of oxygen which is known as ozone (from the Greek ὄζειν, to smell). It was so named by its discoverer, Schönbein, who announced that the sulphurous smell produced by a stroke of lightning was due to this substance, which is also known as "electrified oxygen." It is formed by the sparks from the static electrical machine, and also during the electrolysis of water and during the slow combustion of phosphorus in a moist atmosphere. Ozone was first obtained in appreciable quantity by von Siemens in 1854, who discovered that the noiseless electric discharge was much more productive of ozone than the intermittent discharge, and he constructed an apparatus for the production of ozone by means of tubes. Subsequently, this has been still farther advanced by the labors of the well-known firm of Siemens & Halske, of Berlin, who furnish a comparatively cheap apparatus, by which an unlimited supply of ozone can be obtained.

Ozone is a colorless gas, possessing a characteristic odor resembling dilute chlorine. If the air contain only the one fifty-thousandth part of ozone this smell is distinctly discernible. It is one of the most powerful oxidizing agents known, attacking and destroying many organic fabrics, such as rubber, paper, etc. Ozone has been liquefied at a temperature of 105 degrees, and under a pressure of 125 atmospheres. According to the investigations of Chappius, ozone in this state is of an intense-blue color. The relationship of ozone to oxygen is peculiar. In the formation of ozone three volumes of oxygen become condensed to form two volumes of ozone. In the presence of iodide of potassium and moisture one-third of the ozone is spent in liberating the iodine and the other two volumes escape as oxygen. Test-papers are made by making a solution of starch and iodide of potassium, in which bibulous paper is immersed and then dried and cut into slips of convenient size. When it is desired to test for ozone one of the slips is moistened ; if ozone is present in the air it will liberate iodine, which, in turn, will act upon the starch, producing a blue color. Ozone is found at the sea-shore ; in the forest, especially if of coniferous trees ; at the summit of mountains and high towers. It is usually absent in crowded cities and where organic matter is undergoing slow oxidation. Clouds owe their formation largely to ozone, which is more hygroscopic than oxygen ; but only the upper surface of clouds and mists which are exposed to the sun's rays contain ozone ; it is not found in dark and thick mists. A great amount of ozone is formed in the mist rising from the cold ground, under a clear sky, on a calm autumn or winter day. As Schönbein demonstrated, atmospheric ozone is only generated in considerable quantity when oxygen moisture and sunbeams combine, as in the familiar illustration of the bleaching of linen upon the lawn from the effects of ozone. According to Scoutetten, under the influence of light the green parts of plants exhale both ozone and neutral oxygen, both of which are again taken up in part by the growing cells of the plants.

Physiological Effects.—Some interesting results were obtained by Ringk after treating withered and drooping house-plants by ozonized water, a striking improvement being soon manifested. Owing to its powerful oxidizing effects, ozone is believed to play an important part in nutrition. The red blood-corpuscles have the power of converting oxygen into ozone, and it has been suggested that, since ozone has the power of rendering albuminous solutions uncoagulable by heat, it exercises a similar effect in the human body, and prevents coagulation in the blood-vessels during life. Protoplasm has the power of storing up ozone, which it subsequently uses as a source of energy. In many organs, such as the liver, spleen, and thyroid glands, ozone is found in considerable quantity; in the muscles only slightly. Owing to the superior affinities of nascent oxygen, ozone plays an important part in tissue change.

In concentrated form ozone is irritating to the air-passages, and may cause inflammation, salivation, bloody expectoration and death. Œdema of the lungs was noticed by Binz, who claimed that a comatose condition supervened before any noticeable irritation of the bronchial tubes occurred and that guarded administration produced soporific effects. The effects of an increase or diminution of atmospheric ozone upon the health of communities has not yet been positively determined. Professor Falb, having noticed a remarkable diminution of ozone in the air in the summer of 1889, was led to attribute the epidemic of influenza to this fact. The air-bacteria are either destroyed or rendered less active in the presence of ozone, and, where this is absent, infection is more apt to spread. Ozone is nature's antiseptic agent, and Dr. B. W. Richardson, in his "City of Health," suggested that there should be a building like a gas-house, in which ozone should be made and dispensed by pipes to every house.

Ozone in Medicine.—It is evident that one of the principal advantages gained by sending patients away from a crowded city, especially where infection is present, is that the air is pure and contains appreciable amounts of ozone in the country. When it is possible, children, especially, should have frequent opportunities of getting fresh air; and, therefore, the charities which, like the Fresh-Air Fund and Country Week, take city children out of town during the extreme heat of summer are of great value, both in curing and preventing sickness. By special apparatus, it is possible to charge distilled and sterilized water with ozone, or ozonized oxygen may be passed through oil until it is saturated. These ozone preparations have high value as disinfectants and deodorizers. Ozonized water is capable of producing beneficial results in diseases of deficient oxidation, as in anæmia, chlorosis, lithæmia, and may be very useful as a germicide in treating infectious dyspepsia. The oily solution is claimed to have especial value in chronic skin diseases, by inunction; in the dermato-mycoses, or parasitic diseases, and in cases of infiltration of the skin and glands.

Schmidt (*Münchener Med. Wochenschrift*) has reported excellent results in two cases of epithelioma following parenchymatous injections of ozonized water, and considers that it may also be serviceable in sarcoma and in tuberculous tumors. In the treatment of diphtheria, Schmidt reports remarkable success from applications of ozone-water, and Ringk advises its internal administration. Dr. Schnee, of Carlsbad, claims that ozone-water is of the greatest benefit in true as well as in functional diabetes. In phthisis, ozonized oxygen (9 per cent.) gave good results, in the hands of Dr. A. Ransome.* The inhalations, which were taken three times a day (seven litres each sitting), were followed by notable improvement, chiefly by gain in weight. Iodoform in pills and codliver-oil was given, in conjunction with the oxygen, but much better results were obtained with the oxygen than previously. In cystitis, Dr. Duhrssen, of Berlin, obtained successful results following injections of ozone-water.

Ozonized air may be obtained by the apparatus of Labbé and Oudin, which consists of concentric tubes, three to four millimetres apart, the intervening space being traversed by static electrical current. To obtain a sufficient quantity of ozone, they take the interior tube, sealed and containing the rarefied air, which acts as a perfect conductor, and is perfectly applied to the surface of the dielectric, which is the glass. The other armature of this form of condenser is constituted by a metallic sheet applied to the internal face of the external tube, and it is between the metallic sheet and the surface of the internal tube that the current forms the ozone. The slightest elevation of temperature which is produced in the cylindrical space separating the two tubes is sufficient to produce a current of air, which ascends and bears along the ozone thus formed. Under the circumstances, the air does not contain more than eleven to twelve hundredths of a milligramme of ozone per litre, which the authors term the therapeutic dose. Experimentation having shown the perfect innocuousness of these inhalations, they were given to children suffering with cachexia and anæmia, and were not only well borne, but evidently curative, by increasing the oxyhæmoglobin until it reaches the normal figure. It was found, also, that tubercle bacilli were rendered less virulent, as a result of exposure of cultures to currents of ozonized air.

Peroxide of Hydrogen.

According to Dr. B. W. Richardson, peroxide of hydrogen is water which contains a certain number of atmospheres of ozonized oxygen in a state of combination, and not as a simple mixture. The usual solution is one of 3.2 per cent., which is capable of yielding fifteen times its bulk of oxygen. The oxygen is given off under the influence of light and heat, and the solution should therefore be kept in a dark, cool place. Glycerin may be used as a solvent, under pressure, yielding a solution which is claimed to be more efficient than the ordinary solution, in spite of the fact that glycerin checks the reaction between the peroxide and organic snbstances. The action of glycozone is slower than that of the peroxide.

* Medical Recorder, London, May, 1890.

Physiological Action.—When solution of peroxide is added to cultures of bacillus anthracis, bacillus pyocyaneus, typhoid bacilli, cholera bacilli, yellow-fever microbes, streptococcus pyogenes, micro-bacillus prodigiosus, bacillus megaterium, and the bacillus of osteomyelitis, the destructive action of the peroxide is almost instantaneous. This is due to the contained ozone, and not to the oxygen alone. A characteristic reaction of peroxide of hydrogen is that in the presence of pus it undergoes rapid decomposition, producing bubbling or frothing, with escape of oxygen.

Muscular relaxation is produced by peroxide of hydrogen, which, in large amount, is capable of destroying life. It has no effect, under ordinary circumstances, when applied to healthy mucous membranes; injected hypodermically, it produced local emphysema; wherever it comes in contact with devitalized organic matter it becomes decomposed. When injected directly into the lung, there is diffusion of oxygen, so that life may be supported for several minutes with respiration entirely cut off. If absorbed too rapidly into the circulation, death may result from oxygen embolism and heart-failure, as after the entrance of air into a large vein.

Therapeutic Uses.—Peroxide of hydrogen is of great practical value to the surgeon and obstetrician, and is a most efficient deodorant and detergent for cleansing the hands. In hay fever, Alexander Rixa * reports excellent results from local treatment with this agent. The patients, for two weeks before the expected onset of the disease, had the nose irrigated with a warm solution of chloride of gold four times a day. After each irrigation, the nares were thoroughly sprayed with equal parts of peroxide of hydrogen and pure glycerin. Three days before the date of the expected attack, phenacetin and salol, 5 grains each, three times daily, were administered internally to each patient. The results were described as remarkable. No symptoms of the disease appeared. The treatment was continued throughout the fever season, the applications being reduced in number to once or twice a day. The internal medication was stopped at the end of one week. In pulmonary tuberculosis, Dr. Richardson considers that it aids respiration. Four ounces of a 10-per-cent. solution have been given. In pertussis he recommends ozonic ether (made by adding two volumes of anhydrous ether to one of peroxide). Of this mixture, 10 to 60 minims may be given, four times a day, well diluted. It may also be used as a spray. It is also useful in asthma and in angina pectoris. In diabetes he gives the following:—

* Therapeutic Gazette, January 15, 1891.

℞ Codeinæ,	. . . .	gr. iij.
Alcoholis,	. . . .	f℥ij.
Liq. hydrogen peroxid. (10 per cent.),	. . . . . .	f℥ij.
Aquæ,	. . . . q. s. ad	f℥xij.

M. The dose is a tablespoonful three times a day.

An interesting point in connection with infant-feeding is that the addition of hydrogen peroxide to milk does not cause it to curdle or become sour, but, on the contrary, keeps it from becoming sour in summer-time (Heidenhain). This observation may be of great importance in the prevention of summer-complaint and diarrhœa. Dr. Tromp (*Centralblatt für Bakteriol. und Parisitenkunde*) proposes hydrogen dioxide as the ideal sterilizer for water, as it imparts neither odor nor taste, and is harmless, while efficient. Dr. Althoerfer confirms this, and states that 1-to-1000 solution is required, when, after twenty-four hours' standing, the water-microbes, as well as pathogenic microbes (cholera, typhoid, etc.), will be destroyed. In using it for this purpose, it will be sufficient to add ten cubic centimetres of a 10-per-cent. solution to a litre of water.

Nitrogen and Nitrogen Monoxide (Nitrous Oxide).

In the mixture of gases constituting the atmospheric air, nitrogen simply acts the part of a neutral body, or as a diluent for the oxygen. The effects of breathing super-oxygenated air have already been considered. If we now turn to hypo-oxygenated air, or air containing increased quantities of nitrogen, we are brought in face with the phenomenon known as "asphyxiation." When pure nitrogen is breathed the effects upon animals is quite uniform. Dr. George Johnson, in a paper on the "Physiology of Asphyxia and on the Anæsthetic Action of Pure Nitrogen,"* found that the animals rapidly succumbed as a result of the arrest of the pulmonary circulation. The right cavities of the heart were found enormously distended and the left were comparatively empty, —a condition which is evident during the life of the animal, the change from the normal taking place progressively during the progress of the asphyxiation. In the last stage of asphyxia there is a continuous increase of pressure in the pulmonary artery, while the systemic arterial pressure is falling. The immediate cause of the arrest of the pulmonary circulation appears to be the contraction of the pulmonary arterioles. The phenomena which result from the inhalation of nitrous oxide as an anæsthetic, in the opinion of Dr. Johnson, are strictly analogous with those observed in the early stages of asphyxia. At his suggestion, nitrogen was employed at the dental hospital for extracting teeth in nine patients: "In every case the result was the production of complete

* The British Medical Journal, February 21, 1891.

anæsthesia, with general phenomena precisely similar to those observed during nitrous-oxide inhalation. The pulse was first full and throbbing, then feeble; in the advanced stage respiration was deep and rapid, with lividity of the surface, dilated pupils, and more or less jactitation of the limbs, the only difference, in the opinion of some of those present, being that the anæsthesia was less rapidly produced and somewhat less durable than that from nitrous oxide, though in each case the tooth was extracted without pain." Subsequent experiments with a mixture of 3 per cent. of oxygen gave the following results: "Five patients took the 3-per-cent. gas. Anæsthesia was complete in 75 seconds (maximum) and in 60 seconds (minimum), the average time required being 67.5 seconds. In each case the tooth was extracted without pain, the duration of anæsthesia being somewhat longer than with pure nitrogen. In each case there was lividity, dilatation of pupils, and more or less jactitation." With a mixture containing 5 per cent. of oxygen the average time for producing anæsthesia was increased to 87.5 seconds. In each of four cases there was complete anæsthesia. One patient had three molar teeth extracted. "Although she said she felt the last two, the sensation appeared to be that of a pull and not of acute pain. In most of these four cases there was slight lividity before the removal of the face-piece. In only one case was there slight jactitation of the limbs; the other three patients were perfectly quiescent."

An interesting feature in Dr. Johnson's experiments upon animals was the effect of nitrite of amyl in overcoming the contraction of the pulmonary arterioles, and thus permitting the right side of the heart to become empty, and the heart's action, previously almost suspended, was restored. By this means life was prolonged until death finally occurred from increasing venosity of the arterial blood. Inhalations of nitrite of amyl may, then, be regarded as the remedy for asphyxia, and at least a partial antidote to nitrogen or nitrous oxide, especially when aided by artificial respiration.

The similarity of the anæsthesia produced by nitrogen monoxide to that occurring from asphyxia by any neutral gas, such as nitrogen, hydrogen, or carbon dioxide, was first pointed out by Professor Thomson, in a communication to the Philadelphia *Medical Times*, in 1875 This theory of the action of nitrogen monoxide in producing anæsthesia denies any specific action, and ascribes the effects solely to the deprivation of oxygen. While this is possibly true of the complete anæsthesia, yet it must be evident that smaller quantities of nitrogen monoxide produce a sense of mental and physical exhilaration and increase the pulse and respiration, which is not due to diminution of oxygen, and does not occur with the other neutral gases above mentioned. It is this preliminary intoxication which has given it the popular name of "laughing-gas." It has already been suggested that the addition of nitrogen monoxide to pure oxygen is useful as a respiratory and cardiac stimulant, and its effects are preferable to those of oxygen alone; and this combination is also decidedly safer than pure oxygen, which is sometimes irritating.

In the *American Journal of the Medical Sciences* for August, 1891, appeared an article by Dr. Wm. W. Van Arsdale, giving a report of his experience with a mixture of nitrogen monoxide and pure oxygen as an anæsthetic. His object was to obtain anæsthesia without causing asphyxia. From Paul Bert's experiments, it is known that the latter can be obviated by the mixture of as much oxygen as is contained in atmospheric air (20 per cent.); but, under ordinary circumstances, the tension of the nitrogen monoxide is so reduced by this combination that no anæsthesia is produced, and animals breathe it with impunity, just like atmospheric air. The problem of obtaining the atmospheric super-pressure was solved by Paul Bert in his hermetically-sealed, glass operating-chamber,—like a diving-bell. In this cage the patient, surgeon, and assistants were admitted, and, by means of the air-pump, any desired density of the air was obtained. Under these circumstances, it was found that the nitrogen-monoxide and oxygen mixture produced anæsthesia without asphyxia. Dr. Van Arsdale sought to do away with the expensive chamber, and substituted a mask for the patient's face, which would admit of administration of the gas under pressure. He prefers a 10-per-cent. mixture of oxygen, administered by an ordinary bag, rubber tube, and an air-tight mask. The great difficulty in most cases was found to lie in the fact that patients would not breathe deeply, but this was overcome by applying pressure,—by placing a board weighted to five pounds upon the reservoir-bag. His conclusions were, that many cases were unsuitable to this method, the failures being due to nervousness, idiosyncrasies, and possibly alcoholism. But ruling out these cases, he says: "In the majority of cases, however, in young, healthy individuals and in females, the anæsthetic mixture, when administered under pressure, was found to work well, and to be much superior to the pure nitrogen monoxide for surgical purposes. It induces a state resembling a quiet, deep sleep, in which the respiration is slow and regular, the pulse regular and full, and not much, if ever, increased in frequency. The blood-pressure is not increased, and insensibility to pain and unconsciousness go hand-in-hand.

"We have," he says, in conclusion, "in the 10-per-cent. mixture of oxygen and nitrogen monoxide, an anæsthetic which may be administered with perfect safety, and for a sufficiently long time to permit of the circumspect performance of most minor operations, but one which may be characterized as a weak anæsthetic. For, although it will plunge the average adult into a state resembling peaceful slumber, in which anæsthesia and unconsciousness are well marked, it cannot gain victory over states of great nervous excitement or dread, or certain habits or idiosyncrasies." In other words, this form of anæsthesia resembles ether, which sometimes fails to produce anæsthetic sleep, and recourse then is usually had to the more powerful chloroform.

Nitrogen monoxide has been used therapeutically in certain nervous affections. Dr. W. R. Birdsall * published the results of his experiments upon sixteen patients suffering with various neurotic complaints. In none of these did he observe any positively beneficial effect. He used 20-per-cent. diluted gas during a *séance* lasting ten to thirty minutes. The effects were transient, and he concludes that the uses of nitrogen monoxide for medical and surgical purposes must be restricted to its effects as an anæsthetic and as a placebo.

Nitrogen monoxide is usually obtained by heating ammonic nitrate, which decomposes at an elevated temperature and forms water and nitrogen monoxide ($NH_4, NO_3 = 2\ H_2O + N_2O$). The product is washed by passing through water, which soon becomes saturated with the gas. It is kept in a gasometer, or in retorts obtained from manufacturers of the gas, in which it is reduced to a liquid form by strong pressure. From these small cylinders the administrative bag is filled, as occasion requires, for use in brief surgical operations, such as pulling teeth, etc.

Oxygenated, aërated water is a proprietary article containing five atmospheres of nitrogen monoxide in water. It has but little odor, and is slightly sweetish to the taste. It has no special therapeutic effects.

The other gaseous elements are used in medicine only very exceptionally. **Hydrogen** gas will produce asphyxia, like nitrogen monoxide, but its inflammability and liability to be contaminated with metals like arsenic and zinc make it dangerous. It has been lately brought to notice by Dr. Senn, of Milwaukee, who injected it into the bowels, in order to detect any perforation, by the flame-test, but this has been found unsatisfactory, and has been abandoned.

Pneumatic Differentiation.

In the preceding article reference was made to an apparatus for the administration of remedies under pressure. Pneumatic differentiation is the process by which the air surrounding the body and that entering the lungs are rendered of different pressures. It may be positive, negative, or alternate. The first is where the air entering the lungs is maintained, during both respiratory acts, at a greater pressure than that

* New York Med. Journal, March 7, 1891.

surrounding the body. Negative differentiation is the reverse of this. Alternate differentiation is where the other two forms are alternated successively, the air entering the lungs under greater pressure, and in expiration the pressure surrounding the body being greater.

An apparatus was invented by Dr. Williams, for the purpose of applying this method of treatment, and is known as the "Pneumatic Cabinet." The physics and physiological effects of pneumatic differentiation have been sufficiently discussed in a number of communications, which appeared some ten years ago, when the Williams Pneumatic Cabinet was first brought to the notice of the profession. In an article by Dr. Isaac H. Platt, of Brooklyn,* on the "Physics and Physiological Action of Pneumatic Differentiation," a very good *résumé* of the subject is presented. It is very evident that this apparatus, which increases the air-pressure within the lungs, and also enables us to diminish the tension of the external atmosphere and thus empty the air-cells more completely, will not only produce fuller respiration, but also will act as pulmonary gymnastics, through the greater activity of the bronchioles and air-cells. There is, in consequence, freer expansion and the opening up of collapsed lobules, while the expectoration of exudative material and foreign substances will be assisted. The secondary effects upon the pulmonary circulation will also be of considerable importance in bringing a larger quantity of blood under the influence of the air, but the effect of this is not so great as would at first be expected, owing to the tendency to increase of residual air, and the production of qualitative or partial emphysema. Dr. Platt concludes, from a summary of the effects of pneumatic differentiation, that, "by means of the differential process in its three forms, we can increase or diminish the difficulty of expiration or of inspiration; we can increase or diminish the tidal air, the vital capacity, the stationary air, and the residual air. We can, to some extent, control the amount of blood in the lungs, and consequently control pulmonary congestion and hæmorrhage, and we can raise or lower arterial blood-pressure. It is hardly possible that such widespread phenomena can be induced without producing other and secondary results, through the influence of the nervous system and otherwise." Therapeutically, Dr. Platt concludes: "The result of my experience and study has been to convince me that a large share of the benefit derived from the use of the cabinet is due to reduction of congestion, and consequently of inflammation, in the diseased lung by the differential pressure, in very much the same way as a bandage will afford relief to an inflamed joint. In addition to this, undoubtedly, the increased expansion to which the lungs are subjected, and the passive exercise

* New York Medical Journal, November 6 and 13, 1886.

which they are afforded, will do much to modify their nutrition and increase their vitality."

The pneumatic cabinet has also been advocated as a means of conveying medicated vapors and gaseous medicaments deeper into the pulmonary structures than is possible by ordinary means. Although the enthusiastic advocates of this treatment speak in high terms of the results, it really has not been shown beyond question that such remedies are really introduced more deeply into the air-cells and bronchioles than under ordinary pressure, except in so far as air-cells which had collapsed or have been plugged up have expanded under the pulmonary gymnastics. The subject is worthy of more attention and study, but it is beyond the reach of the ordinary practitioner. In institutions for treating pulmonary affections and hospitals room may well be found for such a highly specialized apparatus, and a limited field of usefulness determined for it.*

More attention has been given to the subject of the administration of air and other gaseous elements, under varying pressure, of late years, especially in Europe. In France, at Contrexéville, there is an aëro-therapeutic institute. The pneumo-therapeutic institute of Brussels is especially worthy of mention. It gives :—

1. Baths of compressed or rarefied air, with or without supersaturation with oxygen-gas.
2. Inhalations of compressed air with expiration into rarefied air.
3. Electrotherapy.
4. Acts as a depot for manufacture and sale of oxygen-gas.

The effect of baths of compressed or rarefied air will be discussed farther on, when considering the physiological effect of climate. Reference can only be made here to the apparatus of Waldenburg, Solis-Cohen, and others, for the administration, by a sort of gasometer, of compressed or rarefied air, the effects of which resemble those already mentioned as resulting from the pneumatic cabinet. For further elucidation of the subject the reader is referred to Dr. Arthur Hill Hassall's work on "The Inhalation Treatment" (London, 1880) and other recent literature in this field of therapeutics.

Medicated Vapors—Atomization—Inhalation.—Volatile medicinal substances may be vaporized and the odor, smoke, or vapor inhaled; non-volatile substances may be dissolved in any convenient menstruum, such as water, liquid petrolatum or oil, glycerin, etc., and made to assume a condition of fine spray by means of an atomizer, of which there are several kinds. In the first form to be described the apparatus consists

* Those interested in this subject may refer to the Proceedings of the American Climatological Association for 1886 for papers by Professor Loomis, of New York; Dr. Donaldson, of Baltimore; Dr. Williams, of New York, and Dr. Platt's paper, already referred to. The Philadelphia Medical Times, vol. xvi, p. 654, contains abstracts of these papers.

of a convenient-sized rubber bulb connected with a hermetically-sealed bottle or receiver containing the medicated solution, into which air is forced by compression of the bulb, thus displacing the liquid, which escapes through a tube with a capillary point, at the side of which a strong blast-air is forced, thus comminuting the drops into a fine spray. In another form the air is not forced into the bottle, but is directed across the extremity of the delivery-tube in such a manner as to produce a partial vacuum, which causes the liquid to rise into the tube and to escape in a fine cloud. In an improved form, the blast of air is supplied from a metallic receiver, into which it had previously been forced by an air-pump. A well-known form is the steam-atomizer, in which the steam from boiling water supplies the blast. In the several forms of steam-atomizers there is the advantage of the warm moisture, but the remedies should be in stronger solutions than for the hand-atomizer, or dry atomizer, because of the dilution by the steam. Solid substances may be finely powdered for insufflation and inhalation, although this scarcely comes within the limits of the present subject. Below may be found some formulæ for use with inhalers and atomizers.

Formulæ for Inhalation.—These remedies may be ordered to be simply dropped upon a handkerchief and held to the nose, or poured upon absorbent cotton, in a test-tube or special-shaped tube for inhalation, or contained in a **respirateur** of wire gauze covering the nose and mouth. In infants or invalids the remedy may be dropped upon the patient's clothing or simply upon the pillow :—

℞ Spts. ammoniæ aromat., ... q. s.

For inhalation in syncope, heart-failure, narcotic poisoning, etc., being careful that the vapor or gas is well diluted with air.

The following combination is much used in England :—

1—℞	Acid. carbolic., pur., ...	ʒj.
	Carbon. ligni, ...	℥ss.
	Iodi, ...	ʒj.

Mix the pure carbolic acid with half of the wood-charcoal thoroughly; mix the iodine with the other half, and mix together.

2—℞	Ammonii carbonat., ...	℥j.
	Carb. ligni, ...	℥ss.
	Camphoræ, ...	ʒj.

M. Add Numbers 1 and 2 lightly together, add 20 drops of oil of lavender, and as much compound tincture of benzoin as is needful to make a thick paste, and put in a wide-stoppered bottle.—Mr. Durham, of London.*

The following is Brand's (of Vienna) remedy for acute coryza, and is much used as an inhalation for nasal catarrh and coryza :—

* From "Nasal Catarrh and Allied Diseases," by Beverly Robinson. Second edition. New York, 1885.

℞ Acid. carbolic.,
Aq. ammoniæ fort., ... āā fʒv.
Alcoholis, ... f℥ij.
M. Sig.: Keep in a dark place or in a tinted-glass bottle.

A few drops are to be poured on blotting-paper, and this rolled into a cone, and the vapor inhaled as long as it rises. The eyes should be kept closed, on account of the irritating nature of the vapor.

℞ Camphoræ, ... ʒj.
Sig.: Add to a pint of boiling water, and inhale the vapor, for acute coryza.

Beverly Robinson also recommends the following:—

℞ Acid. carbolici,
Creasoti, ... āā fʒj.
Tinct. iodi, ... fʒiv.
Alcohol., ... f℥j.
M. et Sig.: For inhalation.

℞ Ol. pini sylvestris, ... fʒj.
Succus conii, ... fʒij.
Tinct. benzoin. co., ... fʒij.
Magnesii carb., ... ʒss.
Aquæ, ... f℥j.
M. Sig.: For inhalation with a nasal inhaler.

By employing a receptacle holding hot water (a pint or less), the volatilization is hastened by the heat, and the effect is more powerful. In the dry form of catarrh, steam fumigation or atomization is better than the dry inhalation. The following require hot water:—

℞ Tinct. benzoini co., ... f℥j.
Sig.: A teaspoonful for each inhalation.

℞ Ol. pini sylvestris, ... fʒij.
Magnesii carb., ... ʒiss.
Aquæ, ... q. s. ad f℥iij.—M.

Or the following:—

℞ Creasoti, ... fʒiv.
Mag. carb., ... ʒj.
Aquæ, ... q. s. ad f℥iij.
M. Sig.: A teaspoonful for inhalation.—Robinson.

℞ Tinct. iodi co., ... f℥j.
M. Sig.: Ten to twenty drops for inhalation.

℞ Amyl. nitritis, ... fʒj.
M. Sig.: Three to five drops may be inhaled from a handkerchief; or small, glass pearls, each containing the required dose, may be used in the same manner.

℞ Chloroformi, ... fʒj.
Tinct. lavandulæ co., ... fʒiij.
M. Sig.: A few drops may be inhaled for irritative cough, as in phthisis.

The following, which is known as Dobell's formula, is very largely employed as a detergent (Dr. Robinson uses thymol in place of carbolic acid) :—

℞ Acid. carbolic., ... ♏xl.
Sodii biborat.,
Sodii bicarb., ... āā ʒij.
Glycerini, ... f ʒvij.
Aquæ, ... f ℥iij.

M. Sig. : Solution for nasal spray, to be used as directed.

℞ Acid. salicylic., ... ʒj.
Sodii biborat.,
Sodii phosphat., ... āā ʒij.
Chloral. hydrat., ... gr. xx.
Glycerini,
Aquæ rosæ, ... āā f ℥j.
Aquæ, ... q. s. ad f ℥viij.

M. Sig. : Use frequently in initial stage of acute coryza.

Morell Mackenzie * recommended the following :—

Antiseptic Nasal Sprays or Nebulæ.

Sol. acid. carbolici, ... gr. iij ad f ℥j.

Sol. acid. sulphurosi. (Should be cautiously inhaled.)

Iodum cum acidi tannici :—
℞ Tr. iodi, ... ♏iij.
Glyceriti acid. tannici, ... ♏xij.
Aquæ dest., ... q. s. ad f ℥j.—M.

Sol. iodoformi :—
℞ Iodoform., ... gr. xl.
Ether. (sp. gr. 735), ... f ℥j.—M.

Potassii permanganat., ... gr. v–f ℥j water.

Sodii benzoat., ... gr. xx-f ℥j water.

Zinci iodati :—
Iodated zinc caustic, ... ♏xij or more.
Aquæ destill., ... q. s. ad f ℥j.—M.

Astringent Sprays.

Acidi tannici, ... gr. v ad f ℥j.

Alumen. chlorid. :—
℞ Liq. alumin. chlorid., ... ♏iij.
Aq. dest., ... q. s. ad f ℥j.—M.

Alumen., ... gr. viij–f ℥j.

Ferro-alumen., ... gr. iij–f ℥j.

Ferri perchlorid., ... gr. iij–f ℥j.

Ferri sulphas, ... gr. ij–f ℥j.

Zinc. chlorid., ... gr. ij–f ℥j.

Zinc. sulphat., ... gr. v–f ℥j.

* "Diseases of the Throat and Nose." Morell Mackenzie, London, 1884.

Detergent Sprays.

Dobell's solution.

Potassii chlorat.,	gr. xx–f℥j.
Sodii chlorid.,	gr. v–f℥j.

Sedative Sprays.

Potass. bromid.,	gr. xx–f℥j.
℞ Tr. belladonnæ,	♏x.
Aquæ calcis,	f℥j.—M.

Antiseptic Sprays.

Acid. lactic. :—

℞ Acid. lactic.,	♏xxx.
Aquæ,	f℥j.—M.
Liq. calcis,	q. s.
Sodii salicylat.,	gr. xx–f℥j.

There is often an advantage in having the liquid warm before spraying; this is not required when the steam-atomizer is used.

Those of our readers who are specially interested are referred to Dr. Mackenzie's "Pharmacopœia of the Hospital for Diseases of the Throat"; "A Pharmacopœia for the Treatment of Diseases of the Larynx, Pharynx, and Nasal Passages," by Geo. M. Lefferts, of New York; and the systematic treatises of Cohen, Sajous, Robinson, and others.

HYDROTHERAPY AND BALNEOTHERAPY.

The medicinal application of water by any method comes, strictly speaking, under the domain of hydro-therapeutics, which is, therefore, a very comprehensive term. Hydrotherapy (ὕδωρ, water, and θεραπεύω, I treat) comprises both the internal and the external use of water in the treatment of disease. The numerous forms of external administration—by wet packs, showers, douches, sitz or partial, plunge, and hot and cold baths—have given greater importance to the latter of these methods, so that the popular idea of "water-cure" is that it is mainly a course of bathing. Balneo-therapeutics (βαλανεῖον, a bath, and θεραπεύω, I treat) is that department of therapeutics which deals with the application of baths in the treatment of disease, the different varieties of which will presently be considered in detail. The term "balneo-therapeutics" is also applied more specifically to the science that treats of the effects of mineral waters and baths, especially as conducted at certain health resorts, known as "baths" or "springs." Leichtenstern, in von Ziemssen's "Hand-book of Therapeutics," defines balneotherapy as "the science of the therapeutic application of mineral waters," or "the science of the method and mode of operation of bath- and well- cures." In connection, therefore, with this topic, the composition and character, also the physiological and therapeutical effects, of various more or less celebrated mineral springs, require to be considered somewhat in detail. At the outset of our discussion of the therapeutic applications of water and water-dressings, we encounter the difficulty, as pointed out in the most recent and highly valuable little treatise of Dr. Simon Baruch,* of the existence of a belief on the part of many enthusiastic advocates of hydropathy, that it is a panacea, and that it is a complete system of therapeutics rivaling regular medicine, and destined, finally, to overcome it. This is unfortunate, since it has led to the establishment of "water-cure" establishments for the treatment of all diseases, and too frequently these are carried on in an empirical manner, under the control of ignorant laymen or irregular practitioners. Moreover, the influence of Priessnitz, who, by occupation, was a farmer, but who was an ardent advocate of hydropathic treatment for all diseases, is still felt by his successors; so that there is still, in some quarters, decided antagonism between the practitioners of scientific medicine and the sect of so-called hydropathic physicians. This reproach of hydro-therapeutics is now about to be done away with. Of late years, the subject has attracted the attention of able investigators and teachers, among whom stands, notably, Professor Winternitz, who by Dr. Baruch is styled the father of modern hydrotherapy, and who is the author of the able treatise upon this subject in the fifth volume of von Ziemssen's "Handbook of Therapeutics."

Historical.—It is simple justice to the ancient physicians to state that the therapeutic, as well as the hygienic, value of water and bathing was highly appreciated by them. In the "Vedas" of Susrotas, water is often spoken of as an article of dietetic treatment, and even as an antidote, the number and the times of the baths being exactly regulated, and, indeed, with great minuteness of detail. In ancient Greece, in the midst of groves rich in springs, and in the vicinity of thermal springs particularly, stood temples dedicated to Asclepias. Prayer, fasting, and bathing were conducted, under the strict rules of the priests, and, after the patients had pursued the required course, a votive offering was made containing brief notes of the symptoms and treatment. In the halls of these temples Hippocrates found a rich mine of therapeutic literature, which he utilized with the hand and brain of a master. It is not surprising, therefore, that his system of pathology was principally humoral, and that water played an important part in his therapeutics. "He was the first to maintain that cold water warms, whilst warm water cools, the body. He was acquainted with shower-baths and shampooing; he

* "Uses of Water in Modern Medicine." Physicians' Leisure Library, Detroit, 1892.

noticed that warm showers induce sleep, and cold water, poured over the body, is useful in fainting. He treated tetanus with showers, and in affections of the joints he recommended the pouring over of cold water as being useful in relieving the pain and curing the affection. 'Articu lorum tumores et dolores absque ulcere et podagricas affectiones . . . . frigida large effusa (aqua) levat et minuit, doloremque soloit.' Withal, his views on the hygienic value of water were remarkably advanced. He says, in the 'Tractatus de Aëre, Aqua et Locis,' that 'the first duty of the physician, when he comes to a town, is to become acquainted with the peculiarities of the waters used there,—whether they are boggy, or hard, or soft, and whether they come from hills or rocks,' etc. Since elevation of temperature was known to him as a symptom of fever, he recommends the use of cold water against the different varieties of it; even the reactionary influence of cold applications was not unknown to him." He also understood the principle of revulsion, as well as the heat-abstracting action of cold-water applications. "We perceive, also," continues Winternitz, "in the introduction of therapeutical principles true to nature, the first important beginnings of hydro-therapeusis in scientific medicine. From this time, water commands a place in therapeutics, and, since its soothing and anti-inflammatory properties are the most striking, we see how it is taken up by the different medical schools," all making greater or less use of it, even with fundamental doctrines as much at variance as the humoralists or physiaters and methodists, or the dogmatists and empirics. In the writings of Galen, due recognition is made of the value of water in therapeutics. With the exception of the celebrated code of health of the school of Salernum, however, the writings of the Middle Ages contain little reference to this method. In the seventeenth century it began to receive greater recognition, especially in England (Floyer; T. Smith), and, in the beginning of the eighteenth century, in Germany. F. Hoffmann and Hahn, toward the middle of the last century, advocated cold sponging in fevers.

Hydrotherapy received greater impetus toward the latter part of the century, in England, by the writings of James Currie, William Wright, and W. Jackson. The method was subsequently advocated by Reuss, Frohlich, Brandis, Horn, and others. About 1743, John Sigmund Hahn, in Germany, systematized the practice of hydropathy, but it was falling again into disuse, when, soon after 1820, Vincent Priessnitz, a small farmer of Graefenberg, in Silesia, began to treat every kind of ailment, chronic as well as acute, with various hydro-therapeutic procedures, and added to the external applications the abundant internal use of water, combined with active exercise and a very simple diet, prohibiting, at the same time, all alcoholic beverages, and also tea and coffee.* The error of Priessnitz has already been referred to, and is one that medical-system makers generally fall into. It was that there is a universal method of treatment applicable to all cases. He, however, succeeded in making the medical value of water to be better appreciated by both the profession and the laity, and the furore which his treatment excited was of great value to regular medicine, in directing attention again to this highly important therapeutic resource.

Among contemporaneous writers, we may mention Ernest Brand, who published his work in 1861, showing remarkably favorable results, especially in typhoid fever, following immersion and compresses at from 54° to 68° F. Beutels, Juergensen, Winternitz, Charcot, Valleix, Dujardin-Beaumetz, and numerous other authorities and teachers have, by their labors, brought the science of hydropathy into system, and greatly advanced its practice.

Kneippism is a recent development of hydropathy, under the direction of an enthusiast almost as ignorant of medicine as Priessnitz, and, in his methods and results, curiously recalling to our mind the history of the great empiric. The Abbé Kneipp is 70 years old, a parish priest of the Roman Church. Having read Hahn's book, and cured himself by the liberal use of cold water, according to its directions, he has ever since been a zealous advocate of cold water as a remedy for all diseases. A recent writer, Dr. L. Reuss,† thus describes his method :—

He undertakes to cure a long list of maladies, from asthma to shingles. For each of these maladies, Vater Kneipp's principal, if not his only, medicine is cold water, applied in the shape of douches, foot-baths, head-baths, sitting-baths, and so on. Given in the form of drink, the water is often mixed with infusions, decoctions, or alcoholic tinctures. Always, however, water is the base of the medication. The simples recommended by the Abbé are very numerous, and the country people know them well. The leaves and flowers and roots and berries which he uses can be found, with few exceptions, at all our herbalists.

The worthy Abbé's system, however, is not one of therapeutics alone; it is also one of hygiene. He maintains that the many diseases of our day—affections of the heart or the breast, gastritis, anæmia, nervous disorders—were almost unknown to our ancestors, and are the result of our bad mode of living. He declares that the most of our maladies are due to trouble in the circulation of the blood. To remedy this, the body should be subjected to the action of the exterior air, combined or not with the action of icy-cold water. Children should be

* Herrmann Weber: Quain's Medical Dictionary, p. 667.

† Annales d'Hygiène Publique et de Médecine Legale; Times and Register, May 7, 1892, from Literary Digest.

allowed to go without shoes or stockings. Adults should often walk in the fields, even in winter, barefooted. In winter a walk with bare feet in the snow is absolutely recommended, only the snow should be fine, like dust, freshly fallen, and there should not be a cold and piercing wind blowing. The length of this snow walk should not exceed three or four minutes. A walk in running water has an incontestable tonic effect.

To keep well, according to Kneipp, you must dress and eat according to a certain system. You must discard woolen clothing next to the skin. Kneipp declares that if wool develop more heat than other cloth, it does so to the detriment of the human body. You must wear next to the skin a shirt of coarse cloth, as coarse as that of which grain-sacks are made. Fur collars, fur gloves, knit vests and shawls, and all that sort of thing, must be absolutely discarded.

Finally, if people want to get well and stay well, they must change their diet and drink. They must eat food which is richest in nitrogen,—milk, cheese, peas, beans, lentils, meat, and fish. They must avoid food poor in nitrogen, like the cereals, potatoes, vegetables generally, and fruits, and have nothing to do with fats and oils. They must drink a minimum of wine, of cider, of beer, and have nothing to do with brandy. Coffee, with or without milk, chocolate, and tea are anathematized, especially coffee with milk, which debilitates the stomach, leaving it without digesting. Coffee with milk, and beer, Kneipp counsels to replace with coffee prepared from acorns or with malt. This drink (Kneipp coffee) has nutritive and sedative qualities, in which ordinary coffee is absolutely lacking, and has also an excellent taste.

"Such is Kneippism. Whether it will make the tour of the world or even the tour of all Germany, the future alone can disclose. At all events, the system, if it cannot be recommended in its entirety, is not without commendable features."

At the present day, the achievements of hydrotherapy and the advancement of physiological and pathological knowledge demand from every intelligent physician an attentive investigation of its principles and practice. If this should be generally done, it will, beyond doubt, lead to a more general employment of such a valuable therapeutic aid. Professor Peter, of Paris, indeed, goes so far as to declare, in his preface to Duval's "Hydrotherapie," that "hydrotherapy suffices, in most cases of disease; added to other treatment, it is a most powerful auxiliary. Can any one speak better or say more of it?" *

Physiological Effects.—The erroneous idea has gained ground that the only object of bathing, in acute diseases, is reduction of temperature. It is true that pyrexia can be modified or reduced by this means,

* Quoted by S. Baruch, *loc. cit.*, vol. i, p. 12.

but other physiological and therapeutic results are produced, as will be seen from the following brief review of the physiological effects of water :—

Thirst is the sensation analogous to hunger experienced as a result of privation from water or fluids, after profuse watery discharges or hæmorrhages, and also as a result of the drying up of secretions, in some cases of fever. Life cannot be sustained without constant renewal of the water of the organism, to replace that lost by excretion, exhalation, and evaporation. Tissue-change and its functions are dependent upon the presence of water in sufficient quantity. This is partly supplied by the water contained in our food, and partly by the water which is drunk. Temporary excess of supply leads to increased discharge by the excretions and enhanced metabolism; whereas, relative deficiency produces a diminution in the quantity of the excretions. Where the increased ingestion of water continues for several days, it is observed that volume of the blood is increased, and there is an increased removal of the products of retrogressive tissue-change; the blood, the tissues, and the kidneys being, so to speak, washed out by it. The urine is more abundant and the solids are slightly increased. In consequence of the removal of the used-up material, the organism is able to take up a larger quantity of new nutritive substance. As a result, if not carried to excess, so as to disturb digestion, plentiful water-drinking causes increase of bodily weight; the urine, the saliva, bile, pancreatic and intestinal juices, and the perspiration are increased; the proportionate increase being determined by circumstances of temperature and bodily exercise, clothing, etc. The acknowledged benefits from a course of mineral waters are largely due to the increased quantity of water swallowed, and it is found that certain remedies, such as potassium iodide, are more efficacious when given largely diluted with water, and many pharmaceutical preparations must be given diluted, more or less, in order to make them less obnoxious to the palate.

Excessive water-drinking, especially of ice-water, causes digestive disorder; but what constitutes excess is relative, and not absolute, since some persons may, without any apparent ill effect, take quantities which would be injurious to others. Used systematically, water increases the watery contents of the stools and favors peristalsis; but excessive water drinking dilutes the gastric juice and tends to produce diarrhœa. It reduces the density of the blood, and may interfere with the nutrition of the great nerve-centres and of the heart.

The external uses of water produce different physiological effects, in accordance with the mode, duration, and time of application. The primary effects are local or general abstraction of heat and the stimulation of greater or less cutaneous areas. Indirectly, we have stimulation of the nerve-centres and disturbance of function of the vasomotor system, and the resulting effects upon metabolism, excretion, and assimilation. Hydro-therapeutic measures, apart from their antipyretic applications, are sometimes divided into stimulant and calmative, but no exact line can be drawn between these two classes. Among the former, the full or plunge bath, cold rain or shower bath, the douche, the spray or needle-bath (circular shower bath), sponge or towel bath, of short duration, usually preceded and followed by friction of the skin, are most used. A hot bath is a powerful nervous **stimulant.** The stimulating effects of these are shown in the reaction which follows, accompanied by a sense of exhilaration. Where the reaction does not occur, and the patient is blue and depressed after the bath, it fails of the anticipated good effect, and will be injurious, if continued. Some individuals have an idiosyncrasy in this respect, but where this is due solely to being unaccustomed to bathing it can be overcome by a system of graduated baths. By altering the temperature and duration of the bath, the effects may be considerably modified. The **calmative** effects are obtained from the wet-pack, in which the patient is enveloped in a wet sheet and rolled up in blankets; wet compresses; the hot foot-bath; the sitz-bath; the warm bath without motion. The effects noticed are abstraction of heat, diminution of nervous irritability of sensation, and mental activity; also, of the force and frequency of the heart's action. There is a feeling of lassitude and a tendency to sleep. As suggested by Weber (*loc. cit.*), "These forms of application can be modified, and the effects will vary in proportion. Thus, the wet-sheet envelope allows ample variation by using warm or cold water; by using the sheet dripping, or wrung out; by making the sheet fit tightly around the neck; by moving the sheet to and fro; by frequently changing the sheet, etc. The calming and stimulating form may be farther combined by using, first, the wet-sheet envelope, or the woolen-blanket envelope, for a sufficient period to produce perspiration, and then a more or less cold bath or shower bath of short duration." The various forms of hot-air and steam baths, combined with douches and baths of various temperatures, in the forms commonly known as Turkish, Roman, or Russian baths, are powerful hydro-therapeutic helps. Ice may be applied so as to act as a stimulant, or, on the other hand, as an antipyretic and sedative. To obtain the former effect, pieces of ice are applied suddenly to different portions of the surface of the body, thus exciting reflex action and stimulating the vasomotor nerves. They may also be introduced into the rectum as a general stimulant, as in chloroform or ether narcosis, as recommended by the late S. D. Gross.

Obstetricians sometimes excite the uterus to contraction in post-partum hæmorrhage by inserting ice into the cavity. Applied over a nerve, ice may produce anæsthesia, or even paresis of its peripheral fibres. Weir Mitchell demonstrated that anatomical changes may be produced by intense cold applied to the nerves, such as congestion with or without sanguineous exudations. Briefly applied, cold produces a rapidly-passing congestion without leaving traces behind, but, if prolonged, the nerve increases in volume, chiefly by dilatation of its blood-vessels. There may be actual effusions in the structure of the nerve, producing more or less paralysis in the parts supplied by it, but they usually disappear, although some of the nerve-fibres may degenerate. "Thus," says Baruch, "we may account for some cases of acute neuralgia, myelitis, and acute spinal paralysis following great temperature effects." All observers are agreed upon one point which is of great importance in clinical hydrotherapy, to wit, "an evanescent thermic application excites, while a prolonged one depresses." There is a more energetic reaction when the transition is abrupt from hot to cold, or the reverse, than where it is graduated.

Irrigation of the mucous cavities of the bodies by large amounts of fluid is a well-known and valued therapeutic measure. Large cold-water enemata have been used as a means of reducing temperature in typhoid fever; injections of warm water break up masses of fæces and cause evacuation of the large bowel; irrigation of the stomach removes mucus and acts as an antiseptic. Hot water is an excellent styptic and antiseptic.

Clinical Applications of Water in the Treatment of Disease.—In the author's work on "Heredity, Health, and Personal Beauty," * the relationship existing between bathing and health is especially considered, in the chapters on "The Bath as Promotive of Health and Beauty" and on "Bathing as Practiced in Ancient and Modern Times."

The internal uses of water have already been suggested; it is indispensable both in health and disease. It is owing largely to Dr. Hiram Corson and the late Dr. J. F. Meigs that the practice of refusing water to children during fever has been abandoned; and the fever-thirst is no longer met by small sips of hot water, but the patient is allowed to drink freely of cold water, which reduces temperature, slows the pulse and makes it fuller, favors diaphoresis and excretion, and washes out the kidneys. As a matter of precaution, it is considered advisable to filter and boil water, so as to render it aseptic, especially when epidemics of typhoid fever, cholera, dysentery, and similar diseases prevail. In the treatment of **chronic gastric catarrh,** hot water plays a very important

* Published by The F. A. Davis Co., Philadelphia, 1890.

part. Since it is capable of flushing the stomach and washing out the collection of *débris* and mucus, with bacterial and other microbic colonies, it relieves nausea and favors appetite and digestion. Many persons have tried hot water for their **dyspepsia,** as it was a fad a few years ago, and afterward abandoned it because it did them no good. The fact is that they used it improperly, and drank a cup of hot water just as they sat down to a meal. If they had taken professional advice they would have learned that they should take from half a pint to a pint of hot water at least half an hour before each meal, and in some cases an hour is better. The water should be too hot to drink, and should be merely sipped or taken by the teaspoonful. When this has been faithfully done for a short time patients are astonished by their improvement. Nausea disappears, appetite returns, digestion is facilitated, and constipation overcome. It may be necessary to order some compound tincture of gentian or cardamom, or similar stomachic, to be added to the water, in order to insure obedience and perseverance. In the temporary arrest of secretions and suspended digestion accompanying **fever,** water plays an important part in keeping the mouth and throat from being parched, and in removing mucus and epithelial *débris* from the intestinal and urinary tracts. Fever patients should, therefore, be encouraged to drink pure water. The thirst is often better relieved by carbonated waters, such as Vichy or Giesshübler. When the stomach contains objectionable material, the simplest **emetic** is water, heated to about 90° F., into which salt or mustard may be stirred if desired; but the water should be supplied to the full capacity of the stomach, since it acts principally mechanically.

In **summer-diarrhœa of infants** the following method is successful in washing out the intestinal tube: A soft-rubber tube, such as No. 8 Nelaton or Jacques catheter, is gently, but firmly, pushed through the pharynx into the stomach of the child, which is held upright in the nurse's arms. In very many infants this is not a difficult procedure, as they will aid it by sucking the tube. In older children it is more difficult, and had better be avoided. The procedure should not be made in the presence of the mother, nor of anxious friends, if it can be avoided, because the occasional anxious and cyanotic appearance of the baby, although evanescent, and not denoting harm, will interfere with the procedure in many instances. The catheter being lodged in the stomach, it is connected with a fountain syringe, from which simple, boiled water, of 95° F., is poured. The infant will probably vomit, but it is better to disconnect the catheter from the syringe, and allow the water containing products of fermentation, mucus, and undigested curds to escape through the tube. If the tube be not firmly held, it will be vomited (Baruch).

This brings up the question of irrigation of the stomach, or **lavage,** as it is called by the French. Lavage is both a diagnostic and a therapeutic agent. The technique, as followed by Baruch, is as follows: The patient is told to eat a hearty meal at 12.30 P.M., and to present himself at 5.30 P.M. for irrigation of the stomach by tepid water. "A long, soft, but firm rubber tube, with open end, and one eye near the latter, is introduced into the stomach. The necessary quantity of warm water (usually two to six quarts) being in readiness, a basin is placed upon a chair in front of the patient. It is well to protect the clothing of the latter by a doubled sheet,—or what I use in my office, an oil-cloth apron,—secured around the neck and reaching over the knees. Artificial teeth, if present, are to be removed. The patient is requested to sit upright, with his head thrown back. The physician, standing on the right, dips the lower end of the tube in warm water (oil is unnecessary, and injures the tube eventually). Holding it between the thumb and forefinger, he introduces it over the tongue until it strikes the back of the pharynx. The patient is now told to bend his head forward. In the first effort gagging will ensue, but an abundant mucus is secreted in the throat, which lubricates the tube. The patient should be re-assured, if he feels choked or distressed, by informing him that this is the usual effect, and that, if he will keep his mouth well open, he cannot choke, because there is ample room in the pharynx for a larger tube. The physician must refrain from sharing the patient's excitement, and, by his calm demeanor, re-assure him when he, as is often the case, protests that he is utterly unable to do his bidding." If a spasmodic contraction of the œsophagus should occur, the operator should wait a few moments and have the assistant pour some warm water down the tube. The tube can then gently pass down into the stomach, the distance having first been measured externally and a mark placed upon the tube showing how far it should pass into the mouth. When in position, the warm water is poured into a funnel at the free extremity of the tube, from whence it passes to the stomach. If vomiting ensue, the patient is instructed to lean forward over the basin and allow the vomit to flow out around the tube and partly through it. If the lower end of the tube become blocked up with undigested food, the funnel may be held higher up, so that the water may flow with greater force. After a pint or so, according to the case, has been injected, the funnel end is promptly depressed into the basin, and a reverse current is set up by siphonage from the stomach. This should be done quickly, as suggested by Baruch, **while the water is still flowing,** in order to establish siphonage. A neglect of this simple point defeats the proper emptying of the stomach. This procedure should be repeated until the stomach is thoroughly washed, even if several gallons are required, using no larger quantity at each injection than a pint. The washings are now carefully inspected. If there is undigested food in quantity, it denotes feeble digestion; if there is much gastric mucus floating in the surface, in a thick, tenacious, brown mass, it indicates gastric catarrh; if stringy mucus is present, it generally comes from the throat or gullet; a red tinge to the water suggests that an ulcer is probably present, in which case further use of the stomach-tube should be suspended. In gastric catarrh, systematic washing out of the stomach is of the greatest service, in conjunction with proper diet and the usual remedies. The irrigation may be practiced with warm Carlsbad or Vichy water, dilute solutions of boric acid, borax, or nitrate of silver, or simply recently-boiled water, every morning, or every second morning, gradually increasing the intervals as the patient improves. Dr. Baruch cites cases of nervous dyspepsia, in which there was neither mucus nor undigested food in the washings of the stomach, in whom hygienic management and hydrotherapy, externally applied, was successful after all the ordinary remedies had been tried in vain. As regards the time of day, Küssmaul, who, in 1867, introduced this method of treating stomach disorders, selects the morning, before breakfast. Riegel and others assign good reasons for preferring the evening, just before retiring to bed; while Baruch prefers the afternoon, about 5.30 o'clock, a light lunch having been taken at 12.30. In fact, much must be left to the judgment of the physician and his understanding of the requirement of the particular case in hand. A word should be here said about the abuses and possible dangers of lavage and irrigation of the stomach. Cases have been reported of unfavorable results following the use of the stomach-tube, and several cases of boric-acid poisoning have resulted. It is evident that great care should be exercised, and that the operator should proceed cautiously at first, especially where there may be a gastric ulcer, or with a nervous patient.

Bathing is a very ancient therapeutic resource. The limits of the present article only permit a very insufficient outline of its applications in medicine. The baths may be general or local. Of general baths, we recognize the plain and the medicated, and, as regards temperature, we have cold, warm, and hot baths. Baths of hot air, or Turkish baths, and of steam (either plain or aromatic) have been already mentioned. The present consideration is restricted to baths by immersion of the body in water, either plain or containing substances in solution. It has been established by recent investigations that absorption through the skin, during a brief immersion in a bath, is practically impossible, and that, therefore, medicated baths are useful only for their direct effects upon the skin. There is little, if any, absorption in a cold bath, and absolutely none in a hot bath. When it is desired to administer remedies for their constitutional effects by the route of the skin, the drugs should not be put into the bath at all, but should be applied to the skin after the bath, upon compresses or by inunction. This will be referred to again, under local hydro-therapeutics.

Baths are called cold, tepid, warm, or hot, according to the temperature of the water. By a **cold** plunge is meant immersion of the body in water below the temperature of 70° F. Anything below 50° F. is considered a very cold bath. In some rare instances of hyperpyrexia, we may even add pieces of ice to the water, as in the treatment of **sun-stroke.** The **tepid** baths, of a temperature of 75° to 95° F., are intermediate between cold and warm baths. The **warm** bath is from 95° to 104° F. Above this is a **hot** bath, and very hot baths may be given up to a temperature of 114° F. As already intimated, the physiological effects depend upon the temperature and duration of the bath. Under ordinary circumstances, when no time is mentioned, the duration depends upon the objects sought to be attained by the baths and personal convenience. Prolonged immersion is sometimes practiced in some surgical cases and in skin diseases. The **cold** bath should be brief, as the rule, and followed by friction with the flesh-brush or coarse towel. This expedient is most valuable in invigorating the system, and is utilized in the treatment of catarrh, in conjunction with local treatment. Some patients bear cold better than others, but prolonged immersion is depressing, owing to continued loss of heat. The secondary effects of cold bathing—which accelerates tissue-change, augments the excretion of carbon dioxide and of urea from the system, and improves the appetite—are used to advantage in many chronic disorders, and particularly in **lithæmia** and **rheumatism.** Cold sea-bathing has an important part in favoring **neurasthenia.** especially in children ; but in many instances it should be preceded by a graduated system of warm bathing, until the patient is strong enough to bear the shock of the plunge. Where motion of the body, as in swimming, is combined with the cold bath, the depressing effects are less than when the subject is kept quiet. The hygienic effects of a stay at the sea-shore also enter into the advantages of sea-bathing. The **warm** bath is that generally resorted to for cleansing purposes, and is accompanied by frictions of the skin. It is without shock ; it causes a moderate increase of capillary circulation, and scarcely affects the pulse. As the stay in a warm bath is generally longer than in a cold bath, the loss of heat may be actually greater than from a cold bath ; hence the aphorism of Hippocrates, that " a cold bath warms and a warm bath cools." This is the form of bath which is generally resorted to in the treatment of fevers, and which will be referred to in detail in discussing the Brand method of treating typhoid or enteric fever. **Hot** baths exert a powerful stimulating effect upon the nerves and blood-vessels of the skin, and are used in narcotic poisoning and in overcoming a tendency to coma in low fevers.

Caution is to be observed in adapting the bath to the condition of the patient. Cold baths are fitted for the vigorous and robust, but even in them, as pointed out editorially in the *British Medical Journal*, it may be carried to excess and become injurious. Cold bathing every morning throughout the year may be conducted in such a way as to be beneficial, viz., if the plunge be brief and be followed by friction of the skin and prompt dressing. But because it can be carried on with advantage by one person who reacts well after it, it does not follow that another can do it with impunity, especially if he finds that reaction is slow after the bath. In the latter a moderately warm plunge-bath or shower-bath might be borne well and be followed by beneficial results. Open-air bathing in winter is not likely to have many advocates in this uncertain climate, but it appears that it finds some defenders in England, where school-boys, who do not like to be outdone by their seniors, we learn, are in the habit of taking a cold bath before the morning-school. This is apt to be injurious to the weakly ones and to retard development in the strong unless followed by running or other active exercise, to restore the circulation. Cold baths should never be taken when exhausted or directly after a full meal, or if there be reason to suspect congestion of any internal organ. The anæmic and debilitated may combine the advantages of both the tepid and the cold bath by immersion in or sponging with warm water, followed (while still standing in warm water) by the rapid application of a sponge, wet with cold water, to the general surface or to the throat and chest. Asthenic persons are often unable to take a full bath, and subjects of vascular degeneration or heart disease should only use warm water. The excessive use of decidedly warm or hot baths is relaxing to the system and debilitating.

The treatment of **typhoid fever** by Brand's method involves the administration of a bath at 68° F., given every three hours, where the rectal temperature is 102.2 degrees or over, and lasting about fifteen minutes. With some modifications, this form of antipyretic treatment of typhoid fever is now in general use, and a very marked improvement has been observed since its introduction. In the *Practitioner* for March, 1891, Dr. F. E. Hare, of Brisbane, analyzes two series of cases of typhoid fever,—the one including eighteen hundred and twenty-eight cases and treated expectantly, the other comprising eleven hundred and seventy-three cases and treated with cold baths. Dr. Hare deals most effectually with possible objections to his statistics. He shows that the treatment has no effect upon the occurrence of perforation and hæmorrhage beyond rendering the latter less dangerous; that the death-rate from exhaustion and from pulmonary and cerebral causes is diminished, especially in cases of early admission to the hospital; and that the prognosis becomes even better in women, since they are less liable to perforation and hæmorrhage than men. The lethal influence of the intestinal lesion is lessened under this treatment, by moderating the diarrhœa and by sustaining the strength of the patient. Brand's rules and cautions as to contra-indications were observed. Dr. Hare incidentallly remarks that quinine is of much service as a cardiac stimulant in simple pyrexial cardiac failure. The author concludes by saying that hospital mortality may be greatly reduced—upward of 50 per cent.—by the cold-bath treatment; but that it can hardly fall below 5 per cent., since the death rate from perforation and hæmorrhage amounts fairly constantly to 4½ per cent. As the result of the different liability of the sexes to these accidents, the prognosis under the bath treatment is vastly more favorable in females than in males, as above stated.

As this method requires a portable bath-tub, or subjects the patient to considerable disturbance of body, which is opposed to the first principles of treatment of typhoid, various methods have been devised to overcome this objection. The patient may be placed upon rubber cloth and the edges lifted up in such a way as to make the patient lie in a hollow, which may be partly filled with water of any desired temperature, as recommended by Prof. H. C. Wood. Niemeyer's method is somewhat similar, the patient being enveloped in a wet sheet, and water, at the temperature of 70 degrees or less, is then applied by means of a watering-pot or rose-spray. Prof. Da Costa prefers cold sponging, repeated every hour or two when the temperature is over 102 degrees. The following is a method advocated by Dr. T. Peyre Porcher, of Charleston, Va.:—

"1. A soft towel, folded, is soaked in a basin of iced water, then wrung out and applied over the forehead and temples.

"2. The palm of one hand and the arm are sponged off with another towel, which has been dipped in the cold water and wrung out.

"3. The towel which has been left upon the head is turned and re-applied, so as to have the cold surface next to the skin.

"4. The other hand and arm are treated as was the first.

"This process, strictly followed, is continued for fifteen, twenty, or thirty minutes, or until such time as the surfaces have become thoroughly cooled and blanched, when it may be discontinued,—to be renewed whenever there is a rise in the surface-heat. Sometimes, if it does not cause fatigue, both hands and arms, if hot and dry, are allowed to remain submerged, or be bathed directly in the cold water." *

Dujardin-Beaumetz is an advocate of the hydropathic treatment of typhoid fever, but is opposed to the cold bath. He sums up Brand's method as follows: "You must administer baths of 64° to 68° F., of fifteen minutes' duration, from the fifth day of the fever; these must be repeated, day and night, every three hours, as long as the temperature of the rectum exceeds 102° F." In applying rigorously this treatment, so simple in appearance, Brand considered himself warranted in affirming that "every case of typhoid fever, treated regularly from the beginning by cold water, will be exempt from complications and will get well." The method of Brand is carried out rigorously at Lyons by Dr. Glenard, who reports such good results in his service that the method has extended to all the other hospitals of Lyons. Ziemssen reports a great reduction of mortality in Germany. At the same time Schmidt, of Erlangen, and others have shown that a rigorous application of the cold bath to typhoid-fever patients is not without its dangers, and the death-rate may be actually increased by it. Dujardin-Beaumetz, after a review of the question, asserts that "the method of Brand is impracticable in the majority of cases and outside of military practice," and this applies to hospital as well as private practice. He bases this statement upon the fact that it is not possible to begin the practice as early as the fifth day in all cases, because they never enter the hospitals so early, and because we cannot be sure of our diagnosis till after the seventh day. Moreover, he justly states that "we cannot, without danger, subject all our fever patients to a rigorous and severe method, and where we are ignorant of the cause even of the febrile process." Since the cold bath may determine profound congestions, he declares that Brand's method is not free from danger, and is itself the cause of not a few complications, especially pulmonary congestions and inflammations. As regards intestinal hæmorrhage, he believes that in certain cases the cold baths may favor these hæmorrhages in patients who are predisposed.

In summing up, he says: "I consider the exclusive method of Brand, and the rigorous and mathematical rules which he has formulated, as deserving to be banished from the treatment of typhoid fever, and for this reason especially: because it requires, in order to derive from it all the results which it promises, to be applied before the diagnosis can be certain; for, employed later, this system only gives, according to the acknowledgments of the most zealous partisans, results comparable with those of other therapeutic methods, and with greater danger to the patients. . . . In fact, we have, for the treatment of certain mani-

* Transactions of the Association of American Physicians, vol. i, p. 29.

festations of typhoid fever, hydro-therapeutic means much less dangerous and quite as powerful,—not, perhaps, from the point of view of hyperpyrexia, but from that of the other symptoms of typhoid fever; for, in my opinion, the advocates of refrigerant medication have committed an error in vociferating, 'The hyperpyrexia!—Behold the enemy!' The hyperpyrexia, as Peter has well said, does not constitute all the danger of the disease, of which it is only one of the manifestations."

Dujardin-Beaumetz * prefers the tepid bath or the **wet pack,** applied as follows: "The patient, in a state of nudity, is wrapped, from head to foot, in a sheet or blanket wrung out of ice-cold water. It is well, as a preliminary step, to have a rubber blanket spread upon a mattress; over this you place the wet sheet, in which you wrap your patient. Liebermeister advises that this envelopment should be continued for ten minutes; for my part, I prefer a shorter duration (of a minute or so), after which the patient is taken from the wet sheet and removed to his bed. If I prefer wet wrappings, of short duration, to the practice of Liebermeister, it is because I do not wish to obtain refrigeration from these envelopments, but only a regulative modification of the nervous system, and this effect will be the more marked the shorter the duration of the cold application. This is one of our most powerful modes of treatment, in cases of typhoid fever of ataxic and adynamic character. . . . Foltz has recently added cold lavements to the refrigerant medication. These lavements of water, at 50° F., lower the temperature of patients,—in a feeble manner, it is true, but still appreciably,—and this is a fact worthy of being remembered.†

The principal local applications of hydrotherapy consist of affusions or douches, compresses or partial packing, and local immersion. There are a variety of methods of administering douches,—the shower-bath; the douche proper, in which a column of water falls or is projected upon the body; the needle-bath, in which several rings, at different levels, discharge minute streams of water, from all directions, upon the body; and the movable jet or spray. Where the force of the water is rather great, we should avoid douching the head. The douche may be, like the full bath, cold, temperate, or hot; but it has this advantage over the full bath, that the temperature may be abruptly changed, thus producing rapid alternations of temperature, which are decidedly stimulating to the nervous system, both central and peripheral.

In the so-called "Scotch douche,"—a shower-bath in which the temperature, at the beginning, is about 86 degrees, and it is gradually

* Clinical Therapeutics, by Professor Dujardin-Beaumetz, p. 383. Translated by E. P. Hurd, M.D. Detroit, 1885.

† Clinical Therapeutics, *loc. cit.*, p. 387.

raised to 122 degrees, which is about as hot as can be borne,—this is followed immediately by a douche about as cold as ice. The duration of the douche should be very brief (ten to twenty seconds), and should be preceded by active exercises, to produce action of the glands of the skin. It is, therefore, a measure better adapted to vigorous persons than invalids. It can be utilized, however, in the manner described upon the preceding page as the method of Niemeyer. The cold shower is of service, when directed against disorders situated in various organs of the body, and, when followed by vigorous friction, or, as Gross recommended, whipping with the fringed edge of a towel, it is a powerful nutritive stimulant. The cold douche to the lumbar region stimulates the kidneys in suppression of urine; but in advanced Bright's disease the wet pack is better, on account of the free perspiration which it induces.

Dr. Hiram Corson, of Pennsylvania, highly recommends cold douche in the delirium of **scarlatina** and other eruptive diseases, the water being poured from a pitcher, elevated a foot or two, and sufficient in quantity to reduce the temperature and delirium. The cold douche to the spine is useful in chorea and in many other disorders of the spinal chord. The application of ice to the spine, for sea-sickness, chorea, etc., will be referred to in the chapter on "Cold and Heat as Therapeutic Agents." The local application of moisture is largely employed in medicine, in the form of stupes, cataplasms, or poultices, and compresses; especially when used in connection with heat, it favors local hyperæmia and hastens the process of suppuration in abscesses and boils. This method is also useful in relieving pain and relaxing tissues, as where joints have become stiffened. Cold compresses, especially when some agent is added to favor evaporation, as alcohol, are useful in various forms of inflammation. A common resource in pharyngitis, tonsillitis, and inflammation of the throat attending scarlet fever and diphtheria, is the application of wet compresses, which may be dipped in ice-water, as recommended by Dr. Hiram Corson.

To review the therapeutic applications of water, we would place at the head of the list the hydriatic treatment of **fever.** Dr. Baruch has pointed out * the principal reasons why this method is not in general use, as (1) it is believed by many to savor of quackery; (2) the difficulty of applying its principles, and necessity of apparatus; (3) the necessity and difficulty of an exact technique; and (4) the objection of patients and the natural aversion of some people to water. The main obstacle, however, is probably the absence of hydropathic teaching in the medical colleges, and want of appreciation by physicians of the advantages of

* Journal of Balneology, March, 1892, p. 2.

this mode of treatment. Under the direction of the leading clinicians of Europe and this country, a rapid revolution is occurring in medical practice, and the expedients of hydropathy are coming into more general use as the knowledge of their utility and safety becomes more widely diffused among physicians and the community. In **typhoid fever,** some form of bathing is now universally resorted to for the relief of hyperpyrexia, although, as Dujardin-Beaumetz insists, the effects of the bath upon the functions of the nervous system are of greater importance than the mere abstraction of heat, in favoring recovery and diminishing liability to complications. In scarlatina, measles, and other exanthemata, the wet pack is useful in bringing out the eruption, relieving restlessness, and reducing fever temperature. In chronic metal poisoning (lead, mercury, arsenic), the increased perspiration favors elimination. In muscular rheumatism and lithæmia, and various forms of chronic rheumatic inflammation of organs, the wet pack and vapor-baths are very useful. A convenient method of obtaining a vapor-bath, without apparatus, is to strip the patient and envelop him in a wet sheet, then seat him upon a cane-seat chair. Under the chair, upon the floor, is placed a small alcohol-lamp, over which is a small receptacle filled with water. After lighting the lamp, the patient is covered with blankets, which pass from his neck to the floor, thus retaining the heat. In a few moments, perspiration will begin to come out, and profuse sweating will ensue. After ten or fifteen minutes, the patient is allowed to lie down upon a bed, and is thoroughly dried with towels, followed by friction. If desired, medicinal substances may be combined with this bath. For instance, some pine-needle-oil (oil of pumílio pine) may be added to the water. Some sulphur may be burned at the time that the skin is perspiring freely, or 10 or 20 grains of calomel or red oxide of mercury may be vaporized by placing them upon a metal plate, over the lamp, as a substitute for the water-pan after free diaphoresis has been produced.

Another method of causing diaphoresis, which is a combination of hot air and moisture, is conveniently used as follows: A small tin pipe (like a rain-spout) is obtained, which is rounded in the middle so that the ends are in planes at nearly a right angle to each other. The patient is placed in bed, upon a rubber sheet, covered by a blanket. The bed-clothing is brought tightly around the neck and shoulders, but lifted from the remainder of the body by means of half-hoops, or other means of elevating the bed-clothing, so as to make it into a hot-air chamber. The pipe is attached to the foot of the bed so that one end enters the cavity of the hot-air chamber and the other is outside, directed downward. Under the latter is placed a lighted alcohol-lamp, so that the heated air from the flame will pass into the pipe and be carried under the bed-covers. The patient will be made more comfortable by having a compress, wet with cold water, applied to his forehead during this period. After profuse perspiration has been excited and continued for the desired time, the patient is rubbed down and dried as before. This is of great advantage in chronic rheumatism, Bright's disease, uræmia, and similar conditions.

In **gouty** or **rheumatic inflammation,** restricted to certain joints, the local compress is serviceable, and good reports have been made of the application of 10-per-cent. solutions of salicylic acid or salicylate of sodium to the joints. By combining electricity with these compresses absorption is favored, and remarkably good results have been obtained, as has been already stated in the article upon Electricity under "Electrolysis and the Cataphoretic Action of the Galvanic Current."

In **syphilis** and **skin diseases** the bath is indispensable, and the application of various forms of hydrotherapy is set forth in more detail than is permissible here in the author's work * on "Diseases of the Skin."

The results obtained at the Montefiore Home by Dr. Baruch, in the treatment of **phthisis** by hydriatic measures, have been so successful that further trial of this method is recommended. The technique of these procedures varies with each case. Brief applications of low temperature, as by the douche or rain-bath, the wet pack, or rapid ablutions, are followed by rapid reactions, and, if well borne, are exceedingly useful as tonics; while, on the contrary, in cases suffering from elevated temperatures and great debility, more gentle procedures and higher temperatures are required. Dr. Baruch warns against too cold applications, which are better indicated in a febrile or mildly febrile condition. He gives the patients a thorough cleansing with soap and warm water upon entering the hospital, after which a day is allowed to elapse. "The patient is now wrapped snugly, quite naked, in a woolen blanket, so that his entire body is excluded from air; other blankets are piled over him; the windows are opened, and he is given a small glass of iced water every ten minutes. Having lain in this position an hour, now one part of the body is exposed and bathed as follows: A basin of water at 75 degrees is ready, into which the attendant dips his right hand, covered by a mitten or glove of Turkish toweling. With the wet glove the face is well bathed. Now, one arm is exposed and rapidly washed and rubbed, then dried and replaced under the blanket. Other parts are then successively treated. At the termination of this ablution the patient is rapidly rubbed

* A Practical Treatise on Diseases of the Skin. Second edition. New York: D. Appleton & Co., 1892.

all over with a coarse towel. The treatment is repeated daily, the temperature of the water being reduced 2 degrees on each occasion."* The next step is the dripping-sheet. "The patient, standing in a tub of water at 100° F., has a sheet, dipped in water at 70° F., thrown over his head and body from behind, and is wrapped completely and snugly in it. The attendant now passes his outstretched hands over successive parts of the body, with some pressure on the sheet. He rubs the **sheet,** not **with** the sheet. One or more pitchers of water, 5 to 10 degrees colder, are thrown upon the parts that have been subjected to friction. The sheet is removed and the patient thoroughly dried. This method requires great care and skillful application. Its success or failure depends upon ascertaining by previous treatment the reactive capacity of the patient. The most useful hydriatic procedure in phthisis, however, is the rain-bath. Unfortunately, this finely-divided douche can only be administered in institutions. The patient stands within a frame constructed of six semicircles of inch tubing, the upper one on a level with the clavicles. Each tube has three lines of fine perforations, the upper one directed upward, the middle straight forward, the lower downward. The water should have a fall of not less than forty feet. The temperature adapted to the average case of phthisis is 65° F. Here the pressure with which the water strikes the body affords a kind of massage, which assists in producing reaction even in feeble individuals. But it should not be applied without previous training of the skin, as above described. The rain-bath is an apyretic of great value if its temperature is not below 60 degrees nor above 70 degrees; it is a stimulant and tonic if between 55° and 65° F. The skin should become pink under it, and the patient must not be chilled by it; at least, any coldness he may experience should disappear after he is dried. **This, indeed, is the test of all hydriatic procedures.** Decided chilliness continuing after thorough drying and friction is an evidence of improper selection of the temperature, duration, and method of the bath. These should be modified as indicated by their effects." The progressive increase in weight and improvement of general condition in phthisis are accompanied by a diminution in the expectoration and the numbers of the bacilli.

Hydropathy in Nervous Diseases.—In many nervous affections disturbances of function are due to some obscure lesion or fault of nutrition, which can be removed or amended by judicious hydrotherapy. Professor Erb says: "Cold and cool baths, in various forms, belong to the most important therapeutically active agents in the field. This method has, since it has been more carefully studied and more rationally pursued, made notable advances. Its results in all possible forms of chronic

* Dietetic and Hygienic Gazette, March, 1892.

nerve-troubles are extraordinarily favorable. There are few remedies which have an equally powerful influence upon the nervous system." * An excellent review of this subject is contained in a recent lecture by Prof. Chas. L. Dana, M.D., of New York, delivered before the Post-Graduate College of that city. †

The various forms used by the neurologist are :—

1. General hydrotherapy, tonic hydrotherapy, sedative hydrotherapy, indifferent baths for mechanical purposes.

2. Local hydrotherapy.

Tonic Hydrotherapy.—For purposes of stimulating nutrition and increasing vasomotor tone we employ cold plunges, the rain-bath or shower, the jet, cold sponging, cold sitz-baths, cold sheets, local applications of ice or cold compresses, or cold rubbing, ice-bags, brine-baths, brief cold packs, and sea-bathing. The technique of these is as follows :—

The Cold Plunge.—The bath is filled with water, at from 60° to 70° F. The patient steps in, immerses his body, and at once jumps out and rubs himself vigorously, or is rubbed by attendants, until reaction occurs.

The rain-, jet-, shower-, or needle- bath requires a form of apparatus which delivers the water in fine jets, either vertically or laterally, against the body. The force of the water is an important feature, and both it and the temperature should be properly regulated. In the rain-bath the patient stands in a tub containing some warm water, and the shower is directed upon successive portions of his body. The water may be at first moderately warm and gradually made cold, or it may be cold from the beginning. Where it is desirable to give a shock to the peripheral nerves the latter is preferable, or there may be a succession of showers, alternating hot and cold. Rain-baths should not continue beyond one or two minutes. A solid jet of cool water may be thrown or allowed to fall with force upon the back of the patient, either from a tap or a hose. In the latter case the jet may be thrown from a distance of several feet.

Cold sitz-baths are taken, at a temperature of 70° to 80° F., from twenty to thirty minutes. The **cold sheet,** or **drip-sheet,** is used by wringing a cotton sheet out in cold water, and wrapping it suddenly about the standing patient, who is then vigorously rubbed.

Ice-bags may be kept in contact with the spine, in the lower cervical or upper dorsal regions, for one or two hours, once, or several times, daily.

The half-bath and wash-off consists of a tub partly filled with water

* Article by Professor Erb, of Heidelberg, on "Diseases of the Nervous System," in Ziemssen's Cyclopædia.

† The Dietetic Gazette, December, 1891, p. 237.

at a temperature of 65° to 80° F. The water only half covers the reclining body. While lying in it the patient is vigorously rubbed. A cold cloth may be laid on the head. After five or twenty minutes affusions of colder water are poured over the shoulders and along the spine.

Brine-baths contain about 2 per cent. of salt (sodium chloride). They are given, at a temperature of 100° F., from twenty to thirty minutes daily; or four baths of 70° F. may be given for five or ten minutes, the patient exercising himself or being rubbed in the meanwhile.

The physiological effects of these different forms of hydrotherapy should be kept in mind. Cold applications produce a local contraction of the blood-vessels, followed by dilatation. There is usually increased tissue-metamorphosis, increased secretion of urine, increased absorption of oxygen, and increased excretion of carbonic acid. In non-febrile persons cold applications abstract some heat, but they also stimulate the heat-producing centres, so that the total effect is to increase the heat of the body. Only very cold baths lessen heat production as well as excretion of carbon dioxide.

Cold baths at first accelerate and then tend to retard pulse and respiration. Cutaneous sensibility is at first increased. After a cold bath there is a sense of exhilaration and increased muscular power, provided the bath be not too cold or too long continued. The duration necessary to produce a reaction varies with different people, and some weak and sensitive patients never can be made to react. Cold baths, systematically taken, furnish a kind of vasomotor gymnastics. The neuro-mechanism controlling the blood-vessels becomes more supple and the tendency to local congestion of the viscera and mucous membranes is prevented.

The shower and jet furnish the most valuable means of securing tonic effects in nervous disorders. These are not used with cold water alone. The temperature may be gradually changed from 95 degrees or more down to 60 degrees or less, or the hot and cold may alternate. In this way, says Dana, tonic effects can be obtained even with very feeble persons.

Sedative Hydrotherapy in Nervous Disorders.—The sedative baths are the lukewarm bath, the wet pack, Turkish and Russian baths, the hot sitz-bath, pedal baths, compresses and fomentations, and hot-water bags. The following is the technique:—

The lukewarm baths are usually at a temperature of 95 to 98 degrees, and are given from ten minutes to half an hour, daily. If a slight tonic effect is desired also, the patient should receive an affusion afterward, basins of cold water at 60 or 70 degrees being poured over his shoulders.

Medicaments, such as salt or pine-needle extract, may be added to the bath with advantage.

The wet pack: A large, thick blanket is spread upon the bed, and over this a linen sheet, wrung out of cold water (40 to 60 degrees). The nude patient lies upon this, and the sheet is then smoothly wrapped about him, the head and feet not being included. The sheet is carried between the legs and made to lie evenly in contact with the body. Then the blankets are folded over him, and other blankets may be piled upon these. Sometimes it is well to place hot-water bottles at the feet and a cool compress on the head. The patient lies in this pack from thirty to forty-five minutes, and is then rubbed off. A cool affusion may be given first. To increase diaphoresis some hot infusion may be administered during the time the patient is in the pack.

Turkish and *Russian baths*, or hot-air and steam baths, as given in establishments devoted to the purpose, should have professional supervision, and the temperature, ventilation, duration, and after-treatment, by jet, shower, or plunge, carefully adapted to the individual case. A shower or cold affusion to the lower spine is an excellent stimulant to the kidneys.

In a *hot sitz-bath* the patient sits in water at a temperature of 100° to 125° F. for twenty or thirty minutes. Salt or mustard may be added. This is an excellent sedative in dysmenorrhœa; or *hot compresses*, consisting of flannels wrung out of hot water and covered with dry flannels and a rubber cloth, may be substituted in local pains and inflammations. The hot compress is often effective, when applied in this way over the abdomen, for the relief of insomnia. *Hot sprays and douches* are used for similar purposes. The hot spinal bag and hot-water bags for the feet should not be applied at a temperature of over 120 degrees, and should be enveloped in flannel and not placed in contact with the skin.

Warm baths increase heat radiation and conduction, and thus lower bodily temperature; the warm, moist pack, followed by sponging with tepid water, is the most convenient method of applying the water. On the contrary, the bodily heat may be raised in the pack by applying hot-water bags to the surface and adding blankets. "Warm baths increase the circulation of the skin, lessen cutaneous sensibility, withdraw blood from the central organs, increase the exhalation of carbon dioxide, but lessen respiratory activity, on the whole. Nitrogenous metabolism is increased from 2 to 3 per cent., and more urea is excreted. Pulse and respiration are increased. Nervous excitement is lessened, and the general effect is to cause sedation and abating of languor." *

The wet pack is a most useful sedative in **neurasthenia** and **insomnia,**

* Dr. Dana, *loc. cit.*, p. 238.

and may take the place of medicinal sedatives, like the bromides. It should be given three or four times weekly or for a short time daily. The lukewarm bath ranks next in its sedative efficacy. Dr. Dana also points out that applications of water to the feet and abdomen especially affect the intra-cranial circulation, while those given to the thigh and wrists affect the pulmonary circulation, in each case cold causing congestion, and heat anæmia, of the distant parts. [If this be a physiological fact it would oppose the method of Dr. Porcher, given upon a preceding page, for the reduction of bodily temperature in typhoid fever.] Cold to the spine is believed to cause, at first, constriction and, later, dilatation of the thoracic, abdominal, and pelvic viscera; heat has the opposite effect. Hence, cold applications are used to relieve **cold feet** and also anæmic conditions of the viscera.

In **neurasthenia** Dr. Dana recommends wet packs and half-baths, followed by shower, jet, or plunge. For weak, sensitive, and anæmic women he prescribes, first, dry, hot packs for a week, then wet packs, and, finally, the drip-sheet or shower-bath.

In **epilepsy** dry and wet packs may be given; but the best method for a fairly robust person is that originally described by Fleury. This consists in giving simultaneously the rain, shower, and the jet. The patient, standing in the shower, receives a jet of water on the posterior surface of the body for fifteen seconds; then the jet alone for fifteen seconds; finally, the jet alone on the anterior surface of the body for thirty seconds.

In **hysteria** the rain-shower and the jet are usually most efficacious.

In **locomotor ataxia** lukewarm baths, with pine-needle extract, or half-baths, with affusions, are indicated.

In **peripheral pains** from neuritis and neuralgia the continuous application of ice-bags is often efficacious; and hot sand- or water- bags are sometimes applied continuously to the spine for one or two hours, with the purpose of increasing the circulatory activity of the cord.

Cold applications to the spinal column are resorted to with benefit in **chorea** and other spasmodic disorders, such as **persistent vomiting, hydrophobia,** etc. The ice-bag to the scalp is of the highest service in **cerebral meningitis** and **cerebritis,** whether primary or secondary; and it relieves the **headache** and **delirium** in the specific fevers.

MINERAL SPRINGS.

The subject of mineral springs has relations of the most intimate kind with balneology and also with climatology, and naturally comes up for consideration in close connection with the preceding section, in which the therapeutic applications of water were dwelt upon. At the very beginning it is proper to direct attention to the fact that the distinction between water and medicinal water is not absolute, but simply one of degree. Pure water only exists in the laboratory; in nature water is always, to a greater or less degree, contaminated with various soluble substances, which it dissolves from the earth's crust or absorbs from the atmosphere. The degree of contamination or impregnation depends upon certain circumstances which are largely of a local character, the springs of one neighborhood containing mineral and other ingredients, which are constantly present and characterize them, so as to distinguish and make them different from other springs, either of the same or of a distant locality. Therefore, degrees of purity are recognized, while absolute purity is not expected; and where the mineral contamination is sufficiently great to make the water produce therapeutic effects, we can divide the waters into classes in accordance with such effects. It is a matter of observation that springs and streams of water, in addition to the natural contamination, may contain, by accident or design, other constituents, which are called pathogenic organisms or disease-germs, owing to their effects upon the general health of those using such water. These come under the general head of pollution. Thus, organic refuse, excreta of animals or human beings, sewage and waste from manufactories, etc., pollute a water-supply, and are a frequent source of epidemics. With these pathogenic forms of contamination the present article has nothing to do further than to give a mere reminder of a lurking danger which may unexpectedly be encountered at health resorts and, with this very important exception, among the most sanitary surroundings. As every intelligent person, and especially every practicing physician, should be able to pronounce upon the presence or absence of suspected impurities, and as physicians are often called upon for an opinion as regards the wholesomeness of water, the following tests may enable him to come to a decision. The clearness, transparency, and general appearance of the water, as compared with a sample of distilled water. The odor that it may have is developed by slightly heating some in a small flask and smelling it; the odor may or may not indicate the presence of deleterious substances. Color and turbidity may depend upon vegetable or mineral impurities which are not necessarily prejudicial to health. Should these be absent it must not be at once decided that, because the water is clear, transparent, and odorless, it is wholesome; on the contrary, the most attractive-looking water may contain dangerous pollution, and be entirely unfit for use. The total solids of a good drinking-water should not exceed 25 to 30 parts in 10,000, the character of the solids, of course, affecting the results upon health. The total solids are determined by evaporating a certain quantity of water to dryness and weighing the residue. This may be subsequently subjected to chemical examination, if desired to have a complete analysis of the water. Any gases which may come off from the water should be collected, measured, and identified. Qualitative tests for organic matter with permanganate-potassium solution, and for chlorides by nitrate of silver, for nitrates with pyrogallol, and for ammonia by Nessler's reagent are usually resorted to. If the permanganate be decolorized after standing a few hours it indicates presence of organic matter, but not necessarily of animal origin; it may be vegetable and harmless. If a solution of nitrate of silver causes an abundant precipitate of chlorides, this may be due also to mineral contamination, as well as to animal excreta. The determination of nitrites and nitrates is of more importance, since they lead to the suspicion of sewage contamination. "They are the resultants of oxidation of nitrogenous organic matter, and, although water containing them is not necessarily dangerous, their presence should render a thorough examination of the source of supply imperative." The pyrogallol test is applied as follows: Put 2 cubic centimetres of pure sulphuric acid in a small test-tube and add 1 cubic centimetre of water to be tested. To this mixture is added 1 drop of a solution of pyrogallol (65 centigrammes in 30 cubic centimetres of distilled water, acidulated with 2 drops of sulphuric acid). The water becomes colored a dark amethyst or wine-brown if the salts are present. The depth of color indicates approximately the amount of the impurity. A very delicate test for nitrous acid or nitrites is that with iodide of potassium and starch. Three hundred and fifty to 600 cubic centimetres of water, in a flask, are acidulated with a few drops of dilute sulphuric acid, and a little solution of iodide of potassium added. About 2 grammes of freshly prepared starch are added, and the mixture shaken. If nitrous acid be present the iodide is decomposed, setting free the iodine, which combines with the starch, causing a blue color.*

Bacteriological tests are now made by all experts in water analysis, and such determinations are absolutely necessary in order to decide positively upon the potable quality of any water-supply. A rough bacteriological test can be made by placing a sample of the water in a clean flask and filling the neck with absorbent cotton in place of a cork. The

* Geo. H. Rohé, Text-Book of Hygiene, p. 74. Philadelphia, 1890.

flask is now placed in a warm situation (say, at a temperature of 90 to 100 degrees) for ten or twelve hours, and then examined. If it become cloudy and develop a putrid smell, it should be regarded as unwholesome and some source of pollution suspected.

The mineral poisons, especially the common metallic forms,—lead, copper, zinc,—are easily recognized by the sulphuretted-hydrogen test, and arsenic by Marsh's test. In making the former test, about half a pint of the water is placed in a tall glass and acidulated with hydrochloric acid. To this an aqueous solution of hydrogen sulphide is added, and if, upon looking downward through the column of water, a brownish or blackish coloration or precipitate is seen, either lead or copper may be present. The precipitate is collected and dissolved in hot, dilute nitric acid. To this a solution of potassium bichromate is added, and if a yellow precipitate is thrown down which is soluble in caustic potash the metallic contamination is lead. If the precipitate thrown down by the hydrogen sulphide is dissolved as above, and ammonia added, the appearance of a blue color will indicate the presence of copper. To detect zinc the sulphuretted-hydrogen precipitate is treated with caustic soda, again filtered, and sulphuretted hydrogen added to the filtering liquid. A white precipitate indicates the presence of zinc. The following summary is given of the inferences to be drawn from these tests by Parkes * :—

If chlorine be present in considerable quantity, it either comes from strata containing chloride of sodium or calcium, from impregnation of sea-water, or from admixture of liquid excreta of men and animals. In the first place, the water is often alkaline, from sodium carbonate; there is an absence, or nearly so, of oxidized organic matters, as indicated by nitric and nitrous acids and ammonia, and of organic matter; there is often much sulphuric acid. If it be from calcium chloride, there is a large precipitate, with ammonium oxalate, after boiling. If the chlorine be from impregnation with sea-water, it is often in very large quantity; there is much magnesia, and little evidence of oxidized products from organic matters. If from sewage, the chlorine is marked, and there is coincident evidence of nitric and nitrous acids and ammonia, and, if the contamination be recent, of oxidizable organic matters.

"Ammonia is almost always present in very small quantity; but if it be in large enough amount to be detected without distillation, it is suspicious. If nitrate, etc., be also present, it is likely to be from animal substances, excreta, etc. Nitrates and nitrites indicate previously existing organic matters, probably animal, but nitrates may also originate from vegetable matter, although this is probably less usual.

* Parkes's Hygiene, vol i, p. 79.

If nitrites largely exist, it is generally supposed that the contamination is recent; the coincidence of easily oxidized organic matters of ammonia and of chlorine, in some quantity, would be in favor of an animal origin. If a water give the test of nitric acid, but not of nitrous acid, and very little ammonia, either potassium, sodium, or calcium nitrate is present, derived from soil impregnated with animal substances at some anterior date. If nitrites are present at first, and after a few days disappear, this arises from continued oxidation into nitrates; if nitrates disappear, it seems probable this is caused by the action of bacteria or other low forms of life. Sometimes, in such a case, nitrites may be formed from the nitrates. Lime, in large quantity, indicates calcium carbonate, if boiling removes the lime; sulphate, or chloride, or nitrate, if boiling has little effect. Testing for calcium carbonate is important, in connection with purification with alum. Sulphuric acid, in large quantity, with little lime, indicates sulphate of sodium, and usually much chloride and carbonate of sodium are present, and in evaporation the water is alkaline. Large evidence of nitric acid, with little evidence of organic matter, indicates old contamination; if the organic matter be large, and especially if there be nitrous acid, as well as nitric, present, the impregnation is recent." Finally, the microscope will often give valuable assistance by examination of the sediment. De Chaumont divides waters into (1) pure water, (2) usable water, (3) suspicious water, and (4) impure water, with the following characters:—

Physical Characters.	*Microscopical Characters.*
1. Colorless, or bluish tint; transparent, sparkling, and well aërated; no sediment visible to the naked eye; no smell; taste palatable.	1. Mineral matter; vegetable forms with endochrome; large animal forms; no organic *débris.*
2. Colorless or slightly greenish tint; transparent, sparkling, and well aërated; no suspended matter, or else easily separated by coarse filtration or subsidence; no smell; taste palatable.	2. Same as No. 1.
3. Yellow or strong green color; turbid; suspended matter considerable; no smell, but any marked taste.	3. Vegetable and animal forms more or less pale and colorless; organic *débris;* fibres of clothing, or other evidences of house refuse.
4. Color yellow or brown; turbid, and not easily purified by coarse filtration; large amount of suspended matter; any marked smell or taste.	4. Bacteria of any kind; fungi; numerous vegetable and animal forms of low types; epithelia, or other animal structures; evidences of sewage; ova of parasites, etc.

The "hardness" of water is due to the presence of earthy carbonates, or sulphates, or both. The former constitutes "removable hardness," because by boiling the carbon dioxide is driven off. and the base (calcium or magnesium oxide) is precipitated upon the bottom and sides of the vessel. The presence of earthy sulphates causes "permanent hardness," and the sum of the two, if present in any given specimen of water examined, constitutes the "total hardness." The degree of hardness is determined by the soap-test. The drinking of hard water is not necessarily injurious, although, to persons unaccustomed to its use, it may cause looseness of the bowels, or even dysenteric discharges. It has also been credited with causing stone in the bladder and goitre, perhaps without sufficient proof. Hard water is wasteful of soap, and in cooking vegetables does not soften the more solid portions; in making tea and coffee there is a loss of active principle, so that larger quantities are required of these materials.

Physiological Effects.—The effects of drinking natural waters may be divided into two groups: (1) those due simply to an increased supply of water to the organism, (2) those which may be ascribed directly to the mineral or other ingredients which may be present. Keeping in mind the bulk of fluid which is swallowed during a "course" of mineral waters, it is evident that the effects of the water itself must be taken into consideration.

Water is necessary both for the digestion and the assimilation of food. In excessive quantity, it dilutes the digestive fluids and interferes with absorption. In the conversion of sugar, if there is an insufficient amount of water, no fermentation will take place; if there is a large excess, instead of vinous, acetous fermentation will take place. Drinking habitually an excess of water at meals often aggravates dyspepsia, and may produce flatulence, and what Chomel termed "indigestion of fluids." The drinking of a glass of water, on first rising in the morning, clears the stomach of mucus and has a laxative effect. Small quantities of warm water, half an hour before meals, increase appetite and digestion. A large quantity of fluid in the stomach favors vomiting, and, in cases where an emetic is given, swallowing a pint of warm water will greatly assist its action. The action of water in the intestines is similar to that in the stomach, and a too free indulgence in fluids often causes or keeps up a diarrhœa, as it increases the water, but not the solids, of the fæces. Water passes readily into the blood, especially after privation or hæmorrhage; in the latter case, the too rapid ingestion of water may have an injurious effect upon the red blood-corpuscles, causing their destruction by osmosis. The excess of water passes off by all channels of excretion, but it is principally noticed in the increase of the volume of urine. Not only is the water increased, but the excretion of urea, phosphoric and sulphuric acids, and chloride of sodium is augmented, the latter only temporarily, but the former permanently. From this it has been inferred that water leads to augmented disintegration of tissues containing nitrogen and sulphur. But, as pointed out by Ringer, "simultaneously with the rapid disintegration a corresponding increase of assimilation takes place in the same tissues, whence it happens that water, taken under certain precautions, may increase both construction and destruction of tissue, and so act as a true tonic, improving the vigor of body and mind. . . . The effects of water-drinking vary in different persons. The disintegration is greatest in weakly persons, on whom this process may produce almost a febrile state. Disintegration is greater in children than in adults, and greater, perhaps, in women than in men. A high temperature of the water, or of the external air, increases disintegration. Bodily exercise produces the same effect." (Parkes.)

It is a well-known fact that there are other restorative agencies at work at medicinal springs besides drinking the waters. The sanitary surroundings, fresh air, the tonic effects of change of air and scene, the physical and moral advantages of the regulated life, and systematized rest and exercise under medical direction all assist in producing the effects which follow a visit to the "Springs." This is especially seen on the continent of Europe at Carlsbad, Vichy, Homburg, Ems, Kissingen, Baden-Baden, and numerous other German and French health resorts.

The mineral constituents of medicinal waters enable us to identify and classify them. They are usually divided into the chalybeate, or ferruginous; the acidulous, or carbonated; the alkaline; the saline; the sulphuretted, or hepatic waters; chemically indifferent, and unclassified waters.

The **chalybeate waters** contain a small quantity of iron, which is in solution when fresh, but after bottling tends to precipitate in the form of oxide. They sometimes contain, also, a minute quantity of arsenious acid. They are divided into two classes: first, those which contain carbon dioxide, and where the iron is in the form of a carbonate; and, secondly, those in which the iron is in the form of a sulphate. In **anæmia, chlorosis, struma, incipient phthisis,** and other conditions of **debility** they are highly useful, but should be avoided by the plethoric and by those who are subject to headache after taking iron.

The **acidulous waters** contain free carbon dioxide, and are sparkling and agreeable, but frequently contain in solution carbonates of lime, soda, and magnesia. In rheumatism, lithæmia, and dyspepsia the acidulous waters are useful, especially when taken at the springs. These waters vary greatly in the proportion of their solid constituents, and thus different waters of this class also possess properties which would place them in some other group, with which they might be classed with propriety.

Alkaline waters contain, besides carbon dioxide, an excess of sodium carbonate and other alkaline substances, and also chlorides and sulphates. An example of this class is Vichy water. In the purest alkaline waters there are scarcely any solid ingredients except the carbonates of the alkalies. They are frequently met with as thermal as well as cold springs.

Where there is a marked excess of sulphates and carbonates of the alkaline earths, which are held in solution by an excess of carbonic acid, the water is known as a **calcareous,** or **earthy** water. Sulphate of lime is the particular salt present upon which the properties of these waters commonly depend, usually associated with lime carbonate. Such waters are "hard." (See page 251 for explanation.) The phosphate of lime is also sometimes found in calcareous waters, and is a valuable constituent.

These waters are useful in the treatment of constipation, sluggishness of digestion, and deficiency of secretion, their purgative effects leading them to be universally used. Those containing sulphate of magnesia and of soda are the best known, as Congress Spring, Saratoga; Cheltenham, and Friedrichshall. Wiesbaden and Baden-Baden contain chlorides; Homburg and Kissingen contain traces of iodine and of bromine; Carlsbad is an alkaline spring, and contains a small quantity of lithia; Vichy, Ems, Apollinaris, and Hunyadi Janos contain the alkaline carbonates.

Saline waters are solutions of halogen compounds of the alkalies, commonly distinguished by the presence of a large amount of sodium chloride. They also comprise solutions of calcium, potassium, lithium, and aluminium chlorides. Such water is "briny," and may contain traces of bromine or iodine in combination with the alkalies or alkaline earths.

Sulphuretted or **hepatic waters** are recognized by their odor of hydrogen sulphide, the gas being derived from the oxidation of iron pyrites in contact with water. The sulphides of sodium, calcium, magnesium, and potassium are sometimes present in these waters, singly or together, but always in very minute proportions. The hydrogen sulphide may vary from a mere trace to forty-two cubic centimetres in the litre. These waters are widely distributed, cold or thermal in various degrees. (A. N. Bell.) *

In the United States there are large numbers of medicinal springs, and within the last fifty years there has accumulated a fund of information upon this subject, which only needs to be systematized and published in order to enable our own resources to be appreciated by American physicians. In many cases patients are sent to the older health resorts in Europe who could be as well treated here and saved the discomforts

* "Mineral Springs of the United States." Journal of Balneology, May, 1892.

of ocean voyages. Much credit is due to Dr. A. N. Bell for disseminating valuable information in the journal of which he is the editor,—*The Sanitarian*,—and also for the valuable work, which he published some years ago in Wood's Library, on "Climatology and Mineral Waters of the United States." *

Dr. Bell classifies our native springs as follows :—

ALKALINE.
- Adams, California.
- Albury, Vermont.
- Alum, Virginia.
- Borax, California.
- Blount, Alabama.
- Berkshire, Vermont.
- Cañon City, Colorado.
- Carlisle, Colorado.
- Congress, California.
- Elgin, Vermont.
- Fry's Soda, California.
- Highland, California.
- Highgate, Vermont.
- Lower Soda, California.
- Milford, New Hampshire.
- Manitou, Colorado.
- Middletown, Vermont.
- Napa Soda, California.
- Newbury, Vermont.
- Perry, Illinois.
- Rocky Mountain, Colorado.
- Ravenden, Arkansas.
- South Park, Colorado.
- Summit Soda, California.
- Seltzer, California.
- Sheldon, Vermont.
- Vichy, California.
- Wilhoit Soda, California.

CALCIC.
- Bethesda, Wisconsin.
- Butterworth, Michigan.
- Birch-Dale, Vermont.
- Clarendon, Vermont.
- Eaton Rapids, Michigan.
- Gettysburg, Pennsylvania.
- Hubbardstown, Michigan.
- Silurian, Wisconsin.

CHALYBEATE.
- Abbeville, South Carolina.
- Bedford, Pennsylvania.
- Blassburg, Pennsylvania.
- Cooper's Well, Mississippi.
- Estill, Kentucky.
- Fayette, Pennsylvania.
- Gordon's, Georgia.
- Greencastle, Indiana.
- Kittrell's, North Carolina.
- Madison, Georgia.
- Manley, North Carolina.
- Milford, New Hampshire.
- Montvale, Tennessee.
- Owosso, Michigan.
- Rowlands, Georgia.
- Schooley's Mountain, New Jersey.
- Schuyler County, Illinois.
- Sparta, Wisconsin.
- Versailles, Indiana.

PURGATIVE SALINE.
- Blue Lick, Kentucky.
- Crab Orchard, Kentucky.
- Elgin, Vermont.
- Esculapian, Kentucky.
- Harrodsburg, Kentucky.
- Midland, Michigan.
- Pagosa, Colorado.

SALINE.
- Fruit-Port Well, Michigan.
- Grand Haven, Michigan.
- Louisville Artesian, Kentucky.
- Michigan Congress, Michigan.
- Mt. Clemens, Michigan.
- Ocean, Alabama.
- Salt, Virginia.
- Spring-Lake Well, Michigan.
- St. Louis, Missouri.

SULPHUROUS.
- Alpena, Michigan.
- Balston, New York.
- Bladon, Florida.
- Blue Lick, Kentucky.
- Carlisle, Pennsylvania.
- De Soto, Louisiana.
- Dremion, Kentucky.
- French Lick, Indiana.
- Glenn's, South Carolina.

* New York: Wm. Wood & Co., 1885.

SULPHUROUS.
- Highgate, Vermont.
- Indian, Georgia.
- Indian, Indiana.
- Lodi Artesian, Indiana.
- Manley, North Carolina.
- Minnequa, Pennsylvania.
- Montesano, Missouri.
- Olympian, Kentucky.
- Portea Springs, Colorado.
- Salt Sulphur, Virginia.
- Saratoga, New York.
- Sharon, New York.
- Sheldon, Vermont.
- Shocco, North Carolina.
- St. Helena White Sulphur, California.
- St. Louis, Michigan.
- Sweet, Missouri.
- Valhemosa, Alabama.
- West Baden, Indiana.
- White Sulphur, Louisiana.
- White Sulphur, Montana.
- White Sulphur, Virginia.

UNCLASSIFIED.
- Alum, Virginia.
- Birch-Dale, New Hampshire.
- Borax, California.
- Climax, Missouri.
- Eureka, Arkansas.
- Fairview, Texas.
- Greeneleone, Florida.
- Geysers, the American, Wyoming.
- Geyser Spa, California.
- Iodide and Bromide, Missouri.
- Piedmont, Texas.
- Stafford, Connecticut.
- Summit, Maine.
- Sheldon, Vermont.

THERMAL SPRINGS.
- Aqua Caliente, New Mexico.
- Arrow-Head, California.
- Buncombe County, North Carolina.
- Calistoga, California.
- Chalk Creek Hot, Colorado.
- Charleston Artesian, South Carolina.
- Des Cehutes Hot, Oregon.
- Harbines, California.
- Hot Springs, Arkansas.
- Idaho Hot, Colorado.
- Merriweather, Georgia.
- Middle Park Hòt, Colorado.
- Ojo Caliente, New Mexico.
- Paraiso, California.
- Passo Robles, California.
- Salt Lake, Utah.
- Seigler, California.
- Skagg's, California.
- Volcano, Nebraska.
- Warm and Hot, West Virginia.

Some of the above-mentioned springs have won a high reputation, and the water is transported in large quantities to different parts of the country. From what has been said previously, it is evident that the water-cure is largely assisted by the sanitary surroundings. Some value, however, must be accorded to the water, and this may undoubtedly be obtained from bottled, genuine waters, although the tonic and stimulant effects of change of air and scene will be missing.

CLIMATOTHERAPY AND CLIMATOLOGY.

Climatology, according to Dr. A. N. Bell, comprises "the sum of the influences exerted upon the atmosphere by temperature, humidity pressure, soil, proximity to the sea, lakes, rivers, plains, forests, mountains, light, ozone, electrical, and, doubtless, by some other conditions of which we have no knowledge" beyond observation of their effects. Climatotherapy studies the effects of climates and climatic conditions upon health. This brings us to the definition of climate by which we designate the characteristic and prevalent characters of a place as regards conditions of atmosphere, its temperature, moisture, purity or contamination, electrical tension and chemical constituents of the atmosphere. Climatic conditions are largely affected by the physical configuration of the earth's surface,—the presence or absence of mountains, forests, lakes, rivers, etc.,—and also by the latitude. In the summer months the sun passes north of the equator, until, at the summer solstice, it, at its zenith, is in the zodiacal sign of Cancer; at the winter solstice the sun is at its zenith in the sign of Capricorn. Two imaginary lines, drawn the one north and the other south of the equator, and parallel with it at a distance of 23° 28′ in each hemisphere, would include the torrid zone, which includes the **north** and **south tropical zones.** Other circles, drawn at a distance of 66° 32′ from the equator, or 23° 28′ from the pole, in each hemispere, mark the upper limits of the north and south **temperate zones.** The areas included between the polar circles and the poles are known as the **frigid zones.** Heat is a very important factor in climate. Maximum atmospheric temperatures are met with in the tropics, minimum in the frigid zones. The intermediate zones, which are the largest, present, also, the most favorable conditions for human existence and a great variety of climates, though, on the whole, temperate as compared with the polar or equatorial regions. Temperature is affected, also, by altitude. As we descend below the surface of the earth the temperature increases at the rate of 1° F. to every one hundred and twelve feet, and at less than two miles we have the temperature of boiling water, and at thirty miles it is estimated that, at the same ratio, "the heat is sufficiently intense to melt all the rocks and metals contained in the earth's crust and to account for the torrents of molten, fiery lava belched from the craters of raging volcanoes. It is to this internal heat of the earth that hot springs and the warm water of deep artesian wells are due." (Bell.) On the other hand, temperature declines as we ascend above sea-level at a rate of about 1 degree for every four hundred feet of altitude in the United States; so that high mountains stretch their tops into the regions of perpetual snow. At a certain elevation the moisture of the air congeals into snow, and this forms the "snow-line," which, for obvious reasons, is higher at the equator; but it is not uniform, even on the same parallel, owing to local influences. The angle at which the sun's rays impinge upon the surface is the great cause of the diversity of temperature and the succession of climates from the equator to the poles, and irregularities of the surface give rise to various differences of climate in the same latitudes. The number of hours of daily sunshine in a given locality is a feature of great importance in climate. The direction of the prevailing winds, the amount of movement of the air, and the presence of moisture, also affect the salubrity of a locality and contribute to give it its therapeutic value. Aqueous vapor in the atmosphere constitutes a moist stratum which retards the process of nocturnal cooling of the whole atmosphere and prevents excessive alternations of temperature between night and day. The atmosphere always contains some moisture at a temperature above 32° F. The temperature of the sun's rays is greater than in the shade at any elevation, and the difference, according to Dr. Chas. Denison, of Colorado, augments with elevation, there being "1 degree greater difference between the temperature in the sun and shade for each rise of two hundred and thirty-five feet" This is owing to the fact above indicated, that the atmosphere is more easily traversed by heat when the amount of moisture is small. At an altitude of four thousand feet and upward the increase of heat in the sun's rays relative to the temperature of the surrounding air becomes a marked feature, insomuch that, at an altitude of from six thousand to ten thousand feet above the level of the sea, the thermometer exposed to the rays of the sun usually registers about one-third higher than when in the shade.

As regards valleys and hills, Dr. Bell makes the original observation that it does not follow, because the hills are higher than the valley, that they are necessarily colder and the valley warmer. The hills enjoy more sunlight and less moisture. The cold air, by reason of its greater density, descends into the valley and the warm air rises to the top of the hills, except where there is sufficient wind to produce disturbance and intermixture of the higher and lower strata of air, when this exception to the general rule will not occur. This affords a useful hint about selecting a habitation. "The damp and chilly valleys, with their attendant ills, are more frequently chosen as building places than drier, warmer, and healthier hills." Winds are always produced by differences of temperature and of atmospheric pressure due to expansion of air under the influence of heat. The direction in which winds blow depends upon the distribution of heat upon the earth's surface and the daily rotation of the earth. Winds always flow from a region of higher pressure to a lower one.

When air contains all the aqueous vapor which it can take up it is said to be at the point of **saturation,** which is also the dew-point, because above this point the moisture is deposited upon surrounding objects, in the form of dew. The higher the temperature of the air, the more moisture it is capable of taking up, in a geometrical ratio with the increase of temperature. The quantity of water in a given volume of air is called the **absolute humidity.** The ratio between the actual absolute humidity and the point of saturation is the degree of dampness, or **relative humidity.**

The atmosphere of the ocean and sea-shore is often supercharged with moisture from the spray, which it carries even for several miles inland. Winds from the sea are likely to have a high relative humidity. Winds from the poles are cold; those from the equator are warm, as the rule, in each hemisphere. When the temperature of air is rapidly reduced, the absolute humidity may approach the point of saturation, and the excess of water be precipitated as rain or snow. When a warm wind from the sea meets the cool air of a mountain-range, the excess of water is precipitated in the form of rain, and the air has its relative humidity reduced. The result is that a mountain-range parallel with a sea-coast will have a humid atmosphere upon one side and a comparatively dry one upon the other side.

The pressure of the atmosphere at the sea-level is fifteen pounds to the square inch of surface, which is equivalent to a weight of thirty inches of mercury, as demonstrated by Torricelli. The total pressure upon the surface of a man's body of ordinary size is nearly fifteen tons. This enormous pressure is not felt, for the reason that the human organism is adapted to it by nature. As the pressure diminishes, at the rate of about one pound for each two thousand feet, one of the factors in the therapeutic effects of high altitudes is probably the alteration of pressure upon the bodily surface and the resulting physical changes in the circulating fluid and the tissues. In mountain-climbing there is experienced a feeling of exhilaration and a lightness which may be due, in part, to the diminished density of the air. At an elevation of from ten thousand to sixteen thousand feet, rapid breathing, dyspnœa, and increased action of the heart occur, with feelings of faintness upon slight exertion; and, if the ascent has been rapid, as in a balloon, blood may pour from the nose and mouth and other mucous orifices of the body. A removal from the level of the sea to an altitude of two or three thousand feet, in the summer time, which is undertaken for sanitary and physiological reasons by large numbers of the population, is more than simply changing from a polluted atmosphere to a pure one, more than exchanging a humid atmosphere for a dry one, or a hot for a cool one; it is throwing off from the surface of the body a certain proportion of the atmospheric pressure and breathing a somewhat rarefied air, which of itself causes greater inspiratory effort and quickens the circulation.

As pointed out by von Petenkofer, Bowditch, and others, the nature of the soil and the drainage and rise and fall of the ground-water have much to do with the healthfulness of a climate. Bodies of water give forth moisture; bodies of sand and dry soil absorb it from the air. Sand being a poor conductor of heat, the sun's rays do not penetrate deeply, and the heat is radiated at night, making the night cold and the days hot, which feature characterizes the desert climate. An alluvial soil (clay or loam) being a better conductor, and usually being covered with vegetation, absorbs heat during the day and does not readily part with it at night, partly on account of the layer of moisture to which attention has already been directed. In consequence of this fact, a certain effect is exerted upon climate; the temperature does not get so hot during the day and is less cold at night. Forests protect the earth's surface from the action of the sun; the temperature of the woods is, therefore, cooler than the surrounding atmosphere, and, owing to the interference with evaporation, there is more moisture. Owing to the fact, in vegetable physiology, of the decomposition of carbon dioxide by the green parts of growing plants, in order to appropriate the carbon, there is a constant evolution of oxygen in the woods. The agitation of the air by the green leaves, especially in the coniferæ, causes some of the oxygen to appear as ozone, the effects of which upon the human body have already been referred to. This agent, which has been called "nature's antiseptic," is, therefore, likely to be met with in the woods, and also upon the sea-shore, but only exceptionally, and to a slight extent, in large cities. The fact that a forest between a marsh and a city would protect the latter from paludal poison was known to the ancients. In recent times, the marshes around Rome have been redeemed and made habitable by the labors of the Trappists, who set out plantations of eucalyptus trees, which naturally absorb large amounts of moisture from the soil. Trees have a very decided effect, therefore, upon climate, not only by protecting the soil from the rays of the sun and favoring the healthfulness of a locality, but, as oxygen generators and ozone producers, as well as carbonic-acid destroyers, they play an important part in the preservation of animal life.

Water has an important function in climate. On account of its high specific heat, it abstracts heat from the surrounding air and cools it in summer, and in winter it yields up its store of heat slowly, by radiation, and thus modifies the rigors of climate at the sea-shore. The Gulf-stream makes northeastern Europe habitable, and the comparatively mild climate of our northwest coast is attributable to the warm current of the Japan stream, each of which flows like a great river in the ocean, mainly in a northeastern course. Marshes are caused by water spreading over a portion of ground, on account of the ground being level and porous. Such accumulations of water, with little or no current, and generally accompanied by decaying vegetation, have always been regarded as a fruitful source of ill health and malarial poisoning. As these manifestations usually appeared in the spring and fall of the year, they are sometimes known as vernal and autumnal fevers ; or, from the pathological conditions, they are styled congestive chills, intermittent or remittent fevers, chills and fever.

With regard to the atmospheric electricity and its effects upon climate, very little is known of its relations to health and disease. It is probable that atmospheric ozone may be due to electrical conditions, and that the purity and stimulating qualities of the atmosphere in some localities is due, indirectly at least, to electricity. The frequency of thunder-showers in the mountains undoubtedly contributes to the sanitary qualities of these highly-prized health resorts.

As to the physiological effects of climate upon human beings, very important facts have been established by investigations in the fields of anthropology, ethnology, and vertebrate paleontology. Man is affected by his environment, and the most important factors in the problem are food and climate. Reserving the former for discussion in the section on "Dietetics," we may here devote a few words to a few fundamental facts in physiology and in pathology. At the same time, it must be stated that they are in social relations very closely connected ; because a climate that is unfavorable for human life is also unfavorable for the life of domestic and other animals upon which man depends for subsistence, and is also unfavorable to agriculture, so that insufficient food and a severe climate act in concert to produce physical degradation. A very hot climate, on the other hand, while it favors vegetation, also favors the development of malaria and other miasmatic poisons, like yellow fever, which not only cause disease, but cause physical degeneration in races which do not become acclimated. The dark-skinned races of men are able to live in the tropics with apparent impunity, but the white races do not find the climate propitious, either with reference to individual health or the rearing of children. In a similar manner, certain families or tribes of men, having for many generations lived in one locality and accustomed to the climate (harmonized with the environment), may find great difficulty in becoming acclimated, should they remove into another region having a different character.

While it is difficult to define climate, and while the subject is a complex and difficult one, yet it is one of those scientific terms which have become parts of common speech, and are generally understood in their popular acceptation. Agreeing with the definition of Hann and Humboldt, we may accept climate as comprising the whole of the meteorological phenomena characterizing the state of the atmosphere at any place, particularly as they affect our organs, or have an influence on animal or vegetable life. The general character must be taken, not basing the conclusion upon the limited observation of a few days, or even years; but a period must be taken which is long enough to furnish the data for composing a type. Equal yearly averages do not signify identical climate. A place where the summer heat and winter cold are extreme has not the same climate as one where the range is relatively small, though the yearly average may be identical. Hence we need, says a recent writer,* separate determinations of summer and of winter averages. The combinations of conditions of temperature and moisture may be endless, whilst the averages of either may be hardly disturbed. These facts make it hard to compare climates, even when they are steady for long periods. In the capricious climates of our temperate latitudes, a just determination and comparison form a baffling task.

Local influences may change so as to bring about a modification of climate. This has been noticed after cutting down groves of trees, and especially after draining alluvial soil. A very good illustration is given by Dr. W. J. Hutchinson of the effects upon the climate of Southern California produced by the appearance of Salton Lake. It is claimed that this new-formed body of water has increased the humidity of the atmosphere and the rain-fall over a considerable area. The result has been a reduction of the high temperature which prevails in other parts of Southern California.

The effects of climate upon physical conformation is an inviting field of study. The Serranas, a native tribe of Peru, live in the high peaks of the Andes and are short in stature, but have a remarkably well-developed thorax and lungs, being about thirty-six inches around the chest, with a bodily height of seven and four-fifths inches less than the average height of Europeans.† The Esquimaux are a short, thick-set race, who apparently are so worsted in their struggle with adverse climatic conditions as to extinguish nearly every manifestation of intelligence except as regards the supply of physical wants and the protection from the weather. On the contrary, the hot weather of the tropics is enervating on account, largely, of its excessive humidity, and debility and anæmia are common results. In temperate zones, however, man attains his highest physical, intellectual, and moral elevation, and these regions furnish explorers, armies and navies, and the pioneers of commerce and civilization who discover and rule less favored races, and penetrate to the ends of the earth and make them tributary to science and the social requirements of the age in which we live. The more cultured races having acquired a knowledge of sanitation, and especially of the causes of infection, are able to apply this knowledge for the protection of health. The excessive mortality which formerly prevailed among

* Dr. W. H. Larrabee, Popular Science Monthly.

† Quoted by Dr. A. N. Bell from the Official Report of Medical Inspector B. F. Gibbes, U. S. N., on the Medical Topography of the Pacific Coast of South America.

the English troops in India and the West Indies was attributed by the late Dr. Parkes to the tolerance of unsanitary conditions rather than to the climate itself. Under improved methods of sanitation, especially as regards the purity of the water-supply and cleanliness of habitations, the mortality has been steadily decreasing " until, in some stations in the West Indies (as, for example, Trinidad and Barbadoes), the sickness and mortality among European soldiers are actually less than in home service. In India, a century ago, people spoke with horror of the terrible climate of Bombay and Calcutta; and yet, Europeans now live in health and comfort in both cities. In Algeria the French experience is to the same effect." Parkes also directs attention to the greater necessity of sanitary precautions in hot climates. " The temperature and the humidity of the air are highly favorable to decomposition of all kinds; the effluvia from an impure soil and the putrescent changes going on in it are greatly aggravated by heat. The effects of unsanitary evils—which, in a cold climate like Canada, are partly neutralized by the cold—are developed in the West Indies or in tropical India to the greatest degree. In this way a tropical climate is evidently most powerful, and it renders all sanitary precautions tenfold more necessary than in a temperate zone." Dr. Bell coincides with these views, and even in the case of pulmonary consumption, the prevalence of which in certain localities is usually held to afford a rough indication of the influence of climate, he regards it as " a disease which, probably more than any other, depends upon preventable conditions intimately associated with a foul soil or density of population."

The good effects of the most salubrious climates may be overcome and disease develop as the result of neglect of common sanitary duties and violation of physiological laws. The intelligent physician is able to point out the causes of ill health and enable the patient to avoid them. The philosophy of the modern exodus from the large cities to the country, sea-side, and mountains which takes place in the hot months of the year, may be easily understood from what has just been explained. It is the same in the climatic treatment of disease. If pulmonary tuberculosis be due to overcrowding and a polluted atmosphere, the remedy is obvious,—the patient should be taken to a place which is not crowded and where the air is pure, and he will be placed under the best conditions for his recovery.

Climatotherapy.—No satisfactory classification of climates can be made, and the distinctions made are often conventional and relative. Hot and cold climates, humid and dry climates, marine and inland climates convey certain general ideas to the mind. The climate of elevated plateaus and mountains and the climate of valleys and plains differ to a marked degree, owing to conditions which have been already considered.

The United States, in its wide area, offers a choice of every variety of climate. An ocean climate may be enjoyed at the sea-shore or on islands some distance from the coast. The mountain-ranges of the Appalachian system or of the Rocky Mountains contain numerous health resorts of well-earned reputation. The high table-lands of New Mexico and Arizona are remarkable for their salubrity, while the valleys of California between the Foot Hills and the coast-range of mountains afford spots of remarkable fertility, beauty, and health-giving powers. We have the cold climates of Maine and Minnesota, or the hot ones of the Eastern Atlantic Coast in the Southern States; and in Florida we have a new-world Riviéra upon the Gulf coast, especially around Tarpon Springs.

Change of climate is frequently beneficial in disease, owing to mental and moral conditions, or the psychological effects; on the other hand, it is an act of cruelty to deprive some semi-helpless invalids of the comforts that they are accustomed to enjoy and make them suffer the pangs of home-sickness, in addition to their physical weakness and disease. Moreover, in speaking, in a general way, of climate in the treatment of disease, it must be remembered that each locality possesses individual peculiarities, such as dryness or dampness of the soil. excess of sun or shade, direction of prevailing winds, the presence of forest-trees or bodies of water, as well as convenience of access and other circumstances not climatic (such as comfortable hotel accommodations, good milk and other food in abundance), which contribute very much toward the availability of any particular resort in any special case. It is of importance, therefore, that physicians should acquaint themselves fully regarding the advantages and disadvantages of health resorts that they recommend for their patients, and it is better to do this by personal inspection, wherever possible. Attention has already been called to the fact that the most salubrious localities may lose all their advantages by neglect of sanitary precautions; for we know that cases of typhoid fever and dysentery, and other forms of ill health, may arise from foul drains or an infected water-supply, even among the best surroundings. A good classification is that of Dr. Hermann Weber,* which, with some modifications, is as follows:—

* Von Ziemssen's Hand-book of General Therapeutics, vol. iv. English translation. New York: William Wood & Co., 1885. In connection with this subject, and for information of which want of space prevents proper discussion in this place, the reader is referred to the valuable treatise by Dr. A. N. Bell, of New York, on Climatology and Mineral Springs of the United States, and also to the more recent work of Dr. Bushrod W. James, entitled "American Resorts, with Notes upon their Climate." Philadelphia: The F. A. Davis Co., 1889.

A. Marine Climates.

I. *Marine Climates with High Degree of Humidity.*

(1) Warm and Moist Marine Climates :—
Illustrations: Madeira, Canary Islands, The Azores, Ceylon, Sandwich Islands, Bahamas, Bermudas, Virgin Islands, Cuba, Jamaica, Barbadoes, Florida, Georgia, South Carolina, Society Islands, Tahiti, Tonga, Fiji Islands, Tristan d'Acunha, St. Helena.

(2) Cool and Moist Marine Climates :—
Island of Bute, Rothesay, Hebrides, Orkney and Shetland Islands, Faroë Islands, Iceland, Bergen, Marstrand, Auckland Islands, Falkland Islands.

II. *Marine Climates with Medium Degree of Humidity.*

(1) Warm Marine Climates of Medium Humidity :—
Tangiers, Algiers, Cadiz, San Lucar, Gibraltar, Ajaccio, The Sanguinaires, Palermo, Riviera di Levante, Pegli, Venice, Balkan Peninsula, Corfu, Crimea, Lisbon, Vigo, Santander, Biarritz, New Zealand, Auckland, New Plymouth, Wellington, Nelson, Virginia Beach, Old Point Comfort.

(2) Cool Marine Climates of Medium Humidity :—
Coasts of England and Ireland, Newport, Isle of Shoals, Nantucket, Mount Desert, Fire Island.

(*a*) Winter Resorts :—
Queenstown, Isle of Wight, Florida, Lakewood, N. J.

(*b*) Summer Resorts :—
North Coast of Cornwall and Devonshire, Wales, Ireland, Brest, North Coast of France, Belgium, Holland, Germany, Tasmania.

III. *Marine Climates with Low Degree of Humidity.*

The Western Rivièra, Nice, Monte Carlo, Mentone, Naples, Capri, Ischia, Malta, The Balearic Islands, Smyrna, Athens, South Africa, Australia, New South Wales, Sydney, Victoria, Melbourne, The New Jersey Coast, Long Branch, Atlantic City, Cape May.

B. Inland Climates.

(1) Climates of High Altitudes, or Mountain Climates :—
Davos-Platz, Davos-Dörfli, Davos-Frauenkirch Wiesen, St. Moritz, European Alpine Resorts, German Mountain Resorts, Northern Italy, Apennines and Maritime Alps, Peruvian Andes, Rocky Mountains, Colorado Springs, Denver, St. Paul, Asheville, South Africa, India, Mexico, Catskills, Alleghenies, Cresson, Green Mountains, White Mountains, Glen Summit, Pocono, Kane, Schooley's Mountain, etc.

(2) Climates of Low Levels :—
Dry and Warm Climates : Africa, New Mexico, California.
Dry and Cold Climates : Minnesota, Canada.
Moderately Moist Climates : Rome, Pisa, Pau, New England States, Saratoga, etc.

Choice of Climate for the Treatment or Prevention of Disease.

In determining the correct solution of the question as to the climatic treatment in any given disease, the physician has to solve a complex problem, into which enter the psychical condition of the patient ; his financial ability, his capacity to endure the discomforts of travel, and his personal preferences and habits of life, as well as the nature of his disease and the advantages and physiological effects of the proposed place of residence. Patients with seriously damaged lungs, kidneys, or hearts should not be sent to high altitudes; or, if they insist upon making the experiment, they must be allowed to make the change gradually, by resting for several weeks or months at intermediate points. Patients whose vitality is exhausted, and who are evidently doomed to early dissolution, should not be allowed to go to distant health resorts, deprived of the comforts of home, and only to die among strangers. A very sick patient does not enjoy scenery or the incidents of travel, and often actually suffers more from home-sickness than from his disease. Phthisical cases in the second or third stage should, as the rule, be kept from a moist climate, whether cool or warm, as the progress of the disease is generally hastened.

Summer residence in the country is a prudent, sanitary, and prophylactic measure, by rare coincidence having for its support both fashion and medical teaching. Its effects are most demonstrably evident in the younger members of the family. In some instances, where health is impaired or notably affected by residence in the city, a permanent change of place of living should be advised, if practicable. Pure air, pure water, wholesome food, and a regulated life are the conditions of health and longevity, and, therefore, are factors in the therapeutic problem. A patient cannot live on climate alone, although, in popular discussions of the subject, this is dwelt upon as if it were the only thing to be considered. With this in mind, we will proceed to outline the climatic treatment of some principal diseases:—

Acute diseases, as the rule, should be treated at home, or in the immediate vicinity.

Anæmia and Chlorosis.—Such cases are benefited by life in the open air, where there is abundance of sunshine and the temperature does not forbid physical exercise. The sea-coast, early in the summer, followed by a stay at the mountains later, is advisable, together with outdoor amusements and bicycle or horse-back exercise. If much debilitated, a preliminary visit to a good hydropathic institution would be of great value in building up the nervous system and increasing hæmatosis. Weber recommends places where the whole day may be spent in the open air without demands being made on the bodily strength. Long sea-voyages are often curative.

Asthma.—Where there is no heart complication and no emphysema, these patients do well at mountain stations, or on inland plateaus. Where there is much bronchial complication, a dry climate should be preferred; where the secretion is scanty, the patient may improve more rapidly among the pine-woods, near the coast. We cannot predict, in any given case of asthma, whether it will be benefited by a marine climate or not; but, as a general rule, especially if there is emphysema present, these cases do better at a moderate elevation inland. Mountain-climbing is useful as a form of respiratory gymnastics, especially in catarrhal complications.

Children and nervous subjects are usually benefited by the sea-shore. Hay-fever patients seek a pure atmosphere, free from dust and pollen. They may find relief either in mountain resorts (Bethlehem, White Mountains, Kane, etc.) or on islands (such as Nantucket).

Bronchial Catarrh.—Chronic bronchial catarrh, with merely increase of secretion and a moderate amount of cough, may be benefited by either a marine atmosphere or by mountain or inland climate. The change of residence of itself is of service, even where there is not much difference in climate, altitude, or temperature. In the declining stage of whooping-cough, systematic exercise in the open air is an important part of the treatment; and, as a general rule, in chronic cough, unattended by much pathological change, the best results are obtained from pedestrianism, especially in mountain regions, such as the Catskills.

Blood Disorders.—In morbid conditions of the blood the climatic treatment is a useful adjunct to the ordinary treatment by alteratives, tonics, and chalybeates. Careful regulation of the diet and hygienic management are also required in all cases. Residence at the sea-shore exercises a powerful alterative effect, and, owing to the presence of ozone, it is a decided stimulant to tissue construction. As anæmia and chlorosis may result from a warm, humid climate, a change to a moderately cool, bracing atmosphere is attended by improvement. A moderate amount of cold, even, will do no harm if the clothing and living-rooms be properly adapted to the temperature; the cold will improve the appetite and favor out-door exercise. In cases attended by profuse menstruation sea-climates are often injurious, and in early pregnancy abortion may occur at the sea-shore.

Climacteric disturbances of health are greatly influenced by climatic conditions. Not only at the change of life in women,—at the cessation of menstruation,—but also at puberty do we meet with evidences of disorder, particularly of the nervous system, but the circulation and organs of digestion and assimilation are also affected. There may be delayed development or insufficient evolution of the sexual system and deterioration of the general health. In such cases change of climate, the excitement of change of scene, and pleasure of voyaging are useful adjuncts to the means employed to bring about the normal state. **Premature senility,** either of organs or of the general system, is sometimes mistaken for ordinary disease, and uselessly treated by medicines.

Lowering of general activity, easily-produced fatigue, liability to catarrhal attacks, with impaired digestion, are the prominent symptoms of this condition. By a resort to warm, sunny, and dry climates during the winter season and a moderately elevated mountain climate in the summer many of these complaints are overcome or avoided, and in this way life may be prolonged and senile decay deferred.

Consumption.—The climatic treatment of pulmonary phthisis, or consumption, has been the subject of study from the earliest times, and an abundant literature has accumulated upon it, including such valuable recent works as that of J. A. Lindsay or C. T. Williams. It has also received favorable consideration in the writings of Jaccoud, Austin Flint, Charles Denison, Trudeau, and other authorities. No climate can be regarded as possessing a specific effect in arresting phthisis, although some exert a much more favorable influence than others in bringing this about. According to Flint, "Dryness, equability, and purity of the atmosphere are essential elements of a favorable climate," and he further declares that "there is reason to believe that the benefit derived from climatic treatment is often, in a great measure, due to accessory circumstances."*

In his address read recently before the Berlin International Medical Congress, Dr. Weber considered the influence of climatic, local, and social conditions on the occurrence and course of pulmonary tuberculosis. As already stated, no climate is entirely exempt from phthisis. He agrees with Hirsch that, if we consider the distribution of phthisis over the world, we must come to the conclusion that the climatic conditions alone, apart from other conditions, especially the social ones, will not afford a sufficient explanation of that distribution. It is necessary to consider the temperature, condition of the soil (dryness or dampness), the elevation above the sea-level, race, effect of colonization, social circumstances, and the industrial pursuits. Phthisis progresses more rapidly in the tropics than in the temperate zones, and he considers that the bacilli are favored in their development by heat and moisture, and also that their products are more toxic under such conditions.

Hygienic regulations are more apt to be obeyed at a health resort than at home. There is also a freedom from the cares of business or the household, combined with association with new acquaintances, affording diversion and mental relaxation, which act as nerve-tonics. Very often patients can eat more food when away from home than when at their own table. All these accessory agencies are of value, and contribute to the undoubtedly beneficial effects of change of scene. Cold and damp locations are to be avoided, especially if the patient is thereby compelled to remain in his room. The great object is to select a climate favorable

* Pepper's System of Medicine, vol. iii, p. 429.

to living in the open air the greater part of the time. In New Mexico it is possible to remain day and night in the air, on account of the dryness of the atmosphere. Distance and convenience of access must be taken into consideration, so that, if the patient becomes home-sick or desires to be taken home, it will not be impossible to bring him back without unduly taxing his strength. If the patient be very feeble, it will not be advisable to disturb him with a journey, unless it be merely to the suburbs of the city during hot weather. On the other hand, if the case be in its incipiency and the patient young and his health not much impaired, it may be better for him to emigrate, and remain permanently in some climate that will agree with him. Dr. Flint suggested that, if the patient bear hot weather well and is worse in cold weather, he should go South, at least during the winter; on the contrary, if he is always better in cold weather, he would do wisely in going to a northern resort, such as Denver, Colorado Springs, St. Paul, etc. Some cases have done very well at Newport, but during the summer a stay in the woods is to be preferred to the sea-shore, for reasons already indicated. The Adirondacks have attained a world-wide reputation for the cure of pulmonary diseases, and the pines of Lakewood, New Jersey, and Asheville, North Carolina, are also famous health stations for the cure of consumption.

Exhaustion from Overwork and So-Called Neurasthenia.—These are conditions in a sense allied to hypochondriasis and hysteria, and, with these, are benefited by combined balneo-therapeutic and climatic methods of treatment.

Indigestion and Dyspepsia are closely related to the foregoing, being largely functional, and are greatly benefited by change of climate.

Insomnia is relieved by change of residence, either to the mountains or the sea-shore. In nervous erethism, where patients are easily excited, it is of importance to learn the character of the hotel to which they are sent, inasmuch as their comfort and health depend principally upon freedom from noise and excitement. If music and dancing until after midnight is the rule of the house, their sleep may be more broken than at home. A suitable environment is of as much importance as a proper climate.

Lesions of the Nervous System.—According to Weber, nervous disorders should more often be subjected to treatment by climate than is customary.

Leukæmia is apparently benefited by long cruises in yachts, and Weber advises, in addition, prolonged stay in Egypt or Algiers. In advanced cases little can be expected beyond extending the duration of life. In **malarial toxæmia** mountain regions are curative; damp situations are to be avoided on land, but sea-voyages are useful.

DIET IN DISEASE.

The principles of dietetics, and likewise the physiology of nutrition, apply equally in disease and in health, the only difference being that the power of digestion and assimilation with the secreting and excreting functions are more or less impaired; the food must, therefore, be of a character suitable for assimilation, of nourishing quality, and administered in quantities, and at such intervals, as appear best suited for the case. The aid which properly selected food can render in the treatment of disease is now generally acknowledged. If, as Abernethy is reported as saying, it be a fact that the cause and cure of most diseases is at the table, the importance in therapeutics of food is no less than drugs. Oliver Wendell Holmes, nearly thirty years ago, in his essay on the "Border Lines of Knowledge in Some Provinces of Medical Science," declared his high appreciation of this subject as follows: "I cannot help believing that medical curative treatment will, by and by, resolve itself in great measure into modifications of the food swallowed and breathed, and of the natural stimuli, and that less will be expected from specific and noxious disturbing agents, either alien or assimilable." Dr. Austin Flint, in his posthumous address on the "Medicine of the Future," prepared for the meeting of the British Medical Association in 1886, expressed a similar idea,—"It is a pleasant thought that hereafter the practice of medicine may not be so closely interwoven as hitherto in the popular mind with the use of drugs. The time may come when the visits of the physician will not, as a matter of course, involve the co-operation of the pharmacist; when medical prescriptions will be divested of all mystery, and have no force in the way of fortifying the confidence of the patient. The medical profession will have reached an ideal position when the physician, guided by his knowledge of diagnosis, the natural history of diseases, and existing therapeutic resources, may, with neither self-distrust nor the distrust of others, treat an acute disease by hygienic measures without potent medication. When this time comes a system of practice which assumes to substitute medicinal dynamics for the *vis medicatrix naturæ* will have been added to the list of by-gone medical delusions."*

The influences of climate, custom, and nationality upon diet and the reciprocal relations of diet upon customs and ethnic traits are of the highest importance in the study of demography. Dr. Gihon (*loc. cit.*) says that "the food of a people largely determines its national char-

* This and the preceding quotation from Holmes is taken from the admirable address of Medical Director A. L. Gihon, U. S. N., President of the Section on Medical Climatology and Demography. Transactions of the Ninth International Medical Congress, held at Washington, 1887, vol. v.

acteristics, but climate determines the food." He supplies the following apposite illustration: "The Chinese of the northern provinces live on millet and wheat and vegetables, because these thrive best in the dry and dusty soil and severe winter; while the moist, hot climate of Southern China produces rice, which, with fish, is the staple aliment of many millions of people. The lack of variety harmonizes with the conservatism of the race, and has contributed to that spirit of contentment and domesticity which, as in Japan, are elements of rare happiness not enjoyed by nations boasting a higher civilization." The relation of this to the subject under consideration is twofold. First, in selecting a dietary for a sick person, it is important to learn what kind of food his stomach is accustomed to, as, other things being equal, it will also be the kind that he can most readily assimilate. Secondly, many diseases are traceable to the food being insufficient in quantity, or deficient in quality, or improperly combined. Thus, insufficient nourishment produces anæmia (anhæmatosis), emaciation, debility (neurasthenia), myalgia, neuralgia, and probably rachitis, scrofula, and is an active predisposing cause for phthisis. Food of inferior quality causes such wide-spread disorders as pellagra, beriberi, or kakki, and ergotism. Improperly assorted food causes Bright's disease of the kidneys, scorbutus, many of the disorders of infancy, gout, rheumatism, and possibly cancer (?). Other disorders due to infected food, such as trichiniasis, hydatid disease, intestinal parasites, and infectious disorders, cholera, typhoid fever, dysentery, etc., need only be mentioned here in order to put us on our guard, so that the dietary for the sick may be quite innocent and free from such disturbing elements. Dr. Gihon insists upon the relationship between food and climate, and points out the fact that the climate of India and Equatorial Africa is deadly to those Europeans who keep up the style of eating and drinking that they follow at home; whereas, others who suit their dietary to the climate, find themselves not injured by it.

While physicians are rarely consulted with regard to the selection of food in health, men being guided by the cravings of their appetite and the force of custom in eating, yet a recognition of the existence of this factor in any case of disease will naturally lead to such regulation of the diet as is most favorable for restoring and maintaining health. This truth was properly appreciated by the ancients, who made some applications of it, guided by experience alone. It is a fact, as stated by Prof. J. Bauer, that "the scientific basis of a system of rational dietetics could not be laid until the first principles at least of the processes of digestion and metabolism in the human body, under normal and under pathological conditions, were known." Acquaintance with the chemical composition of foods and proximate principles and knowledge of the part played by each in the organism were necessary before we could properly solve the relation of dietetics to diseased conditions and make the proper selection of viands for the sick. Two difficulties are met at the start,—the kind of food that science would indicate, as the most appropriate might be repugnant to the patient, who would refuse to take it, or, having taken it, such food might not be capable of being digested and assimilated as well as other articles which are less desirable, but more digestible; secondly, the condition of the digestive organs is such that their ability to eat ordinarily articles of food is suspended. In many diseased conditions the waste of the tissues is increased, while the power of the organism to assimilate food is diminished; so that it is difficult, if not impossible, to introduce nourishment in sufficient quantity to make up for the loss. This is especially manifest in acute febrile processes, which are usually accompanied by more or less involvement of the organs of digestion. If the power of digestion is suspended for the time, it is necessary to withhold food until it is, in part at least, restored; otherwise the food would remain undigested in the alimentary canal, and, becoming the subject of fermentative or putrefactive change, it would give rise to additional irritation. Where it is not entirely abolished, we may aid in keeping up the patient's strength by small quantities of bland, easily-digested foods until he is in a position to take more substantial foods. If emaciation is progressing and the patient losing strength, the administration of highly nourishing foods is imperative; if they cannot be retained or digested by the stomach, they may be administered by enema or by hypodermic injection. In extreme emergencies we may even inject milk into the blood, or hypodermically, or blood may be injected into the peritoneal cavity. Baths of milk have been proposed, but, as stated in a previous section, they have no nutritive value. Fatty nutritious substances, like lard, olive-oil, butter, codliver-oil, etc., may be introduced by inunction with great benefit, combined with friction or massage to assist in their absorption.

On the other hand, in plethoric, well-nourished individuals, where the process of denutrition is not going on very rapidly, entire abstinence from food for a brief period will do no harm. After surgical operations it is sometimes advisable to allow the patient to go without food for several hours before the operation is performed, and for several days afterward, allowing nothing but water in teaspoonful doses.

The so-called hunger-cures, in which fasting is followed as a therapeutic measure, are not popular at the present day; but they have, undoubtedly, much to commend them in cases of plethora and so-called subacute rheumatism. In cases of acute pneumonia, food should be of the lightest character, as the rule, and in most acute diseases, where the patient is not asthenic, the diet should consist principally of what are called accessory foods and light broths until convalescence is established, when a more varied *menu* may be permitted. It is evident that many circumstances require to be considered and duly estimated in laying down a dietary for a patient. The extremes of life bear abstinence poorly, as the rule, and success in treatment will often depend upon the maintenance of supplies of food; on the contrary, well-nourished adults may live for a considerable time with the minimum of nourishment. Less food is needed, as the rule, in summer than in winter. At the present day there is a tendency to overfeeding, both among the sick and the well; and where disorders are due to excess of certain forms of nourishment, as particularly insisted upon by T. Lauder Brunton and Milner Fothergill, diminution of food and careful regulation of diet is of more consequence than drugs.

Some of the phases of the question of alimentation have been more fully considered by the author elsewhere * than is possible here. It will be only possible to present here a brief outline of the paper referred to. The fluids and solids which enter into the composition of the human body are constantly the subject of change under the influence of cell-life, and after serving their purpose are excreted from the body. This necessitates renewal by process of nutrition, and such substances are introduced mainly by the food and drink. Chemically, the proximate principles of the food are inorganic (or mineral) and organic, the latter being divided into those not containing nitrogen and those containing nitrogen. Non-nitrogenous substances are again subdivided into hydrocarbons and carbohydrates. Carbohydrates (starch and sugar) contain hydrogen and oxygen in the proportion to form water. Hydrocarbons (oils and fats) are compounds of hydrogen and carbon, combined with a small proportion of oxygen. In addition to these three principal varieties of organic substances, we consume organic acids, present in vegetables and fruits, and pectin, which occupy a humbler position in regard to nutrition, but which assist in maintaining animal heat. Nitrogenized organic substances find their type in albumen, and, on account of their importance, they are often called "proteids." Albuminoids are characterized by the presence of carbon, hydrogen, oxygen, and nitrogen, with other elements variously combined. They occur both in the animal and vegetable kingdoms. The problem of digestion is, to render albumen, sugar, starches, fat, and other food-ingredients, soluble in the gastric and intestinal fluids. Albumen is rendered soluble by being converted into peptones through the activity of the gastric juice, and, in the small intestine, by the alkaline pancreatic fluid. Starch becomes maltose and glucose;

* "Food and Diet in Health and Disease." Medical Bulletin, January, 1892.

this is partly accomplished by the saliva and partly by the pancreatic and intestinal juices. The bile favors the absorption of fat by emulsifying it, and, by its action upon the villi and its antiseptic qualities, preventing the fat from being converted into fatty acids. The pancreatic secretion also acts upon the fatty articles, emulsifying them and favoring their absorption. The portal blood and liver transform peptones into serum-albumen, and change the glucose derived from starch back again into an insoluble form called glycogen, in which shape it is stored up in the cells of the liver, to be given out in small quantities as it is needed to supply energy to the tissues. Fat is absorbed and gradually assimilated by the lacteal vessels and general circulation.

This review of the physiology of food is a necessary introduction to the consideration of its proper administration in health and disease. As the present discussion is limited to the latter, we will omit discussion as to the relative quantity of each form of food, only stipulating that each shall be represented in a full dietary. In this country there is, without doubt, too great consumption of nitrogenized food, which leads to diseases of the kidneys and liver, with many obscure symptoms that find their place under the heading of lithæmia or uræmia. These are often removed by restricting nitrogenous food or removing entirely meat from the diet.

Habits of eating affect the results. Some forms of indigestion or dyspepsia are clearly traceable to insufficient mastication of the food. The therapeutic teaching here is not to change the diet, but to tell the patient to eat more deliberately and chew his food thoroughly. Good food may be spoiled by poor cooking, and the digestibility of food is very much affected by the manner of preparation. The frying-pan is such a frequent cause of indigestion that it has been almost banished from well-managed households.

Different aliments vary as to their digestibility. This depends upon their nature, mode of preparation, age, time of year, mode of life, among animals, and affects their value as foods. The flesh of young animals, though soft and tender, is too albuminous and is less digestible than the older members of the same species,—veal and lamb being less digestible than beef or mutton. If, on the other hand, the animal is too old, its flesh is apt to be tough, unpalatable, and indigestible, but makes better broth than the very young animal. Eggs and milk are much used in the sick-room, on account of their nutritious qualities and ease of assimilation. Among starchy foods bread is at the head of the list; it is, when well made, very acceptable and usually readily digested. If a little stale, or slightly toasted, it becomes more acceptable to invalids or convalescents. Rice is also a useful carbohydrate, and with it may be named farina, tapioca, sago, corn-starch, from which many articles of food for the sick are made. Peas and beans are less digestible on account of their thick, testaceous envelope and the presence of albumen in the form of vegetable casein or legumen. Potatoes, when baked, are very acceptable to convalescents, but other vegetables are liable to cause indigestion, from the amount of cellulose which they contain. Tea, coffee, and cocoa are valuable arterial stimulants, and, with milk and sugar, are nutritive. Chocolate contains about 20 per cent. of albumen and 50 per cent. of fat, with an alkaloid (theobromine) allied to caffeine. Its large proportion of fat will often render it unsuitable for weak stomachs. The question of the administration of alcohol is considered in another place (see Part III). Lighter wines or malt liquors have some nutritive value, and, when used in moderation, are useful, especially among elderly people.

As regards the interval between the administration of articles of food, this should be prescribed as carefully as in taking medicine. Where the amount given at a time is small, the interval must be correspondingly short, having in mind the total amount of nourishment to be taken in the twenty-four hours. The night is long for a sick person, and directions for the administration of some light nourishment should be given. Sometimes insomnia is relieved by taking food at night. In dyspepsia and chronic indigestion, the question of diet is difficult to solve. Many of these cases have gastric catarrh, which requires to be relieved before digestion can be improved. The microbes of fermentation and putrefaction, which cause flatulence, pyrosis, and various nervous disorders,* are present, and interfere with the normal digestion of foods. It sometimes is advisable to place such patients upon a restricted milk diet, giving a tablespoonful of sterilized milk every hour or hour and a half, increasing it, day by day, until six ounces or more are taken every ninety minutes, at which it may be continued for a specified time,—a month or six weeks,—when articles of food, properly selected, may be added cautiously to the dietary. Where there is marked hepatic disorder, accompanied by oxalic-acid or uric-acid deposits in the urine, headache, pains about the body, and lowness of spirits, it will be advisable to limit the albuminous food or forbid meat altogether for a time. In very severe cases of indigestion, especially in young infants, it will be advisable to administer only predigested food for a time.

In weak and impaired action of the digestive organs, articles which readily ferment or turn acid should not be used; sugar, honey, starch or

*T. Lauder Brunton: "On Poisons Formed from Food and their Relation to Biliousness and Diarrhœa." The Practitioner, August, September, and October, 1885. Also, "On Disorders of Digestion, their Consequences and Treatment." London, 1886.

starchy substances, and fat should be avoided as much as possible. Bread should be stale or toasted. Fish, fowl, pork, veal, chocolate, strong coffee or tea, or an excess of water or of other liquids, should be interdicted. Wines and liquors should be sparingly used, if at all. In the weakened digestion of elderly people, articles of food which are easily assimilated should be selected, while indigestible food should be interdicted. Diminished appetite and secretion demand the most nutritious diet. Soft but concentrated food, broths containing malt extract, milk food, or some of the better forms ot baby-food, are used with great advantage. The sedentary life led by such patients does not require much food, and little, if any, meat. A little wine or malt liquor will assist digestion, if it is otherwise suitable.

The question of infant-feeding is too large to go into here. The chief evils of bottle-feeding are (1) overfeeding, (2) too frequent feeding, (3) impure milk, (4) dirty bottles or nipples, and (5) want of uniformity in composition, quality, and temperature of the bottle. That food is best for the child upon which it best thrives and grows, presenting the appearance and physical characters of a healthy infant.

Anæmia and chlorosis require a highly nitrogenized diet, making the change gradually, as the stomach may be intolerant. Oysters, sweet-bread, underdone beef, with dish-gravy on potatoes or rice, with a glass of wine or extract of malt, are decidedly beneficial. Kumyss answers well, being both nutrient and mildly stimulant.

In neuralgia the nutrition is often below par, and in patients subject to neuralgia a generous dietary of easily assimilated blood-making food, with a glass of Hungarian or Egg Harbor red-wine at meals, and the free use of butter, cream, and other fats will often exert a decided effect.

Diabetes in the mild form is easily controlled by limiting sugar or starchy foods, and leading an out-door life. Saccharine diabetes is sometimes intermittent, and its causes are not well understood; possibly it may result from several causes, some of which are slight and inconstant, others are grave. In the more serious form of diabetes mellitus, the withdrawal of starch and sugar from the dietary has very little effect upon the excretion of sugar, which evidently comes from the tissues, since emaciation rapidly continues. In either form, however, the diet is of great importance. There is a difference of opinion as to whether sugar and starch are to be actually prohibited or only reduced to a minimum quantity. Da Costa allows some wheat-bread, in order to retain the co-operation of the patient, who may rebel against a too restricted diet. Coffee or tea may be sweetened with glycerin or with saccharin. Gluten-bread for diabetics usually contains starch. A bread made from almond-flour has been recommended.

Digestive disorders in children are subject to dietetic treatment. Dr. G. Rheiner* warns against beginning the treatment with drugs; the dietetic treatment will remain the most simple as well as by far the most rational. A child that has gastric disorder soon after being weaned should be returned to the breast, as the best remedy, and a further trial made later. In bottle-fed babies, gastric disturbances are greatly relieved by washing the stomach, as introduced by Epstein, of Prague. After this procedure the stomach should be allowed to rest for a few hours, and some albuminized water, or barley-water, may be temporarily used. In intestinal dyspepsia, the diet should be looked after carefully before resorting to anti-diarrhœal mixtures. An exclusive diet of sterilized milk, or of barley-gruel with a suitable proportion of water, will usually bring the patient around all right. In constipation, oatmeal-gruel, thoroughly cooked, will, as a rule, produce one or two loose evacuations a day. Thus, by attention to diet, in many cases, we can get along without drugs, but where fermentation exists salicylate of bismuth and other antiseptics may be used with advantage.

In marasmus, unless the child be suffering with tuberculosis or malignant disease of the retro-peritoneal lymphatics, the best results can be anticipated from an abundance of good food suited to the powers of digestion and assimilation, fresh air, proper clothing, massage, and sleep.

Rickets has been shown by Cheadle to be due to improper feeding. The treatment is primarily and chiefly dietetic. Drugs are of minor import, though lime and lime-salts, warm clothing, fresh air and sunlight, with proper diet, may do good service. Fatty articles of food are useful, and the diet should also be rich in starches and earthy phosphates in a form easy of assimilation.

Obesity is a condition in which the system has accumulated a large proportion of surplus nutritive material in the form of adipose tissue. The remedy is abstinence and abstemiousness. The bear retires for his winter's nap in a comfortable condition of obesity, but after four or five months have passed without eating he emerges from his hollow tree a model of leanness. Dieting is recommended for obesity, but it should not consist in living solely on meat, as has been recently advised, nor in a dry diet with abstinence from water and other fluids as much as possible. Such measures will reduce weight, but they will be likely to cause serious disorder of the kidneys. It is better to simplify the diet, take systematic exercise, and reduce the hours of sleep, taking laxatives occasionally to stimulate the excretory organs. The free perspiration caused by active walking is better than that induced by the Turkish bath,

* Journal Am. Med. Assoc., from Therap. Monatshefte

which should be indulged in with moderation. The use of vinegar and other acids is said to reduce the surplus flesh, but this should not be followed to any great extent, for fear of bringing on digestive disorders or rheumatism. Mountain-climbing is the best form of exercise, but this should not be carried to the point of fatigue, until the muscles become firmer and more accustomed to out-door pursuits. Changes in the diet, like the increase of exercise, should be made with caution. If the individual is a hearty eater he should be directed to curb his appetite and gradually diminish his repasts. Articles containing much fat, starch, or sugar must be very temperately consumed. Fat meats, cream, butter, vegetable oils, nuts, fat fish, farinaceous substances, fruits containing much sugar, beverages such as beer, ale, and sweet wines, should be gradually discontinued. If milk be used at all it should be skimmed; butter-milk may be used, if fresh. No chocolate should be taken, and tea or coffee used without sugar, or sweetened with saccharin. The diet should principally consist of lean meat, poultry, game, eggs, green vegetables, and acid fruits. Not much bread should be eaten; gluten biscuits may be used as a substitute. The dietary which Mr. Banting followed in reducing his flesh from two hundred and two to one hundred and fifty-six pounds, in about a year's time, is as follows:—

Breakfast, at 9 A.M. Five or six ounces of either beef, mutton, kidneys, broiled fish, bacon, or cold meat of any kind, except pork or veal; a large cup of tea or coffee (without milk or sugar), a little biscuit or one ounce of dry toast,—making together six ounces of solids and nine of liquids.

Dinner, at 2 P.M. Five or six ounces of any fish except salmon, herring, or eels; any meat except pork or veal; any vegetable except potato, parsnip, beet-root, turnip, or carrot; one ounce of dry toast; fruit out of a pudding not sweetened; any kind of poultry or game, and two or three glasses of good claret, sherry, or Madeira,—champagne, port, and beer forbidden,—making together ten to twelve ounces of solids and ten of liquids.

Tea, at 6 P.M. Two or three ounces of cooked fruit, a rusk or two, and a cup of tea without milk or sugar,—making two to four ounces of solids and nine of liquids.

Supper, at 9 P.M. Three or four ounces of meat or fish, similar to dinner, with a glass or two of claret or sherry and water,—making four ounces of solids and seven of liquids.

In leanness, emaciation, and marasmus, the reverse course is to be followed to that recommended in obesity. Frequent eating of easily assimilated fatty and starchy foods, sweet-meats, an indolent life, warm baths, and several naps a day will be apt to develop the form, especially if the mind be cheerful in accordance with the old maxim, "Laugh and grow fat."

In the management of phthisis pulmonalis, or consumption, next to the climatic treatment, we would place the dietetic regulations. According to Professor Peter, cases of consumption frequently have their origin in disordered digestion, which lowers the vitality to such a degree as to make the organism susceptible to the disease, or, in modern terms, they are made to afford a proper culture-soil for the bacillus tuberculosis. Some relation evidently exists between insufficient food and consumption, and one of the evidences of recovery is the fact that the patient gains in weight. While the patient follows out the recommendations for the removal of leanness, he should not take too large an amount of fat, on account of the inability of the system to assimilate it, and the tendency to the occurrence of fatty liver. Assimilation is favored by life in the open air and exercise or massage.

In what is known as latent or undeveloped gout, it is of importance that the condition be recognized and due regulation of the diet urged upon the patient by his medical attendant. Dr. William Roberts * has called attention to this, in an able manner, in a recent contribution on the necessity of a revision of diet with advancing years. If the appetite remain good while there is a process of degeneration going on in the liver and kidneys, the power of taking food remains unaltered, while the assimilative powers are on the wane. Some form of nutritive disorder necessarily follows. There is frequently a tendency to stoutness; there is engorgement of the abdominal organs, and the signs of latent gout are likely to appear. The early recognition of this condition is very important, for thereupon depends the prevention or postponement of degenerative processes, which hereafter prove formidable. The most obvious indication is to lessen the quantity of food, and this is a task of varying difficulty.

"Full feeders are rarely aware that they eat too much," says Dr. Roberts. Where the appetite is really strong and the digestion abnormally active, the patient finds it hard to resist the demands of hunger. In such cases, "the less concentrated forms of food are a useful resource (green vegetables, salads, thin soups), which help to fill the aching void without adding materially to the albuminoid and fatty ingredients of the meal. Tea and coffee are also serviceable in allaying an unseasonable craving for food. A stiff cup of tea or coffee, shortly before dinner, certainly takes the edge off a troublesome appetite. It is well, however, to proceed cautiously and tentatively in this direction, for the promptings of nature, however apparently to us misdirected, are

* British Medical Journal; American Lancet, December, 1891.

not to be lightly set aside. The effects of a contracted diet should be carefully and patiently watched, with an open mind for every sign or suggestion, whether of warning, retreat, or of encouragement to advance. I need hardly add that, in regard to this middle-life revision of the dietary, as it may be termed, particular attention should be given to the quantity of alcoholic beverages. As a very general rule, the tolerance for these articles diminishes with advancing years, and it is necessary nearly always, with persons who have used them freely, to reduce their quantity when middle age is reached."

With regard to the ability of the organism to assimilate nitrogenized food in fever, exact observations have finally established the conclusion that seemed warranted by experience. Huppert and Riesell maintained that the administration of albuminates intensified the febrile consumption, and is comparable to pouring oil on a fire. This was opposed by Uffelmann, and controverted entirely by some exact observations made by Bauer and Kunstle. A diet, therefore, consisting exclusively of carbohydrates is not desirable in fever, any more than in health, and, therefore, the addition of gelatin to farinaceous broths, or the administration of beef-juice, Bovinine, or Mosquera-Julia beef-meal is advisable, *wherever the digestive organs are capable of assimilating it*, and in quantities suitable to the condition of the digestive organs. In **typhoid fever**, a milk diet is preferred by most clinicians; but if this is insufficient, we may try Dr. Yandell's advice to allow unlimited bread and butter to the patient to satisfy the cravings of hunger, if he has any. Beef-tea has been finally superseded by various prepared foods containing peptones, beef-juice, or hæmoglobin, as already mentioned. Toast-water may be used to satisfy thirst; all the water drunk should first be boiled, and, if cloudy, strained, before giving it to the patient. On account of the duration of typhoid, the nourishment of the patient should be properly looked after, in order to keep up his strength. Stimulants should not be used as a matter of routine, but may be used sparingly, as an accessory food, during the decline of the fever.

The diet of persons suffering with albuminuria and Bright's disease should be carefully watched, bearing in mind the statement of Prof. Geo. Johnson, that "renal degeneration is a consequence of long-continued elimination of products of faulty digestion through the kidneys." The starting-point of Bright's disease, in the words of Fothergill, is "liver incapacity." This incapacity of the liver, which prevents it from properly assimilating albuminoids, may arise purely from mental worry or overstrain (Clifford Allbutt); it may be due to an excess of excrementitious material in the blood accompanying certain cachexiæ, as gout or lithæmia; it may possibly arise from defective kidney action, the result of scarlatinal or other poison. In any case, when the products of malassimilation pass through the kidneys they ultimately lead to degeneration of a granular character, which may or may not be attended by albuminuria. In some cases, the fault may be traced directly to overindulgence in animal food. The first step would be to restrict the amount of lean meat consumed, and direct the patient to avoid highly-seasoned food and spices. In many cases the best results are obtainable by placing the patients strictly upon a milk diet, which should be skimmed, or, at least, not Alderney. The food should be sparing in quantity, consisting largely of vegetables. Desserts may be allowed of a simple character, but the patient should be cautioned against free indulgence in the pleasures of the table. As the rule, alcohol is forbidden. Soups are useful, fish not objectionable. Cream, butter, and other fats are restricted. Gruels, broths, vegetables, biscuits, bread, crackers, and cheese may be mentioned among the articles which may be employed with advantage. Albuminuria is not the whole of Bright's disease, and may exist from dietetic causes, without degeneration of the kidneys. In a diet rich in albuminoid matter, the urine is apt to be albuminous. In such a case, the remedy suggests itself in due attention to the diet.

The subject of the dietary in various diseased conditions is admirably reviewed in J. M. Fothergill's "Manual of Dietetics," London, 1886. In the present place, we have room only for some useful formulæ, which may be employed in the sick-room with advantage to the patient. At the present time, the physician is not only expected to know what articles of diet are suitable for the patient, but he is also expected to be able to give precise directions how to prepare them, and, in emergencies, to step up and show the nurse or attendant how the thing should be done :—

FORMULÆ FOR FLUID FOODS.

Beef-Tea.

Take a pound of lean beef, free it from fat and fibrous tissue, cut into small pieces, place these in a crock or fruit-jar, with a good cover. Add to it a quart of cold water and ten or twelve drops of dilute hydrochloric acid, and stand in a moderately warm place for an hour; then let it simmer gently for two hours more, then strain and season with salt and pepper, if desired. It should be administered hot, an ounce or two at a time.

Beef-Essence.

The same as above, except that no water is to be added to the meat, which is placed in the fruit-jar and the lid fastened down; the jar is then placed in warm water, which is gradually raised to boiling and kept at this temperature for three hours. It is then taken out, strained, and seasoned with salt.

Beef-Juice.

Broil small steaks lightly, and then make incisions into them and press them in a lemon-squeezer or wine-press; the juice to be taken hot, with toast.

Raw-Beef Infusion.

To a pound of beef, prepared as above, finely minced, add enough warm water to cover it and ten drops of dilute hydrochloric acid. Let it stand for two hours, at a temperature of ninety degrees, frequently stirring it with a glass rod. It should be kept on ice, and administered with milk or a little extract of malt.

Farinaceous Beef-Tea.

To beef-tea, prepared as in the formula first given, add a little well-cooked oatmeal or cracker-dust, and serve hot. Barley-water or rice-water may be likewise enriched by beef-tea.

Beef-Broth.

Take a shin of beef (cracked), and cook, in sufficient water to cover it, for two hours, with rice or barley and a potato. Season with a piece of onion, thyme, or parsley, as may be preferred. Allow it to cool, take off the fat, serve hot, with some of the rice or barley, if permitted, and salt or pepper as desired.

Mutton-Broth.

Cut up two pounds of lean mutton, without fat or skin; add a tablespoonful of barley, a quart of cold water, and a teaspoonful of salt. Let it boil slowly for two hours. If rice be used, instead of barley, it need not be put in until half an hour before the broth is done.

Chicken-Broth.

Cut up an old fowl, remove the skin, and break the bones with a mallet. Cover well with cold water and boil slowly for three hours. Salt to taste. A little rice or tapioca may be boiled with it, if desired. Skim off the fat and add a little parsley, if desired.

White Soup.

Add half a pint of boiled milk to an equal quantity of beef-tea and slightly thicken with flour. Some pieces of celery, or celery-seed, may be added to flavor, and strained out before serving.

Oyster-Broth.

Cut into small pieces twenty-five oysters and put them in a chafing-dish; let them simmer gently for ten minutes at a moderate heat; skim, strain, add salt and pepper.

Clam-Broth.

Take three large clams (having thoroughly cleansed the shells) and let them stand upon the stove until the shells begin to open. Drain out the liquor, add an equal quantity of boiling water, a teaspoonful of finely pulverized cracker-crumbs, a little butter, and salt to taste.

Oyster-Soup.

Take a quart of milk and bring it to the boiling-point and skim it. As it boils add a tablespoonful of flour rubbed smooth with an equal quantity of butter, stirring it until the milk is thickened by the flour. Then add twenty-five or more oysters and bring to the boiling-point, and remove at once or the oysters will be tough. For seasoning, one or two allspice may be added, with pepper and salt.

Oysters Chafed.

Heat the chafing-dish and place in it a lump of butter; when hot, turn in the oysters and let them simmer for a few moments; remove, and add condiments to taste.

Rice-Soup.

Take half a pint of chicken-stock and two tablespoonfuls of rice. Let them simmer together for two hours, then strain and add half a pint of boiling cream or milk, and salt to taste. Boil up at once and serve hot.

Flour-Gruel.

Mix a tablespoonful of flour with milk enough to make a smooth paste, and stir into a quart of boiling milk. Boil for half an hour, being careful not to let it burn. Salt and strain.

Flour-Soup.

In a skillet place a lump of butter, and, when melted, add, with a dredging-box, sufficient flour to cover it; when this is thoroughly browned by the heat add a cup of milk and water, and season with salt while boiling. Strain and serve hot. This and the preceding are useful in bowel disorders.

Flour-Ball.

Moisten a pint of flour with a couple of ounces of cold water, and tie up in a ball, tightly, in a strong cloth. Slightly moisten the cloth and sprinkle it with flour, and boil for ten hours. Then take off the cloth and let the ball dry in a slow oven for ten hours more. It is then ready for use in making

Boiled-Flour Gruel.

Grate two tablespoonfuls of flour from the ball, mix it, with cold water, to a smooth paste, and stir it into half a pint of boiling milk. Simmer about three minutes and sweeten. This is a good food for children while teething.*

Predigestion of Food.†—To the earnest advocacy of Dr. William Roberts, of Manchester, England, the profession is indebted for a clear conception of the great value of the partial digestion of food before administration. The process can be performed extemporaneously in any household, and is an inestimable boon in cases of profound debility of the digestive powers. The following directions are given by Dr. Roberts:—

Peptonized Milk.

A pint of milk is diluted with a quarter of a pint of water and heated to a temperature of about 140° F. (or the diluted milk may be divided into two equal portions, one of which may be heated to the boiling-point and then added to the cold portion); the mixture will then be of the required temperature. Two or three teaspoonfuls of liquor pancreaticus, together with ten or twenty grains of bicarbonate of sodium (about half a small teaspoonful) are then mixed therewith. The mixture is then poured into a covered jug and the jug is placed in a warm situation, under a cosey, in order to keep up the heat. At the end of an hour, or an hour and a half, the product is boiled for two or three minutes. It can then be used like ordinary milk. By skimming the milk beforehand and restoring the cream after the final boiling, the product is rendered more palatable and more milk-like in appearance.

Peptonized Gruel.

A well-boiled, thick, and strong gruel, prepared from any of the farinaceous articles generally used for that purpose (wheaten flour, oatmeal, arrowroot, sago, pearl barley, etc.), is poured into a covered jug and allowed to cool to a temperature of about 140° F. Liquor pancreaticus is then added in the proportion of a tablespoonful to the pint of gruel and the jug is kept warm under a cosey, as before. At the end of a couple of hours the product is boiled and, finally, strained. This preparation is not generally acceptable to invalids, but may be used in conjunction with peptonized milk, as:—

* This and most of the preceding formulæ are based upon those contained in the excellent Text-Book of Nursing, by Clara S. Weeks. New York: D. Appleton & Co., 1885.

† For further observation on food, see author's papers on "Food and Diet in Health and Disease, including a Review of Many Prepared and Condensed Foods." Medical Bulletin, January, June, and July, 1892.

Peptonized Milk-Gruel.

First, a good, thick gruel is prepared from any of the farinaceous articles just mentioned. The gruel, while still boiling hot, is added to an equal quantity of cold milk. The mixture will have a temperature of about 125° F. To each pint of this mixture two or three teaspoonfuls of liquor pancreaticus and twenty grains of bicarbonate of sodium are added. It is then kept warm in a covered jug under a cosey for a couple of hours, and then boiled for a few minutes and strained. The bitterness of the digested milk is almost completely covered in the peptonized milk-gruel.

Peptonized Soups, Jellies, and Blanc-Manges.

In order to vary the regimen and increase its palatability, Dr. J. Milner Fothergill describes* other peptonized dishes which may be prepared. A soup may be made by using peptonized gruel, which is quite thin and watery, instead of simple water, for the purpose of extracting shins of beef and other materials employed for the preparation of soup. Jellies can be made by simply adding the due quantity of gelatin or isinglass to hot peptonized gruel, and flavoring the mixture according to taste. Blanc-manges may be made by treating peptonized milk in the same way and then adding cream. In preparing all these dishes the operation of peptonizing the gruel or the milk must be completed, even to the final boiling, before adding the stiffening ingredient.

Peptonized Beef-Tea.

Half a pound of finely-minced lean beef is mixed with a pint of water and twenty grains of bicarbonate of sodium. This is simmered for an hour and a half. When it is cooled down to about 140° F., a tablespoonful of the liquor pancreaticus is added. The mixture is then kept warm under a cosey for two hours and occasionally shaken. At the end of this time the liquid portions are decanted and boiled for five minutes. Beef-tea prepared in this way is rich in peptone, and its nutritive value in regard to nitrogenized materials is about equivalent to that of milk. When seasoned with salt it is scarcely distinguishable in taste from ordinary beef-tea. As a convenient method of peptonizing milk. Messrs. Fairchild Bros. & Foster, of New York, have now on sale "peptonizing tubes," each of which contains sufficient extractum pancreatis to peptonize one pint of milk.

Kumyss.

Kumyss, or milk-wine, originally made by the Tartars by fermenting mares' milk, is now prepared on a large scale in this country from pure cows' milk. It is deservedly esteemed as a combined stimulant and nutrient, very beneficial in wasting conditions, and, from the carbonic acid which it contains, efficacious in allaying irritability of the stomach. Kumyss may be made at home, according to the following directions of the late Prof. S. W. Gross: "Dissolve half an ounce of grape-sugar in four ounces of water. Dissolve twenty grains of yeast-cake in four ounces of milk. Pour both into a quart bottle and fill nearly to the top with milk. Cork tightly, fastening the cork with wire. Put into a cool place and shake two or three times daily for three days. Keep for use no longer than six days. A champagne-tap introduced through the cork is necessary. Kumyss contains about 16 per cent. of alcohol."

Kumysgen.

Under the name of Kumysgen, Messrs. Reed and Carnrick offer a preparation by which kumyss can be readily generated whenever desired. From the mode in which it is put up it will keep indefinitely. It is made from fresh, sweet milk, and contains fully 30 per cent. of finely-subdivided casein.

* Indigestion, Biliousness, and Gout in its Protean Aspects. Part I. By J. Milner Fothergill, M.D.

Rectal Alimentation and Nutritive Enemata.—It sometimes becomes necessary to abandon for a time the usual route for the administration of food, as in cases of gastric ulcer, persistent vomiting, and athrepsia in infancy. Under such circumstances we may resort to the bowel, and introduce nutritive substances by injection. It is considered advisable to add a certain amount of pepsin or pancreatin to the prepared food in order to facilitate the formation of peptones and the absorption of albuminoids. Milk-punch and beef essence or infusion may be used. with advantage, or sterilized milk, to which pancreatin and soda are added just before introduction into the bowel. Dr. Spencer has suggested nutrient suppositories made of beef chopped up finely mixed with fresh pancreas or with pancreatic extract.

The quantity of fluid food used at each injection should not be more than two to four ounces, depending upon the capacity and toleration of the patient. In infants, from half an ounce to an ounce is the limit. Irritability of the rectum may be overcome by a preliminary irrigation with cold water, or the use of an opium suppository, or laudanum injection. The nutritive enema may be repeated every four hours, and may constitute the sole reliance for nourishment during a period extending over several months.*

PSYCHOTHERAPY; HYPNOTISM AND SUGGESTION; METALLOSCOPY AND METALLOTHERAPY.

Psychotherapeia (ψυχη and θεραπευω), "the treatment of diseases through the mind," plays a most important part in the ordinary every-day practice of medicine. The influence of the mind upon bodily functions is so great that every experienced, intelligent physician is glad to enlist so potent an auxiliary, to some extent at least, in his treatment of diseased conditions. The eminent Dr. Rush always made a point, wherever possible, of explaining the action of the medicine which he prescribed for a patient, who, being thus made acquainted with the expected results, himself unconsciously favored their occurrence by what is known as "expectant attention." The confidence that a doctor inspires is generally acknowledged to be a powerful aid to his therapeutics. His hearty greeting acts like a stimulating cordial upon the drooping spirits of his patient, who takes fresh courage from his cheerful presence. This power of influencing others so as to affect their mental state or physical condition has been known and practiced since the most remote period. In the early history of medicine, when the duties of physician

* "Rectal Alimentation and Medication in Diseases of the Skin," by J. V. Shoemaker. Transactions of the Ninth International Congress, vol. iv, p. 170.

and priest were combined in the same person, many superstitious rites and ceremonies were employed in the treatment of disease in order to impress the mind of the patient and favor his recovery. The practice of the Royal touch for the King's evil, or scrofula, which continued in England up to the time of Queen Anne, is a recent illustration, and the ancient custom of wearing amulets to ward off disease has not yet entirely disappeared from even the most civilized communities. The wearing of iron rings for rheumatism, amber beads to prevent croup, horse-chestnuts in the pocket to protect from gonorrhœa, or gold rings in the ears to cure epilepsy, and other superstitious observances are of the same character. On a larger scale, we observe the so-called faith-cure or Christian science, which could only find supporters among persons absolutely ignorant of physiology and intensely credulous and superstitious. The only proper criticism upon the latter is that "it is not Christian, and decidedly not science." It is merely an outbreak, under another name, of the doctrines of the "Peculiar People" in England, whose practice of neglecting proper treatment for the sick and maimed has come frequently before the courts and has been repeatedly condemned, and, where death has resulted, verdicts of homicide have been rendered. In extreme cases there is, underlying this delusion, undoubtedly a strain of insanity, and some of the most ardent believers in the mind- or faith- cure are destined to eventually find their way into an asylum for the insane. While under the influence of this delusion, however, they are insensible to argument or reason, but, by their persistence and confidence, they attract unreasoning, weak-minded people, especially among the social class suffering with intellectual *surménage* and mental dyspepsia.

In order to properly approach this subject the student should read Tuke's admirable essay, entitled "Illustrations of the Influence of the Mind on the Body in Health and Disease, Designed to Elucidate the Action of the Imagination,"* and also Pettigrew's "Superstitions in Medicine Connected with the History and Practice of Medicine and Surgery,"† and, especially, the little work of Sir John Forbes, on "Nature and Art in the Cure of Disease," each of which is classical and should be part of the necessary course of reading for every candidate for the medical degree.

In every system of medicine practiced among rational beings, the action of the mind is not to be overlooked or ignored. Medicines that are repulsive to the senses of the patient, and that are taken under protest, are likely to excite disgust and nausea even if they are not immediately rejected by the stomach. Such remedies, whenever possible, should be substituted by other pharmaceutical preparations having the

* London, 1884. Second edition.

† Philadelphia, 1844.

same physiological action, but more agreeable to the palate. The latter form will not only be taken more faithfully by the patient, but he will be more ready to acknowledge that they are doing him good, whereas he is sure that the other will not benefit him and is anxious to discontinue it,—an argument for palatable prescribing which should not be despised.

Hypnotism (ὕπνος, sleep), or artificial trance, is a condition accompanied by loss of consciousness and power of voluntary motion, but with preserved intelligence and the ability to perform muscular movements under the verbal directions of another person. Suggestion is the name given to the process of instructing the patient in this way to do certain things. The patient apparently surrenders entirely his individual will and volition, and becomes an automaton under the direction of the operator. It has been said that the effects may remain even after the hypnotic sleep has passed off, and that patients will proceed at an appointed time to perform certain actions, suggested to them while in the hypnotic sleep, of which they retain no recollection when awake. It has been positively asserted that subjects have been hypnotized and instructed, while in this condition, to go on a certain date to a named place and there commit a crime such as stealing a watch or attempting to kill a person with a knife, and that they have afterward obeyed the suggestion, which assumed the form of an uncontrollable impulse. The relation of this to medical jurisprudence is very evident, and at present it is attracting considerable attention. There is a therapeutic application, however, which deserves some consideration. In some neurotic disorders, characterized by pain, spasm, paralysis, or paræsthesia, it has been demonstrated that, by hypnotism and suggestion, these symptoms can be made to disappear either temporarily or permanently. The phenomena of transference, by which a symptom (pain, paralysis, contracture) is removed from one part of the body to another, or even from one patient to another, is also of much interest to the pathologist and clinician. The effects of certain remedies, it was even claimed by Luys, may be produced simply by suggestion, without administering them, but this has been shown to be a fallacy by Dujardin-Beaumetz. Closely related to this subject is metalloscopy and so-called metallotherapy, which will be considered somewhat in detail at the conclusion of this section.

Dujardin-Beaumetz, in a recent lecture* on "Suggestion in Therapeutics," has admirably summarized our knowledge of the medical relations of hypnotism. He traces it to the desire for the marvelous and mystical, which has always exerted a dominating influence upon the mind of man. The fakirs of India have employed it, under one form or another, from time immemorial. The fakir, in truth, is a charmer,—that is,

* Bulletin Générale de Thérapeutique.

a practicer of suggestion,—and he develops in the individuals surrounding him phenomena of hypnotism and somnambulism. This also appeared in Europe under various forms, as the thaumaturgists, the demoniacs, the rosicrucians, and performers of miracles and of sorcery, which occupy so large a place in the history of the Middle Ages. At a later period, we observe these practices assuming a scientific tendency; for, although the suggestive processes are always the same in character, whether performed by Paracelsus or Charcot, there is in our own day a desire to discover for the phenomena a scientific explanation. Paracelsus in the sixteenth century assumed the existence in man of a special animating principle to which he gave the name of animal magnetism. This explanation was adopted by his successors, Van Helmont, Mesmer, and others, under various names (od-force, mesmerism, etc.), and this doctrine of magnetism was professed by many believers. About fifty years ago (in 1842) Dr. James Braid, of Manchester, England, succeeded in modifying this opinion among scientific men, by showing that by the fixation of the vision and attention upon some object, usually a brilliant one, it was possible to provoke the same series of phenomena, which now received the name of Braidism, or hypnotism. For a long time afterward the facts reported by Braid failed to attract much attention, although reports were occasionally published from surgeons of operations performed during the hypnotic state. It is not until we come to the communications of Lasègue, in 1865; of Charles Richet, in 1875; and to the numerous studies by Charcot from 1869 to the present time, that we find a due recognition of the phenomena of hypnotism in their medical relations. Luys ascribes these phenomena to fascination, such as is produced by a revolving mirror which is moved rapidly before the eyes of the subject upon whom this procedure is employed. Whether caused by hypnotism, suggestion, or fascination, Dujardin-Beaumetz states that a series of phenomena are produced in certain patients which may be summarized under three principal types:—

1. The cataleptic state.
2. The lethargic state.
3. The somnambulistic state.

The latter is the suggestive phase of hypnotism. Bernheim and Liébault admit six categories of such hypnotized patients. In all of them the will of the operator takes the place of that of the subject. In the beginning of this provoked slumber there is somnolence and heaviness, and the power of suggestion is feeble. It is, however, sufficient, for example, to prevent the patient from lifting his eyelids without the permission of the operator. In the first and second stages, the patient may be acted upon after the manner of automatic phenomena; subsequently, in the further stages, we arrive at true suggestion, when the patient is related only to the hypnotizer, who makes him execute movements or suggests to him illusions or hallucinations. These nervous phenomena may vary in form in different subjects, and also in the same subject, and the results are also determined to a considerable degree by the expertness of the operator.

The means of evoking hypnosis or the hypnotic sleep are of the most varied character. For the passes of the magnetizers, Braid substituted fixation of the glance upon some object,—something brilliant, such as a bright button, or even the finger of the operator. At Charcot's clinic the sense of hearing is appealed to; the noise of a gong determines the hypnotic state as well as the production of a bright light. In a word, every sensorial impression may be utilized.

The Abbé Faria, in 1814, was the first to protest against the idea of a magnetic fluid and to affirm that the slumber of the hypnotized was produced by suggestion or by will. He fixed the glance of the subject, and showed the back of the uplifted hand; then he advanced several paces, and suddenly lowered his hand, ordering the subject to sleep. This is the method of hypnosis by suggestion which is adopted by the school of Nancy. Liébault thus describes this method: "The subject is caused to fix his eyes, and is directed to think of nothing save of sleeping and being cured; we announce to him the initial phenomena of sleep, —relaxation of the body, drowsiness, heaviness of the eyelids, insensibility. When we perceive that the eyelids move, grow heavy, and that the eyes assume an astonished look, and that the pupil oscillates or dilates, we pronounce the sacramental word, Sleep!" If at the end of a minute sleep be not produced the session is adjourned to another day. Bernheim prepares his patient by placing him in an easy position, and allowing him to think for several moments while telling him that he is to be transported into a state of sweet and calm slumber. Then Bernheim brings his hand softly over the patient's eyes, at the same time bidding him "Sleep!" If there is resistance or winking, he adds: "Yield yourself; your lids are heavy, your limbs are relaxing; sleep is coming. Sleep!" Rarely have one or two moments expired before hypnosis has arrived. Some rest immobile and inert from the outset; others seek to recover themselves,—open their eyes, and start up every minute. In this case he persists in keeping the eyelids closed, and bids them: "Continue to sleep!"

Dujardin-Beaumetz produces sleep by fixation of the gaze and occlusion of the eyes.

As for awakening the patient, this may be done in a number of ways. The usual method is to tell the subject to awake, raising the voice in a tone of command. The same result may be obtained by breathing lightly upon the face of the hypnotized.

The clinical authority from whom the foregoing has been quoted classes patients, who are to be subjected to hypnotism as a therapeutic resource, into three classes: In the first class are the hysterics; in the second the neurasthenics, the illy balanced, the hypochondriacs, the nervous; finally, the third comprises all those suffering from organic affections with lesions, and in whom the nervous element plays only an absolutely secondary rôle. Suggestion, or hypnosis, has always produced its most positive effects in the first group. This group is very numerous, and includes men as well as women. Male hysteria occurs not alone among the well-to-do, but also in the laboring classes. On this soil flourish a number of pseudo-maladies, which, in their manifestations, assume the form and course of diseases of organs, producing gastric or pulmonary hysteria, for instance, which closely resemble organic affections. All of these manifestations can be made to disappear by hypnotism and suggestion.

It is among this class of suggestionable hysterics that we find such brilliant examples of successful hypnotic anæsthesia, during which tedious surgical operations may be performed or accouchement accomplished. A large number of cases have been reported by surgeons of the use of the hypnotic sleep since Esdaile published his records of several thousand cases in India. Owing to its simplicity, it is admirably adapted to short operations, such as extracting teeth.

The second group of cases—the neurasthenic, the hypochondriacal, and the unemployed—are less influenced by suggestion. With such neuropathics the personal influence of the physician and the assurance with which he prescribes his remedies have more effect than the remedy itself. Here lies the success of little parti-colored granules or miniature powders, "over which certain physicians make magnetic passes before administering them"; and, we might add, here is the secret of the financial success of some men whose ignorance is only equalled by their assurance.

As to the third group, it must be stated that, in the presence of actual lesion, suggestion has a very limited field. Pain may be removed for the time and the general state improved by the assurance of an early recovery, the effects of a remedy may be enhanced by expectant attention, "and every new remedy has a phase of success which belongs to the domain of suggestion."

The proportion of patients who are amenable to suggestion is set down very differently by various authorities. Dujardin-Beaumetz claims that the number has been very much overestimated. Even among the first class of hysterics, who are the most susceptible to this mode of treatment, he finds a certain number not hypnotizable; or, at least, there are, among hysterical subjects, many affections which cannot be ameliorated by suggestion, so that the actual proportion of those curable by this method is much smaller than has been claimed.

The recent International Congress of Hypnotism, held at Paris in 1891, is an illustration of the growth of this therapeutic method of late years and its present magnitude. Dr. Ernest Hart, in commenting upon the schools and doctrines of hypnotism, pointed to the published addresses and discussions at this Congress, which he holds are sufficient to show that all is not yet clear, even as to the nature, not to say the grouping, of the phenomena which are included under the name of hypnotism. The school of La Salpêtrière maintains that, in what it calls *le grande hypnotisme*, there are always physical phenomena which arise independently of any suggestion; while the school of Nancy holds that these phenomena are superadded, and only make their appearance as the result of a suggestion, voluntary or not. It was Charcot who put the whole subject upon a scientific basis, and who definitely disposed of the claims of animal magnetism. Following him, are a number of able observers in different countries of Europe who have contributed greatly toward firmly establishing hypnotism within the domains of science. *La grande hypnotisme* constitutes the most perfect and typical form of hypnotism. The whole doctrine of Charcot may be expressed in the following propositions of his favorite pupil, Babinski: First, the physical characters observed in the hypnotism of certain subjects allow the absence of simulation to be affirmed; secondly, hypnotic phenomena may effect a special grouping in three distinct states (see page 288); thirdly, the physical phenomena of hypnotism may be developed independently of any suggestion; fourthly, hypnotism in its most perfect forms must be recognized as a pathological or diseased condition. On the other hand, the doctrine of the school of Nancy may be summed up in the single word "suggestion." M. Bernheim offers the following definition: "The hypnotic state is that peculiar, induced psychical state which augments, in divers degrees, suggestibility; that is to say, the aptitude to be influenced by an idea accepted by the brain and to realize it." The school of the Salpêtrière holds that, in any case, healthy, well-balanced individuals cannot be hypnotized; and that those who are capable of undergoing special psychical transformation are persons who have a neuropathic constitution. This seems like an important fact to establish, and indirectly confirms the opinion already quoted by Dujardin-Beaumetz that hysterical subjects furnish the greater number of successful cases.

Hypnotism may give rise to accidents in certain cases, and, after hearing an address by Dr. Ladame, the Congress demanded that public displays of it should be forbidden, and that it should be considered as a therapeutic method and reserved for physicians alone. At Nancy the doctrine is taught that crime may be committed by a person under the influence of suggestion as the result of such influence. Dr. Gilles de la Tourette declared his belief that the only possible crime which might be committed is on the person hypnotized. Hypnotism is directly dangerous because it may end in completely upsetting the intelligence of the subject, and indirectly by the excessive influence which it gives to the operator over the subject, of which the limits have not been determined. It may influence the actions of hysterical subjects, but it is difficult to ascertain up to what point this proceeding can with advantage be employed to correct the morals of children or evilly-disposed or criminal persons. Doubt is still very permissible on this point, notwithstanding the long list of observations which are found in Bernheim's book. Beyond doubt, however, hypnotism is capable of rendering services in the study of experimental psychology, and much has already been accomplished in this direction.

Hypnotism in General Practice.—It is a proper question to ask, How far may hypnotism be utilized by the general practitioner? In the first place, it is a method which savors of charlatanism, and in a large number of cases is not applicable. As Dujardin-Beaumetz has shown, it is serviceable principally among hysterical subjects. In other words, it is likely to be an experiment doomed to failure in the very class of patients whose esteem is most desired,—the intelligent, well-balanced, and sensible ones. It is not surprising, therefore, that it has been avoided by the majority of physicians. Nevertheless, in selected cases, it can be resorted to as a therapeutic expedient with brilliant results. Dr. Joseph Collins, of New York, reports five cases in a recent issue of the *New England Medical Monthly* (April, 1892), and directs attention to the fact that in suggestion we have a valuable corrective agency for children who have acquired or inherited criminal tendencies. In the cure of chronic inebriates it certainly deserves a trial. In some cases of insanity the outlook for suggestion is promising. It is among functional nervous diseases that we find the greatest field for this measure. "It is for the various paralyses, hyperæsthesias, contractures, spasms, convulsions, and other nervous ailments of non-demonstrable organic lesions where it has its greatest use. Supposed diseases, dread of diseases, disorders of digestion and other functions will, undoubtedly, in many instances, disappear under the influence of mental suggestion."

The susceptibility of children to hypnotism was considered recently by Bérillon, in a paper,* before the Paris Society of Hypnology. It is a matter both of scientific and medico-legal importance. The author claims that 80 per cent. of children, from every class of society, may be hypnotized at the first or second trial. The most singular part is, that children with the most marked hereditary nervous taint are the most difficult to hypnotize. Epileptics are highly susceptible. The author recommends that suggestion be made use of in the treatment of such conditions as insomnia, night-terrors, kleptomania, onanism, and other vicious habits.

In his presidential address before the Colorado State Medical, Dr. J. T. Eskridge † reviews the entire subject in a masterly manner. He declares that by suggestions during the stage of hypnosis he has been able to improve digestion, increase the appetite, and relieve constipation. As a rule, tired and nervous feelings can be abolished by hypnotic suggestion. Slight despondency may be overcome and raised to hopefulness. Headache, if not too severe, is readily relieved; but he had not succeeded in relieving acute pain, such as toothache or trigeminal neuralgia. Stammering has been treated with marked success. Morbid fear of insecurity may be beneficially influenced. With regard to bad habits, Dr. Eskridge states that in no case had he succeeded in breaking up any bad habit except by repeated hypnotic suggestion. Experience has taught that the impressions made by hypnotic suggestion are not very permanent at first, and are only made so by repeated suggestion, extending over a considerable length of time. Dr. Eskridge offered the following as the conclusions of his study of the subject:—

1. That hypnotism is real, subjective, and disassociated from any mysterious influence formerly supposed to be exerted by the hypnotist over the subject.

2. That its therapeutic value depends upon the mental impressions made during hypnosis, the latter rendering one more impressionable at the time

3. That much that is accomplished by the aid of hypnotism may be obtained by repeated impressions without hypnosis.

4. That hypnotism may be attended by certain dangers to the hypnotist, the subject, and the community; but that, so far as the reputation of the hypnotist or the health of the subject is concerned, proper precautions will enable us to prevent any untoward effects, leaving numerous dangers of a medico-legal nature to be guarded against when hypnotism is practiced by unprincipled persons.

5. That whether or not the therapeutic value of hypnotism is greater than the dangers that cannot be prevented from its practice is not deter-

* Gaz. Médicale, July 25, 1891.

† New York Medical Journal, August 1, 1891.

mined, and should receive careful attention at the hands of competent investigators, whose minds are not likely to be unduly biased by skepticism or enthusiasm.

6. That no one should be allowed to hypnotize without a license from the State to employ hypnotism.

7. That the practice of hypnotism should be limited to physicians and other scientific investigators.

8. That no one of questionable reputation should be given a license to hypnotize, and any one so licensed should forfeit it on being convicted of crime.

Dr. C. H. Hughes,* of St. Louis, in a discussion before the New York Medico-Legal Society, declared that public exhibitions of hypnotism should be prohibited by law. Hypnosis, according to him, is an abnormal function of the brain, and the practice of inducing it should not be encouraged when the subjects were persons who were very impressionable. Dr. Nolan † reported a case of insanity following hypnotism in a soldier, the victim of a neurosis produced by debauchery. Profound hypnosis was rapidly induced by gazing at a bright object. From this state the patient did not completely emerge until the lapse of nearly four months. Throughout this period of stupor the patient was disturbed by a recurring visual hallucination of an old hag, who seemed to rush toward him. Dr. Julius Solon ‡ also reported a case where an amateur at a friend's house volunteered to hypnotize a fellow-visitor, and, after two trials, succeeded so well that the subject grew extremely excited, lost the power of speech, and then passed into a condition of catalepsy; subsequently he had severe convulsions. He had been hypnotized by being made to look at a diamond ring, and afterward the sight of anything glittering threw him into a state of violent excitement. He went into a condition of grave hysteria, with maniacal excitement, during which he had numerous convulsions; in the intervals he would sing over, song after song, apparently all the songs he knew, and as long as one remained unsung nothing could stop him. At the end of a fortnight he had an attack of fever, followed by copious perspiration and dyspnœa; a few days later he had a similar attack, and after this he declared himself well. From first to last he was seriously ill for three weeks. The cause of the fever was ascribed by his physician to inflammation of the anterior part of the brain.

Dr. Moll, of Berlin, author of a book on hypnotism in the Contemporary Science Series, speaks favorably of suggestion in childbirth, where it may be used always without damage, and sometimes with most

* British Medical Journal, April 11, 1891.

† Journal of Mental Science; Druggists' Circular, May, 1891.

‡ New York Medical Journal, March 14, 1891.

signal efficacy in relieving suffering. Dr. Moll attaches the greatest value to this as a means of breaking up habits, such as morphinomania, drunkenness, etc., which the patient is no longer able to control.

Dr. Hamilton Osgood * also speaks favorably of hypnotism, and believes that the assertions of the leading hypnotizers of Europe, with reference to the harmlessness of this treatment, when intelligently applied, are true. The possibility of idosyncrasy must be always borne in mind, however, although Osgood has never met it in any of the patients whom he has hypnotized; nor have any, according to him, who confine themselves to the Nancy method. The dangers lie rather in insufficient technical knowledge than in hypnotism itself, and Osgood joins Moll and others in urging the abstaining from suggestions which do not accord with the normal functions of the organism.

Dr. J. Leonard Corning,† of New York, in discussing the therapeutic value of hypnotism declares that the rôle it is destined to play is a subordinate one; it is a collateral expedient, invoked largely with the view of rendering the patient more tractable and amenable to other elements in the plan of treatment.

It should be borne in mind, as insisted upon by the late Dr. George M. Beard, that the phenomena of suggestion are not caused by superior will-power of the hypnotizer. There is no transfer of mental force; there is merely a passive condition of the subject, which makes him act automatically, in a manner suggested by another person, who has no power or control beyond the mere suggestion of the idea.

Hypnotism and the law has been the subject of two essays read before the Medico-Legal Society of New York last year,—one by Clark Bell, Esq., and one by John J. Reese, M.D.‡ The position taken by the former is that the bar and judiciary are in duty bound to carefully and calmly investigate, and, so far as possible, define the phenomena and place its true limitations regarding personal and certainly criminal responsibility. He would advocate restricting its use to qualified investigators, but would oppose limiting it to medical men. Dr. Reese regards it as a true pathological state, even though unaccompanied by any demonstrable change of structure. There should be, in his opinion, legal surveillance over private experiments and public exhibitions.

In mental disease, Dr. Voisin § has had good results in conquering hallucinations, overcoming delusions, and in quieting acute mania. He was able to induce hypnosis in about 10 per cent. of his patients. An

* Boston Medical and Surgical Journal, 1891.

† Journal of American Medical Association, December 13, 1890; from the Medical Record.

‡ Medico-Legal Journal, March and September, 1891.

§ "Proceedings of Congress of Experimental Hypnotism, 1889." Boston Med. and Surg. Journal, September 5, 1889.

editorial in the *Medical News* (October 10, 1891), on the therapeutic value of hypnotism, casts some doubt upon the advisability of substituting one neurosis for another, and suggests a strong relationship between experimental hypnotism and human vivisection. "We must have a better psychology and an infinitely more perfect pathology and pathogeny of psychic disease before we shall be capable of intelligent use of hypnotic control and suggestion as justifiable methods of cure." Dujardin-Beaumetz, in the lecture previously referred to, sums up the value of this method in the statement that "psychotherapy will never constitute more than an exceptional resource in the practice of our art, if we would limit it to the practice of hypnotism, properly so-called," since there will always remain a large pathological group of organic affections against which we must employ special medication, and in which hypnotism can never play any rôle. "To suppose, for a single instant, that it would be possible, by mere affirmation, to cause the disappearance of the entire train of morbid symptoms is an illusion and, worse, an error." Ernest Hart * very fairly sums up the whole matter, as follows:—

"Hypnotism is a pathological modification of the nervous system, which always indicates that the subject belongs to a neuropathic class. The complete and typical form of hypnotism described by Charcot is rare. Suggestion plays a considerable part in hypnotic phenomena, but there are somatic phenomena which are independent of it. Hypnotism may frequently be dangerous, and very rarely useful. It may be the cause of crime, or of mental disorder; it can really cure no disease not more easily curable by simpler and less dangerous methods. A considerable number of facts attributed to it which have most impressed the public imagination, such as the actions of medicines at a distance, the so-called telepathic communications, or communications made without speech, and the clairvoyant phenomena sometimes described, are mere errors of experiment arising from insufficient precautions and a too vivid imagination. Precisely those phenomena which have been most publicly talked about and excited most interest in 'psychical circles,' so-called, are the least real. The hopes which the therapeutic hypnotist aroused have not been realized, and any expectations of producing by hypnotic methods any desirable moral or mental effect rest upon a totally inadequate basis of fact, and are far from being promising."

Metalloscopy and Metallotherapy.—The possibility of affecting bodily functions by the near approximation to the surface, or actual contact, of various metals has been a belief of mankind from a very remote period, and doubtless the phenomena exhibited by magnetic iron-ore had much

* British Medical Journal, March 28, 1891.

to do with giving it something like a foundation in fact. In the history of this subject the name of Dr. Perkins, of Connecticut, will always occupy a prominent place, similar to that of Paracelsus in the early development of hypnotism, and the parallel is not an unjust one to the American. Perkins arranged a combination of metals in the form of a cylinder which could be grasped in the hand or passed over the surface of the body. By the application of these "tractors," as they were called, the morbid process was believed to be drawn out; he applied them with remarkable results, and many certificates of cures were obtained. This method had such success here that it was introduced into England, where it was received with great enthusiasm. It became at once very popular. Crowds of all classes resorted to the Perkinsian Institute, and wealth poured into the coffers of the shrewd proprietor, until Dr. Haygarth opened an opposition institution, and demonstrated to the world that he could obtain equally marvelous results from imitation tractors made of wood. In other words, Perkins's method was not metallotherapy, properly speaking, but an illustration of the influence of the mind over the body and of the curative effect of the imagination. Modern metalloscopy and metallotherapy are further illustrations, in all probability, of the action of this potent therapeutic adjunct under a more scientific dress.

Dr. Burq, in an inaugural thesis in 1851, called professional attention to the curative effects of metals in the form of plates, when applied to the skin in cases of paralyses of motion or of sensibility occurring in hysteria. The same metal is not applicable to all cases,—one being benefited by silver, another by gold, copper, or some other metal. He claimed that the internal administration of the appropriate metal to the given case would likewise produce favorable results. The detection and determination of the particular metal appropriate to each individual he denominated "metalloscopy," and the use of metals in this way "metallotherapy." This is quite different from the external use of magnets, to which attention has already been directed. (See page 169.) Among the phenomena claimed by Burq to be produced by a piece of metal, such as a coin, properly selected according to the special sensibility of the subject, when placed in contact with the skin, is return of normal sensibility in permanent hemianæsthesia (hysterical) in from ten to twenty minutes, through a space of some extent above and below the point of application. Numbness, tingling, and other disorders of sensation precede the return of sensibility in the area immediately adjacent to the metal, and this gradually extends until the whole side returns to the normal. At the same time an elevation of the temperature recognizable by the thermometer and an increase of muscular power take place.

Where sight, hearing, taste, and smell are also in a condition of anæsthesia, as the general sensibility is restored these functions also become normal. A commission appointed by the Paris Academy, with Charcot at its head, having been appointed to examine into their claims for metallotherapy, confirmed them, and added what is known as "the phenomenon of transfer," by which is meant that with the restoration of normal sensibility upon the affected side there is a decline, to a greater or less degree, of the sensation of the corresponding area upon the opposite side. The phenomenon observed and the results obtained by the commission were of such a positive character that Charcot was led to ascribe them to electrical currents stimulated by the contact with the metal. Such currents could only be an exaltation of the normal intercapillary electrical phenomena, since one metal could not originate an electrical current outside of the body even when in contact with it. Professor Westphal, of Berlin, after a careful investigation of the subject, published his results, which, on the whole, were corroborative of those of Charcot and Burq. Dr. Hughes Bennett obtained equally striking results from other substances than metals.

The method of application is to select disks, or large coins, or pieces of wood coated with metal, and apply them to the affected limb, either as a bracelet or a single plate kept in position with a bandage. The effects follow in a few minutes, so that experiment will readily determine which metal is to be used. As the rule, an individual is susceptible to one metal only. The order of usefulness is: iron, copper, gold, silver, tin, platinum.

Besides hemianæsthesia or paralysis of hysterical subjects, cures of writers' cramp, chorea, and neuralgia have been reported. When the metal to which the patient is sensitive is discovered, it is sagely recommended to continue the treatment by the internal use of a salt of the same metal. In giving this advice Bartholow follows Burq's practice, already referred to.

The attentive student of the preceding section on hypnotism and suggestion will find a sufficient and fully-scientific reason for the above phenomena, without invoking any mysterious or occult influence of metals in the treatment of disease, other than in the sense in which Burton, in his celebrated "Anatomy of Melancholy," applies to metallotherapy in his observation to the effect that gold is a potent remedy for lowness of spirits.

Within the last few years the subject of metallotherapy has almost entirely disappeared from medical journals, and is omitted from our principal text-books.

HEAT AND COLD AS THERAPEUTIC AGENTS.

Heat, as measured by the thermometer, is a purely relative term. Living human beings have a normal standard of heat furnished by the surface temperature of the body, which varies a little at different points, but may be roughly stated to be about 100° (F.), or a little less (98.4 to 98.6 in the axilla, a fraction higher in the mouth or rectum). In certain states of the system this may be exceeded by as much as ten or twenty degrees, and, if this continues for a greater or shorter period, the patient is commonly said to have fever, or pyrexia (πῦρ, fire). The bodily temperature, on the other hand, may fall below the standard in collapse, coma from alcohol, loss of blood, starvation, or cancer. Vasomotor paralysis with dilatation of the blood-vessels is sometimes the cause of notable loss of heat after severe injuries of the upper portion of the spine. In sclerema neonatorum Dr. Bäumler * has observed a temperature as low as 71.6° F. (22° C.).

Cold may be defined as a lower degree of temperature than that which is normal to the human body. Absolute cold would be a condition entirely free from sensible heat; it is estimated at several hundred degrees (—459 degrees) below zero. Cold is, therefore, unknown to us, practically, and by the term we mean simply lower degrees of heat. Articles which, when applied to the surface, abstract more or less heat from it, are said to be cold; those which, on the contrary, communicate heat to the body, are said to be hot.

This fact is of considerable service in therapeutics, since we are able, to a certain extent, to regulate the bodily temperature by means of external applications. For convenience we will treat of them under two heads, viz., (1) the effects of hot applications or external heat, and (2) the effects of abstraction of heat by cold applications.

I. Heat as a Remedy.

Physiological Effects ot Hot Applications.—The primary effect of heat, when locally applied to the human body, is that of an excitant or stimulant. If the temperature be sufficiently high,—say, that of boiling water,—irritation will be so great as to lead to serous effusion between the layers of the epidermis, the external squamous layer being thereby elevated and a blister formed, followed by more or less local inflammation. If the temperature be even greater, necrosis of the tissues will take place, to a greater or less extent, followed by sloughing. The application of higher degrees of heat, as by the actual cautery, is attended by shriveling and combustion of soft parts, followed by decomposition, suppuration, and necrosis. More or less pain is caused

* Quain's Dictionary of Medicine, p. 1599.

by the application of anything to the surface the temperature of which is much higher than that of the body. After the application of heat, the electrical currents in the sensory nerves are reduced, or even destroyed. Heat may, therefore, act as a sedative in painful affections of the nerves. Moderate heat, applied generally to the surface, produces important physiological effects, which have already been referred to in discussing the effects of warm and hot baths. Dry heat is better borne than moist heat, and glass-workers, metal-founders, stokers, and others constantly carry on work at a temperature much greater than that of the human body. It is recorded of Chabert, "the Fire King," that he frequently exposed himself to a temperature of 400° to 600° F. without injury; and, in the Turkish bath, the temperature of the hot room is ordinarily from 140° to 160° F.

The effects of exposure to an elevated temperature in dry hot air, for a short time,—from half an hour to an hour,—are: a slight rise in bodily temperature and an increased rate both of pulse and respiration, but more of the former than of the latter. The capillary system becomes congested, and the arterial tension is increased as a result of greater rapidity of the heart's action. The action of the kidneys and skin is more marked, and the proportions of chlorides and urea are increased. The skin becomes bathed in perspiration, which, by its evaporation, keeps the bodily temperature down nearly to normal. In moist air this evaporation does not so readily take place, and much lower degrees of heat speedily become unsupportable. It is on days when the humidity is great that sun-stroke is more apt to happen, since, under such circumstances, the bodily temperature rises until the brain is affected by the overheated blood, and coma or convulsions occur. This is more likely to occur if the person affected has been engaged in active muscular effort at the time of exposure.

Therapeutical Applications of Heat.—General or local measures may be employed to exert thermic influences upon the body. The general applications may be made by means of baths of various kinds, including the Russian or steam bath and the hot-air bath, which have been already referred to. A variety of the latter is known as **heliosis**, or the sun-bath, which has a powerful effect upon nutrition, and in some chronic forms of disease it has curative effects scarcely obtainable in any other manner. It may be taken in a warm room, with the clothing removed from the portion of the body to be acted upon, or the entire body may be exposed to the rays of the sun for a period of half an hour to an hour; or the body may be covered with clothing, and the warmth of the sun principally utilized. That the sun's rays exert a powerful influence is shown by the acute dermatitis which is caused by exposure to the sun while boating or swimming; even blistering is produced, in severe cases, besides discolorations of the skin (tanning and freckles). The direct rays of the sun, concentrated by a double-convex lens, have all the effects of the actual cautery, and may be thus employed to destroy epithelioma, or small growths in the skin.

Local applications of heat may be made by means of hot-water bags, sand-bags, bricks, etc.,* or by cataplasms, fomentations, or local baths. The general application of heat is useful where the body has become chilled, or there is collapse, owing to loss of blood, or shock after an injury; also in alcoholic intoxication. The patient may be covered with blankets, brought close around the neck, but lifted up from the body into a sort of a low tent, into which hot air may be carried from an alcohol-lamp (see page 241), or small baskets, containing hot bricks or sad-irons, may be ranged by the side of the patient. Circulation of the blood may be assisted by rubbing the patient's limbs toward the trunk. The hot bath has already been considered. Baths of hot sand and mud-baths are used in Europe for the cure of rheumatism, paralysis, and spasmodic contractures of muscles. In collapse of cholera and in restoring persons apparently drowned, heat is of great importance. Topical applications of heat are called for in cases of pain, local congestions, or spasms, and to allay irritability by acting as a counter-irritant. Thus, in neuralgia or toothache, the application of heat with a rubber bag, or with the hop-bag moistened with hot whisky, is often of signal service. In a similar manner, colic of various kinds—colalgia, gall-stone colic, nephritic colic—are promptly relieved by hot applications, either dry or moist. In pneumonia and pleurisy, hot poultices relieve pain and congestion, favor perspiration, and moderate the fever and cough. Hot applications will often arrest superficial inflammation, if applied early, and in later stages they favor suppuration and separation of the necrosed tissues from the living. A hot-water bag applied to the spine, in the dorsal region, will stimulate the spinal centres and check uterine hæmorrhage. In rheumatic inflammation of joints, subacute in character, the alternate application of hot and cold applications cause rapid absorption of the effusion. The many uses of poultices and the hot-water bag cannot even be enumerated here, but enough has been mentioned to indicate their therapeutic value. By combination of mustard or spices with a cataplasm or poultice, the counter-irritant effect is greatly increased; but this is beyond the borders of the subject of heat

* Professor Tarnier has used warmth, with remarkable results, in saving the lives of prematurely born or weak infants. He uses a box heated with hot-water bottles, the heat being regulated with the thermometer. This apparatus is called a *couveuse*, and is in general use in maternities and foundling asylums.

by itself, which is now under discussion. The higher degrees of heat are used as escharotics.

The Chinese method of raising a blister is to immerse a plate of metal, of the required size, in boiling water. When thoroughly heated, it is taken out and applied directly to the skin. As this is very painful, it is not to be compared with the ordinary method, and is not likely to come into favor here with the profession or public. The actual cautery is a surgical instrument, but it may be utilized in medicine in the treatment of chronic rheumatic or tubercular inflammation of joints. In sciatica the surface over the course of the nerve may be lightly touched by the actual cautery, to produce a counter-irritant effect, or a piece of flannel overlaid by hardware paper may be placed along the limb over the painful area and a hot sad-iron passed lightly over the surface.

II. Effects of Abstraction of Heat by Cold Applications.

Physiological Effects of Cold.—Cold applied to the living body produces some congestion of the superficial blood-vessels, soon followed by their rapid and extreme contraction and lowering of the surface temperature. If the exposure has been moderate, reaction follows, with redilatation of the capillaries, augmented energy of the circulation, and restoration of the normal heat. In weak or debilitated people, reaction is slow, or may not appear at all; but there is a more or less lengthy period of vital depression, accompanied by enfeebled nutrition, and followed by a slow recovery. Prolonged exposure to a low temperature may induce not only local and temporary vascular syncope, but local or even general devitalization; beyond this point only the physical and chemical effects of cold continue. Complete freezing of a tissue or organ is never followed by complete restoration of function, as the devitalized portion is necrosed and sloughs off. This condition is known as frost-bite and gangrene. Less intense cold may lead to a tendency to permanent dilatation of the capillaries of the skin, associated with paræsthesia and at times pruritus. This is known as **pernio**, or chilblain, and causes much annoyance to children especially. The application of carbolized lotions or petrolatum with carbolic acid (3 to 5 per cent.) affords much relief. Frost-bite may lead to loss of toes or fingers, or even require amputation of portions of the feet, after severe exposure. Death from exposure to cold is attended by shriveling and lividity of the skin, muscular weakness, and rigidity, with mental symptoms, drowsiness, confusion, and coma. These symptoms have been mistaken for the effects of alcohol, and the error is more likely if the subject had been indulging in alcohol before his exposure. The **post-mortem appearances**

consist in a waxy anæmia of the surface, varied by bright-red patches on the more exposed portions of the body. Internal organs much congested. The reddish-brown stains along the course of the superficial blood-vessels are due to disintegration of the blood-cells by the cold and diffusion of the coloring matter through the vascular walls (C. E. Shelly *).

In treating a patient who has been rendered unconscious by extreme cold, the point to be borne in mind is that the restoration of heat should not be rapid, but gradual. The patient should be stripped of clothing and put between blankets, in a cold room; the surface should be stimulated by gentle friction, using snow or ice-water to frozen parts, at first, and afterward dry flannel. The bladder should be emptied by catheter, and small quantities of hot broth, tea, coffee, or beef-tea may be administered as soon as the patient can swallow. After reaction is established, but not at first, some hot toddy may be given. Nutritive enemata may be administered, and the patient carefully nursed, as recovery is usually slow.

Therapeutics of Cold.—Two classes of cases are benefited by the application of dressings, or other agents, of low temperature. These are: where it is desired to have the primary and secondary physiological effects upon nerves, blood-vessels, and cells of the part, and, secondly, where the physical effect is principally sought after through the abstraction of heat or the lowering of abnormal temperature. With regard to the latter, it may be said that Dr. H. C. Wood found that nervous symptoms of various kinds are produced by an abnormal temperature of the blood as it flows through the vessels of the brain, and in what he terms "thermic fever" the principal object of treatment is to protect the brain-centres by abstraction of heat from the blood. In the treatment of pyrexia, cold is used as an antipyretic by numerous methods,—the cold bath, wet pack, sponging of the surface, or by the water-bed or coils of rubber tubing. Cold-water enemata in typhoid fever have some influence upon the temperature, and tend to make the patient more comfortable.

Cold is not only **antipyretic,** but may be applied as a **tonic** and **stimulant,** reaction being hastened by brisk friction. It also acts as a sedative and anodyne by abstraction of heat and lessening the conductivity of nerve-trunks; it may even be a local **anæsthetic**; but care should be taken not to freeze the part to which it is applied. When properly used in this way, it is sufficient to prevent the feeling of pain during small operations, and is frequently resorted to. It is also an **anaphrodisiac** when locally applied, or a shower of cold water is sent along the spine. It is **antispasmodic,** as when a child with convulsions or spasm of the glottis is relieved by pouring several pitcherfuls of cold water over the head and neck. The cold douche is a powerful respiratory excitant

* Dictionary of Practical Medicine. Edited by J. K. Fowler, 1890.

in cases of narcotic poisoning and in asphyxiated infants. In chorea, cold applied to the spine, either by the douche or by ether spray, has produced satisfactory results, and a similar application may be made in hysteria. In hysterical catalepsy, hysteria major, convulsions, etc., the sudden pouring of a bucketful of cold water upon the face and mouth, from an elevation of three or four feet, frequently has a marvelous effect. A similar douche of cold water from a pitcher is useful when poured upon the abdomen in cases of inertia of the uterus, either before or after childbirth. In suppression of urine, a cold douche to the dorsal region of the spine often causes free secretion of urine. Contraction of the bladder may be induced in the same way.

The anodyne effects of cold are utilized in the treatment of inflammation, contusions, etc. Sprains, as a rule, are best treated with a local bath of very hot water, followed by compression. Should pain follow, the dressings may be wet with ice-water. This is also useful if there is pain after fracture. In acute inflammation of joints, the ice-bag is of great service in checking inflammation. Compresses of flannel wet with ice-water are useful in tonsillitis, pharyngitis, and laryngitis. Dr. O'Hara, of Philadelphia, reported a case where the continuous resort to cold applications to the throat in a case of diphtheria averted the supposed necessity of a resort to tracheotomy.*

Dry cold is used by means of an ice-bag or bladder filled with broken ice. The skin should be protected by means of one or two layers of flannel, or local freezing (frost-bite) may be produced. This method is very useful in meningitis, and even a congestive headache. The ice-bag should be partly suspended by a cord so as to take its weight from the head. This also has some effect upon the general temperature. The method has also been utilized in cases of fracture, in vertebral caries, in orchitis, or epididymitis, and in numerous other conditions where it has proved exceedingly valuable.

Care should be taken in applying cold to weak or elderly people, and in those with a marked valvular lesion of the heart; for in all these cases reaction, if it occur, will be slow, and it might lead to catarrhal attacks. The cold douche must not be used in fever if there be extreme weakness and feeble pulse, with delirium and cool, clammy skin.

Evaporating lotions, used in treatment of contusions and inflammations around joints, are merely a method of obtaining refrigeration or cold; but as they commonly involve the use of various medicaments other than cold, they need not be considered here.

Small pieces of ice, allowed to melt in the mouth, allay irritation in cases of sore throat and thirst in cases of fever.

* Transactions of the Philadelphia County Medical Society.

LIGHT AND DARKNESS.

Light and darkness are relative terms. Just as cold is merely the absence of heat, so darkness consists in the privation of light. Like heat, also, it is a form of energy, and is regarded essentially as a mode of molecular motion. Modern physics recognizes, in fact, a very intimate relation between light and heat. In the rays of the sun and those emanating from an ordinary incandescent or luminous object, such as a lamp or fire, light and heat are always associated. The rays of light are less diffusive than heat-rays, and the latter may be separated by passing through a saturated solution of alum, which absorbs the heat-rays, but permits the light to pass. In what is termed phosphorescence in insects and luminous bacteria, the heat-rays are deficient. In addition to light and heat, the rays of the sun contain energy, in a form of peculiar activity. These obscure rays, which, in the solar spectrum, are found in and just beyond the violet, are known as the **actinic** rays. As it has been found that the actinic rays produce very marked chemical and photographic effects, it is very probable that part of the physiological and therapeutical effect of the sun's rays on the human organism may be ascribed to this source. The effects of sunlight upon the nervous system is sometimes excessive and injurious. In the West Indies, for instance, sun-stroke is much more to be dreaded than in more temperate countries, as it frequently sets up myelitis, neuritis, or some degenerative process in the body, which results in paralysis, insanity, or chronic invalidism. Even in our northern cities, meningitis is often caused by the sun's rays. From this we conclude that sun-stroke, or insolation, is something more serious than thermic fever, or a temporary overheating of the blood, the effects of which, by the way, are more marked in the lower animals than in man.

Physiological Effects of Light.—The tissues of the body are ordinarily opaque; but, with a high degree of illumination, such as may be obtained from the electric arc light, there is found a considerable amount of translucency. This is the basis of Voltolini's method of examination of the larynx by trans-illumination. We may also introduce electrical lamps into the stomach, partially distended with water, in order to examine the extent and amount of translucency of the stomach and abdominal walls. Under ordinary circumstances, it is probable that sunlight, at least, to some degree, actually penetrates the skin and enters the soft tissues, stimulating and vivifying the cells by its warmth and actinic influence. That it does exert some very important effect upon nutrition is demonstrated by the fact that persons who pursue occupations that keep them constantly in the shade, and away from the sun, acquire a peculiar pallor, and become anæmic. Moreover, not only are human beings dependent upon light for health, but the lower animals depend upon it for their existence. The Mammoth Cave of Kentucky has very few species of the higher orders of animal life, and these show evidences of defective development and imperfections of structure. It is a well-known fact that plants need light, in order that the cells may properly elaborate chlorophyll. Since the color of chlorophyll is due to a soluble salt of iron analogous to hæmatin, which is the chalybeate compound to which the red blood-cell owes its color, the paleness of plants grown in darkness is strictly analogous to the paleness of mill operatives and weavers, whose occupations keep them from exposure to sunlight. Light is not only necessary for physical health, but also for the moral nature. Darkness is depressing to the spirits and unfavorable to intellectual development. The punishment of the dark cell has been abolished almost entirely from penal and reformatory institutions, on account of its unfavorable influences upon the mind and the tendency to cause insanity which has been observed where it has been practiced. There can be no question that the superior intelligence and quickness of comprehension of the human race, among the highly-favored nations, is due, in great part, to their success in providing artificial illumination for all classes of society,—literally turning night into day.

Therapeutical Deductions.—As the absence of light favors anæmia and consequent lowering of vital tone from defective nutrition of the great centres, it is obvious that where this cause is operative it should be recognized and corrected in the treatment of **chlorosis, scrofula, scorbutus, consumption, debility, dyspepsia, neuralgia,** and a host of other disorders of impaired nutrition. **Neurasthenia,** when unattended by latent organic affection, should be treated by sun-baths, gentle massage, life in the open air, and easily-assimilated nutritious food. In weakly children, this course is followed by very satisfactory results, and a tendency to **marasmus, scrofula,** and **anæmia** may be thus overcome. **Anhæmatosis** is corrected by the actinic effects of the sun's rays, and the early stage of progressive anæmia may be amenable to this form of treatment in conjunction with proper diet and appropriate remedies.

In the treatment of the sick, a light, cheerful room is of great assistance to recovery. Especially should an invalid have a room into which the sunlight may enter. The eruptions of the **exanthemata** are made easier by light and heat, and the course of the disease favored. Where it is not desired to have an eruption, the part of the body may be covered with a piece of muslin, or an ointment which is impervious to light. Thus, in **small-pox,** pitting of the face may be prevented by having the patient wear a mask of linen, or by covering the surface with mercurial ointment. In some cases of **acute mania,** or **delirium,** it is advisable to have the sick-room partially darkened, and in **hysterical neuroses** it is sometimes observed that the patients are extremely sensitive to sunlight. On the contrary, persons suffering with **melancholia** and **hypochondriasis** are benefited by light and attractive surroundings. The low spirits of **dyspepsia** are dissipated by a daily walk in the open air, while regular, systematic out-door exercise is of great benefit to the patient in strengthening the digestive functions and enabling him to "outlive his dyspepsia."

MUSIC.

Music belongs pre-eminently to the domain of psychological medicine. It is, therefore, appreciated to a greater degree by the neurologist and alienist than by the general practitioner. Man is something more than a definite combination of chemical compounds, and even more than a mere rational being; he is a moral and emotional individual, and this particular portion of his organization is the most innate and personal part of his nature as revealed to him by self-consciousness. When a man's feelings are touched he is aware that he is profoundly moved, and that, whatever it may be in this structure which is affected, it lies deeper than his reasoning powers or his physical frame. When a man's sympathies are excited he is impelled to a certain course of action by a more powerful force than that which he recognizes as emanating from his reasoning powers, or from what are ordinarily considered as the imperious demands of his bodily appetites. Happiness and misery, affection and aversion, love and hate find no place in natural philosophy or science, but they are powerful factors in human life, and in determining its issues for good or evil. Man is so constructed that his reasoning powers and emotions cannot be separated, nor can we think of these apart from their embodiment in a corporeal frame by which they are brought into material relationship and communication with the world. This being the case, the complete nature of man must come within the domain of medical science, which, indeed, finds expression in the old aphorism, "*mens sana in corpore sano*," health of the body not being complete without there is also mental health.

Physiological Effects.—Music, in addition to its influence upon the emotions, has a decided influence upon the body. M. J. Rambosson read a paper before the Académie des Sciences, Morales, et Politiques (July 18, 1877) entitled "The Influence of Music on the Physical and Moral Nature of Man." In this essay, he affirmed that there is (1) music which acts specially on the intelligence and the motor nerves; (2) that which acts specially upon the nerves of sensibility and on the sentiments; (3) that which acts simultaneously upon the motor nerves and on the sensory,—that is, on the intelligence and the sentiments. From experiments made by Dogiel upon men and the lower animals, the following deductions are drawn: 1. Music exhibits an influence upon the circulation of the blood. 2. The blood-pressure sometimes rises, sometimes falls. These variations in blood-pressure depend essentially on the influence of the excitation of the auditory nerve on the medulla oblongata, which is apparently in direct continuation with the auditory nerve. 3. The action of musical tones and pipes on animals and men expresses itself, for the most part, by increased frequency of the cardiac contractions, and hence it follows that the automatic centres of the heart act with greater energy. 4. The variations in the circulation, consequent on musical sounds, coincide with changes in the respiration, though they may also be observed quite independently of the respiration. 5. The variations in the blood-pressure are dependent upon the pitch and loudness of the sound and tone-color. 6. In these variations of the blood-pressure, the idiosyncrasies of the individuals, whether man or the lower animals, are plainly apparent; and even the nationality, in the case of man, has some effect.*

Dr. Herbert Lilley, in the year 1880, wrote a pamphlet on the "Therapeutics of Music," in which he claimed that music directly influences the brain, in some individuals more than others, women being more readily affected than men. "Its effects are transmitted by a reflex action, through nerve media, to the sympathetic system governing the vascular supply. The vessels are made to dilate by stimulation of the vaso-inhibitory nerves or paralysis of the vasomotor nerves, and so the blood flows freely and imparts that sense of warmth which is felt by us by reason of the local hyperæmia thus produced. By blood-supply is nutrition effected." The important influence upon the bodily functions of the imagination has already been referred to on a previous page. This, also, is under the influence, to a greater or less extent, of music.

The ancient habit of introducing music at banquets is based upon the well-attested fact that digestion is favored if the mind be pleasantly entertained during the time of eating. On the contrary, unpleasant thoughts or violent emotions will take away appetite and retard digestion. Children are usually fond of music, and their uninstructed attempts at dancing show the stimulating effects which it exerts on mind and body. In the adult life, when the musical taste is more cultivated, the feelings may be swayed by music "from grave to gay, from lively to severe." The sense of pleasure and elation of spirits from inspiring military music has been experienced by most of us; but when to these are added

* Letter to British Medical Journal, by Frederick K. Harford, of the St. Cecilia Guild, November 14, 1891.

the charms of association as familiar airs are heard, the influence is deeper and more affecting. As an illustration, we may mention the effect produced by the unexpected hearing of patriotic airs when in a foreign land. Music may be instrumental or vocal, or both combined, "words to music fitly joined." Vocal music has in it a personal element far greater than instrumental, and the mother's songs to her fretful infant contain a subtle influence to soothe and comfort the child. In the same manner it is observed that in hospitals singing is very grateful, especially to those whose troubled minds increase their restlessness and physical suffering. Music diverts the mind from bodily pain and leads it into more pleasant channels.

Therapeutic Applications.—In dentistry, a pleasant application of music is that in which, during the administration of the anæsthetic gas, a music-box is made to play lively airs. This directs the patient's thoughts into an agreeable direction, and no apprehension beforehand is felt, nor is there any recollection of the tooth-pulling afterward, the patient on recovery being ready to affirm that he had been at the opera or a ball. A further use might well be made of this in practical surgery. In nervous hypochondriacs, people who are morbidly anxious about themselves, it is more proper to recommend the opera on one or two nights weekly—even opera-bouffe, if grand opera be not appreciated—than it is to prescribe ammoniated tincture of valerian, coca, or damiana. For depression of spirits or a tendency to melancholia, lively music, such as a concert by a military band, for those who enjoy it, and vocalization of tender or pathetic ballads for those of more sensitive nerves, are resources within the province of the skilled physician, who knows how to "minister to a mind diseased" and "throw physic to the dogs." In his famous "Anatomy of Melancholy," Burton gives an elaborate account of the medical qualities of music, telling us that "besides that excellent power it hath to expel many other diseases, it is a sovereign cure against despair and melancholy; will drive away the devil himself." Jaques Bonnet, in his "Histoire de la Musique et de des Effets," tells how on one occasion he was entertained by a friend—then in the service of the Prince of Orange—with the performance of three first-rate musicians. This was the remedy, he informed him, which his master employed to get rid of melancholy whenever therewith oppressed. *

In the case of many nervous children, it is a measure of the highest utility to give them a musical training as an outlet for their excitability and as a means of soothing perturbed consciousness. In case there is a tendency to narrow chest and insufficient vital capacity, the respiration may be made more full by having the patients learn to perform on wind instruments.

* London Letter to Medical Progress, January, 1892, p. 607.

In Paris, musical performances are resorted to, with marked advantage, in hospitals, and some investigations have been undertaken, in order to determine the influence of different kinds of music, especially in nervous cases. A St. Cecilia Guild has been formed in England, by Canon Harford. The objects, as set forth in the prospectus, are:—

"1. To test by trials, in a large number of cases of illness, the power of soft music to induce calmness of mind, to alleviate pain, and to cause sleep.

"2. To provide a large number of musicians, specially trained to sing and play the very soft music which alone should be administered to those whose nerves are weakened by illness. These musicians should be in readiness to answer promptly the summons of a physician.

"3. To hire or build, in a central part of London, a large hall, in which music shall be given throughout all hours of the day and night, this music to be conveyed by telephone attached to certain wards in each of the chief London hospitals.

"4. To obtain opinions and advice respecting the classes of illness in which music is likely to be most beneficial, and to collect and record all reliable accounts respecting permanent benefit that has followed the use of music."

The work of sending musicians to hospitals and infirmaries has already commenced, and it is intended to continue the experiment long enough for a definite conclusion to be arrived at as to the services which music is likely to render to the sick. The scheme is said to have the warm approval of Miss Florence Nightingale and Sir Richard Quain and other eminent physicians.*

Professor Tarchanow, of St. Petersburg, in a recent lecture, takes the position that "music is of the greatest service in medicine," and that, by the proper use of it, the system can be tuned like a musical instrument. Sufferers from nerve disorders, especially epileptics, can, he states, be soothed by music, but the remedy must be employed with discretion. He attributes the frequent failure of music to its being used at the wrong time, or in unsuitable cases. He expresses the conviction that a time will come when music, "in the hands of scientifically-trained physicians," will be acknowledged to be an agent of great power for the relief of suffering. That it will relieve insomnia and ease pain, not by any analgesic action on the nerve-centres, but by distracting the sufferer's attention, will be admitted. The *British Medical Journal*, in commenting upon this, observes, editorially: "Here, we conceive, is the true field for music as a therapeutic agency, and it seems to us highly improbable that it can ever do more. . . . Within the limits

* Editorial Annotation, British Medical Journal, September 12, 1891.

which have been indicated, however, music may be a most useful handmaiden to medicine; and, in this age of 'nerves,' it might possibly be made to play an important part in the prevention of the many diseases which are fostered, if not actually engendered, by depression and fatigue."* Dr. Lilley, in the paper previously mentioned, states that there are two principal classes of cases in which music might prove a useful remedy: 1. Melancholic and depressed patients, dyspeptics, hypochondriacs, liver cases, parturient women, men suffering from business reverses or family affliction,—these require the tonic form of treatment. 2. Irritable, nervous patients; alcoholic subjects threatened with delirium tremens, overworked business men, persons suffering with hysteria or the mania of pubescence, pregnancy parturition, the climacteric and chronic insanity, and such like,—these require music of a soothing character. The music itself must be well chosen, well executed, and scrupulously considered in relation to individual natures; otherwise, it is of no value therapeutically. In order to be effectual, it must be of the best quality, and devoid of impurities; it must be administered at regular intervals, and in suitable doses.

It should be observed that, in this country, weekly concerts and the frequent use of musical instruments constitute a part of the course of treatment pursued in all the asylums for the insane and feeble-minded patients, and the influence has been found to be favorable to recovery. Cases which are excited by the music that the others enjoy are kept away from the concerts, although they might be soothed by soft music.

The invention of the phonograph by Edison has greatly simplified the matter of giving music in regular doses and of the proper quality and variety. The use of sounds in Charcot's clinic, in order to produce high-note effects, has already been mentioned under "Hypnotism."

VARIOUS THERAPEUTIC METHODS MORE OR LESS MECHANICAL AND LOCAL IN THEIR EFFECTS.

Acupuncture.—The practice of inserting needles into the living tissues for the relief of pain or other disorder occupies a prominent place in Chinese medicine, and in some instances it is followed by strikingly beneficial effects.

The physiological effects of acupuncture are due principally to the reaction of the part against the traumatism; in other words, there is established a focus in which there is a dilatation and rupture of small vessels, hyperæmia, afflux of leucocytes, and increased nutritive energy

* *Loc. cit.*, May 7, 1892.

due to stimulation of vasomotor and sensory nerves. This is accompanied by slight swelling, moderate increase of local temperature, and tenderness upon pressure. The passage of the needles through dense tissues also favors the escape or diffusion of incarcerated local effusions in the sheath of a nerve or around a joint. It is not impossible that the insertion of a metallic substance into the tissues may produce some alteration in the electrical currents between the muscles, blood, and nerve-plates, and so interfere with the conduction of painful, afferent impulses along the sensory nerves.

Acupuncture is rarely resorted to at present, except in the modified form of the hollow needle connected with the hypodermic syringe, which has been already mentioned under methods of administering remedies. The hypodermic needle, indeed, is a very convenient agent for making acupuncture. Care should be taken that the needle is always perfectly aseptic. In **sciatica** a needle may be made to transfix the nerve as it passes over the bone at its exit through the sciatic foramen, or the point where pain and tenderness are most marked may be selected for the operation. In **lumbago** the introduction of needles into the affected muscles often affords marked relief in a few moments. This is more successful when the pain is bilateral than when only one side is affected, according to Ringer. Should the patient shrink from the punctures, the spot may be made insensitive by the local application of ice and salt or by sprays of rhigolene or ether. Injections, under the skin or into the deeper structures, of morphine, atropine, cocaine, antipyrin, chloroform, or simply distilled water (aquapuncture) are often combined with acupuncture for the relief of neuralgia. In acute rheumatic affections acupuncture is useless unless in the combined form just mentioned.

In dropsy of the extremities, scrotum, etc., multiple acupuncture may be performed in order to relieve tension and encourage oozing. If the punctures are made with hollow needles they may be allowed to remain in place, as suggested by Spender, or fine perforated trocars, with drainage-tubes attached, may be used for the same purpose. Simple punctures close again very promptly, and we therefore must resort either to drainage-tubes or incisions. Exploring needles are convenient for making acupuncture, and useful in establishing a diagnosis. Baunscheidtism is multiple acupuncture, combined with counter-irritation. It will be discussed a few pages farther on.

The combination of electricity with acupuncture (electro-puncture) suggests itself, and has been already considered under "Electricity." The difficulty with it is that, except for the electrolysis of surplus hair and for small growths in the skin, it is too painful. The electrodes are so small that the current is under too high a tension just around the poles.

Macewen, of Dublin, recommends acupuncture in the treatment of aneurism of large arteries like the carotid or subclavian. A long steel needle is introduced into the interior of the vessel, and the internal coat slightly roughened by scratching with the point; in this way favoring the production of a white clot and inducing the deposit of fibrin upon the interior of the aneurism, so as to thicken and strengthen its walls.

In the *Annals of Surgery* for January, 1891, Dr. Lewis S. Pilcher furnished an editorial review of Macewen's operation as described in an address delivered before the Midland Medical Society a little over a year ago.* The operation in question was designed for the cure of aneurism by inducing the formation of white thrombi within the sac. This object is secured by irritation at different times of the interior surface of the aneurism, this being done by a pin of sufficient length to completely transfix the aneurism and to permit manipulation within it. Its calibre should be as fine as possible, the strength being only sufficient to penetrate the coat of the artery and the intervening tissues. It is cylindrical, tapers to a point like an ordinary sewing-needle, and has on the opposite end a somewhat rounded head; as the coats of aneurism vary in thickness, it is necessary for the pins to vary in calibre, since those which may pass readily through the walls of one sac may not penetrate the thicker walls of another. They should also be finely polished not only to facilitate their introduction, but to assist in rendering them aseptic. The object of the operation is to secure a white thrombus in an aneurismal sac, by irritating the wall of the aneurism in such a way as to induce infiltration of the parietes with leucocytes and a segregation of them from the blood-stream at the point of irritation. The irritation ought to be just sufficient to set up reparative exudation, and should not exceed it; if the irritation be pushed to such an extent as to induce softening of the vessel wall, not only would the object be frustrated, but the pressure of blood from within might cause the aneurism to burst. It is sought to have several foci of irritation, in order to obtain which the inner surface of the aneurism is lightly scratched by the pin, which may be introduced through the wall at a convenient location, and the point then moved around in the interior of the sac so as to accomplish the desired result in the manner indicated.

It is considered desirable to secure as many foci of irritation and thrombus formation as possible, in order that the resulting clot may be large enough to occlude the vessel. "The operation is preceded by careful cleansing and asepsis of the skin over the aneurism. The aseptic pin is then made to penetrate the sac and pass through its cavity until it comes in contact with the opposite side, and no farther. Then irritation

* British Medical Journal, November 15 and 22, 1890.

may be effected, either by moving the pin over the surface of the inner wall or by allowing the impulse of the blood-current playing on the very thin pin to produce the same result.

"If the wall penetrated by the pin, on introduction, be dense, the former method will be preferable, as the force of the blood-current will produce so feeble an action on the thin pin as to be insufficient to move it to and fro, while it is firmly grasped by the dense wall. After acting thus for ten minutes at one part, the point of the pin, without being removed from the sac, ought to be shifted to another spot, and so on until the greater portion of the internal surface opposite to the point of entrance has been acted upon." In some cases several punctures will be necessary in order to reach a sufficiently large surface of the inner wall. While the pin is in the aneurism, the protruding portion is surrounded by a bit of aseptic gauze, dry or moistened with an aseptic solution. When it is withdrawn from the aneurism, the part is covered with a moist antiseptic dressing; for this purpose Dr. Macewen prefers a watery solution of carbolic acid, and he keeps this dressing in place for several days.*

Antiseptics are agents which prevent the development and check the activity of septic organisms. Inasmuch as these morbific agents are likely to find entrance by traumatism or by being brought into contact with a raw surface, the means of counteracting them is of great surgical interest, but has less to do with medicine proper. As it has been found, however, that the presence of bacilli and other forms of micro-organisms in the air-passages or intestinal tract or in the blood or the tissues gives rise to various diseases, such as diphtheria, typhoid fever, dysentery, diarrhœa, the exanthemata, measles, scarlet fever, erysipelas, etc., it becomes of medical importance to discover means of opposing them and of rendering them inert or, at least, of so reducing their virulence that they may do the least amount of harm. The problem is to find antiseptic agents which shall not be toxic to the human body, or so slightly toxic as to be perfectly manageable. Among these are alcohol, alpha- and beta- naphthol, antifebrin (acetanilide), antipyrin, chlorates and chlorides, creasote, europhen, hydrogen peroxide, iodoform, iodol, kreolin, naphthalin, quinine and other salts of cinchona, soziodolates of potassium and sodium, resorcin, salicylic acid and its salts, zinc sulphocarbolate, etc. For external use, carbolic acid properly diluted (1 to 20 or 1 to 40) and bichloride of mercury (1 to 500 or 1 to 2000), potassium-permanganate solutions, soziodolate of mercury or of zinc (2 to 5 per

* From "Progress in Surgery in 1891;" being the annual oration before the Academy of Surgery of Philadelphia. By Thomas G. Morton, M.D. Reprint from Times and Register of Philadelphia, January 30, 1892.

cent.) are very efficient. Arsenic and chloride of zinc are powerful antiseptics, but are too poisonous in their action upon the human body to be used unless with extreme care. The use and application of the agents named will be found discussed under appropriate headings in other parts of this work.

Aquapuncture has already been incidentally mentioned under the head of "Acupuncture." It consists in the use of a hollow needle to penetrate the tissues and the injection of pure water, recently boiled and sterile. It has been found from experience that this is often an efficient substitute for morphine injections, and that, in patients who have been unable to sleep without their evening hypodermic injection of morphine, the substitution of water has been made without detection by the subject of the experiment, and that sleep followed as usual. This is largely owing to the mental effect, which is very important to obtain in cases of insomnia as an aid to sleep. There is, however, a local effect of the puncture and injection of water into the tissues which is worthy of attention. In addition to the effects of acupuncture, which are not inconsiderable, there is a local tension caused by the fluid, which stimulates the absorbents to carry it away, and perhaps dissolves some morbific agent which causes pain or at least modifies the local chemical reaction.

Aquapuncture is used in the treatment of **neuralgia**, and, being entirely free from constitutional effects, it is better than morphine, antipyrin, and other agents commonly employed. There is no probability of the habit being formed, as with the use of these narcotic drugs; and, even if it should be acquired, it will be harmless if care be taken to keep the needle and water perfectly aseptic.

Aspiration.—The pneumatic aspirator is an instrument invented by Dieulafoy for the removal of effusions or purulent collections by means of suction, or atmospheric pressure. The apparatus consists of a receiver, which, ordinarily, is a glass bottle of any desired capacity. Into this is inserted a cork having two perforations. Each perforation contains a metallic tube containing a stop-cock, and attached at the free extremity to a rubber tube. Finally, one rubber tube is armed with an aspirating needle, or trocar, and cannula; the other tube is attached to a small pump or exhaust-syringe. Now, the stop-cock attached to the needle being closed and the other one open, the syringe may be worked so as to exhaust the air in the receiver, when the stop-cock is closed and the partial vacuum maintained. If the needle be now inserted into any collection of fluid, and the appropriate stop-cock opened, the fluid will flow into the receiver until the supply is exhausted or the vacuum has been filled. The process can now be repeated, and this is done until the desired quantity of fluid has been removed. It may be necessary to empty the receiver several times during the operation. The great advantage of this method is, that no contamination of the contents of the cavity by the air can take place; nor can air enter the wound of puncture, if it be promptly sealed with adhesive plaster. Several modifications of the apparatus are supplied. In one the syringe itself is made large enough to act as the exhaust chamber, and, by a double stop-cock, the fluid is drawn out by an upward movement of the piston, and by turning the cock it is discharged through a long rubber tube into a basin or other receptacle. Either form may be employed for injection by reversing the process, thus irrigating, or overdistending, the interior of an abscess, as practiced by the late Mr. Callender.

The ordinary hypodermic needle and syringe may be employed for aspirating small cavities or for purposes of diagnosis.

Capillary aspiration may be performed by attaching a long rubber tube to a hypodermic needle and filling it with antiseptic solution, leaving the extremity of the rubber tube beneath the surface of some water in a basin. The hollow needle is now introduced, by a rotary motion, through the tissues directly into the cavity, and retained in place by adhesive plasters. The flow of the liquid is much slower in this case; but this is an advantage in some cases,—for instance, in effusion into the pleura.

One of the dangers of aspiration of the chest is: the sudden alteration of pressure upon the walls of the blood-vessels by the rapid removal of the fluid might lead to congestion and, possibly, œdema. When the apparatus is not rendered aseptic, there is danger of exciting suppuration and septicæmia. Sudden removal of pleural effusions has been followed by death within a few hours, apparently of shock.

Pneumatic aspiration is a useful expedient for removal of dropsical effusions into serous cavities, serous exudations, or purulent collections in any accessible locality. Hydrothorax, ascites, hydrocele, hydropericardium, effusions into the pleuræ, pericardial sac, into the cavities of joints, are all easily treated in this way. Purulent deposits, such as in psoas abscess, hip-joint disease, which do not admit of open incision on account of danger of septic infection, are properly emptied by aspiration. Over-distension of the gall-bladder or urinary bladder may require aspiration, and if properly performed the danger from peritonitis is inconsiderable. Large effusions of blood—hæmatocele, for instance—may be first injected with a pepsin solution to dissolve the fibrinous clot, and afterward exhausted with the aspirator. In pleural and pericardial serous effusions, it is sometimes an advantage to perform capillary aspiration, when immediate relief is not required. The contents of ovarian cysts may be determined by examination of a portion withdrawn by aspiration. Hammond advises the introduction of a long aspirator needle into the liver in nervous hypochondriacs, in order to determine whether or not the symptoms may be due to abscess of the liver.

Bandaging.—In medical practice the ordinary surgical roller bandages are employed to make uniform pressure, in order to promote absorption of effused material; to support inflamed or swollen parts, such as mammary gland or testicle; and to retain dressings, such as poultices or antiseptic appliances. Bandages may be made of any convenient dimensions, and are usually from two to three inches wide and from six to eight yards in length. They are ordinarily made from unbleached muslin free from sizing, but they also are made from thin white flannel, gauze, or crinoline. The flannel bandages not only may be applied to make pressure, but also are useful for their retention of warmth. In fact, in catarrhal inflammations of the throat, tonsillitis, laryngitis, etc., a flannel bandage around the neck is of considerable service. Inflamed rheumatic joints, either acute or chronic, are often materially relieved by a flannel bandage wound closely around the part. A flannel bandage from twelve to twenty-four inches wide, according to circumstances, worn around the waist, in infants, and even in older persons, is useful in preventing attacks of colic from exposure to cold.

In neuralgia accompanying neuritis, or in herpes zoster, a flannel bandage is an important part of the treatment. In acute pleurisy the application of a bandage around the chest prevents excursion of the ribs in coughing, and alleviates pain. It is sometimes useful to apply strips of adhesive plaster in the same way as in treating fracture of the ribs; this not only affords comfort, but keeps the effusion from becoming excessive in quantity. In chronic pleurisy the application of a bandage and the application of counter-irritants to the underlying surface considerably promote absorption. A bandage of narrow strips of adhesive plaster is applied to an enlarged testicle for the same purpose.

After delivery, the parturient woman is made comfortable by the application of a wide bandage extending from the hips well up on to the chest. This, in a measure, supplies pressure to the walls of the abdominal blood-vessels and prevents syncope. A bandage is sometimes applied during labor, previous to delivery, to support the uterus and abdominal walls.

Retentive bandages are required in various forms of hernia, also in varicocele and in varicose veins. When the ankles tend to swell, bandages are applied with much relief and decided effect upon the œdema. A tight bandage around the head sometimes relieves headache. In cases of apoplexy, bandages may be wound around the thighs and arms in order to reduce arterial tension. When venesection is to be performed, a bandage is applied around the arm so as to cause the veins to become prominent. In cases of snake-bite, a narrow bandage should be thrown around the finger, or the limb, in order to prevent the introduction of the poison into the general circulation, except by degrees. In ordinary cases bandages should not be so close as to check the circulation in a limb, or gangrene may result. Retentive bandages are used to keep dressings and medicated compresses upon the surface of the body.

Brown-Séquard showed that the application of a tight bandage around the big toe would, in some cases, check or prevent an epileptic attack.

Baunscheidtism.—As already stated under the head of "Acupuncture," the procedure, named in honor of the German who invented the instrument employed in this manner of treatment, consists essentially in multiple punctures of the skin, into which some counter-irritant application is rubbed. The little instrument contains a spiral spring in a handle six or eight inches in length. At its inferior end the instrument is enlarged to form a circle from three to four centimetres (one to one and one-fourth inches) in diameter. In this crown are concealed eighteen or twenty needles, which are suddenly projected, from a quarter to a half an inch, when the spring is pulled up and suddenly released. If applied to the skin a circle of minute punctures is made by this procedure. Now, if croton-oil, diluted with sweet-oil, be rubbed into these punctures a decided inflammatory reaction is produced, affording considerable counter-irritant effect. This method is used principally for the treatment of chronic affections of joints attended with pains and more or less exudation. It also affords relief in myalgia, lumbago, and some forms of neuralgia.

Blood-Letting and Transfusion.—Blood-letting is not entirely a lost art in medicine, but our therapeutic resources have so greatly increased within the past twenty or thirty years that its usefulness has been very much restricted.

General blood-letting is usually performed by opening a vein,—venesection, phlebotomy,—and the one selected is usually the median cephalic or median basilic, although it may be performed from any large superficial vein, such as the temporal, external jugular, or the veins on the dorsum of the hand or foot. Arteriotomy is sometimes done in cerebral affections, by section of the temporal arteries. In persons known as hæmophiles, or bleeders, any cut or rupture involving a blood-vessel is likely to produce the effects of general blood-letting.

Although rarely resorted to at the present day, general blood-letting is a valuable therapeutic resource. It moderates high tension and vascular excitement, relieves congestion, allays nervous irritability and pain, relaxes the muscular system. It also moderates inflammatory action and promotes absorption, and before the days of arterial sedatives was pre-eminently the leading antiphlogistic remedy. The history of medicine contains many instances of desperate cases, where life was apparently saved by frequent resorts to the free use of the lancet.

The place that venesection occupies in therapeutics is an uncertain one. In a recent paper, Dr. Hiram Corson strongly advocates bleeding for the relief of pneumonic patients, and he thinks that, as there is always more or less attendant congestion, any time is the proper time to bleed. There are others, and these are the majority of clinical teachers, who advocate bleeding in pneumonia during the first stage, where there is a dilated right heart from obstruction in the pulmonary circulation. Finally, many others, of equally high authority, declare pneumonia to be a specific fever, incapable of being favorably influenced in its course or termination by abstraction of blood, which, on the contrary, may do much harm. Under such circumstances the question of "to bleed or not to bleed" must be determined altogether by the circumstances attending the individual case. Bleeding is undoubtedly serviceable in eclampsia, during pregnancy or parturition, or immediately afterward, provided there is high arterial tension and there is congestion of the brain. In convulsions following exposure to the sun, bleeding is practiced with benefit, but it is highly injurious or fatal in the ordinary form of sun-stroke. In narcotic poisoning and in uræmia, venesection is to be used with caution, but it is a justifiable resort in severe cases. In inflammations of strong, robust people, the judicious abstraction of blood makes the patient more comfortable and lowers arterial tension. In iritis, a good bleeding is remarkably beneficial at the outset of the attack.

In patients of large, muscular frame, when there has been a dislocation of a large joint, the abstraction of blood has been resorted to in order to produce complete muscular relaxation.

Blood-letting should be resorted to with caution in persons of feeble digestion and weak assimilative powers, and rarely, if ever, in elderly persons and very young children, in low fevers, in tubercular affections, and in persons disposed to hæmorrhage.

The local abstraction of blood is accomplished in a number of ways, the most common being scarifications, multiple punctures (the antiphlogistic touch of Prof. Wm. H. Pancoast), and by leeches and wet cups.

Scarifications are linear incisions, superficial, for the most part, cutting into the derma or through granulating tissue, for the relief of local engorgement, as in conjunctivitis, granular lids, etc., and tonsillitis. In œdema of the larynx, scarification is of great immediate relief; but in œdema of the scrotum or lower extremities it is objectionable because the incisions do not heal readily. Multiple punctures may be skillfully performed with a fine knife, or tenotome, and congested blood-vessels relieved of their tension. It is absolutely required that the knife shall be surgically clean and recently made aseptic, or serious results may be produced. A felon may be aborted by early punctures through the soft parts to the bone.

A **leech** (hirudo) is an aquatic worm of simple annulated structure found in different parts of the world. Its mouth is armed with cutting teeth, with which it makes an incision through the skin and holds on by exerting a suction power; when it becomes filled with blood it drops off. It can be made to drop off earlier by application of salt water. The European or Swedish leech is about two inches in length, and will draw about half an ounce of blood. If the bleeding from the leech-bites be encouraged by warm fomentations, each leech can be estimated to cause the removal of one ounce of blood. The American leech is smaller, and will only take about one-fourth as much blood. If the discharge of blood from the leech-bites is more than is desired, it may be checked by touching them with a stick of nitrate of silver, a little Monsel's solution, or dry subsulphate of iron, by pressure, or by a small suture.

Cups may be **wet** or **dry.** The cup is a small, bell-shaped glass, which, at its upper extremity, has an opening guarded by a valve, so that, when applied to the surface, and the small syringe-pump employed to abstract the air, a partial vacuum will be formed and maintained in its interior. The soft tissues rise up into the cup and become deeply congested by dilatation of the blood-vessels. The spot may be scarified and the cup re-applied, so that, when the air is exhausted, the blood will flow in to take its place. This is called wet-cupping, and it is a valuable resource for local abstraction of blood and as a revulsive agent. When the proper apparatus is not to be had, cups may be extemporized by egg-glasses or coffee-cups, the edges of which are thick and not likely to cut the skin. The air can be exhausted by pouring a few drops of ether or alcohol into the glass and igniting it; while the vapor is burning the cup is inverted upon the skin and the flame is immediately extinguished. The cup, in cooling, causes contraction of the air, and the tissues are forced into the cavity by atmospheric pressure. A piece of burning paper may be used in the same manner, to exhaust the air from the cup.

Local blood-letting reduces local hyperæmia and swelling, and, consequently, relieves pain; it limits the destructive effects of inflammation and favors restoration to the normal condition.

Cups and leeches are useful as revulsive agents and for local depletion. The latter are useful for inflammation of glands and swollen joints. In inflammation of the eye they are often resorted to. Cups are used in pneumonia, pleurisy, and other affections of internal organs.

Transfusion is the process by which there is introduced, directly into the blood-vessels of a patient, either blood or blood deprived of fibrin, milk, or various saline solutions. The transfusion of blood may be **immediate** or **mediate**; in using defibrinated blood or fluids other than blood, the process is always mediate. In the form known as immediate transfusion, the vein of the patient is practically made a continuation of the vein of the donor of the blood by means of a short rubber tube. The method usually followed is to obtain a small rubber tube, having glass or silver tubes at its ends, and with a bulb in its middle by which the blood can be urged forward on its course. It contains no valves; but when the bulb is compressed the operator must pinch the tube behind the bulb, and before the pressure is removed from the bulb the tube must be released and pinched in front of the bulb so that the suction shall be in the proper direction. This is known as the transfusion apparatus of Aveling. The method of using it is to obtain the assistance of a person who is in good condition and can spare from eight to twelve ounces of blood. The arms of both donor and receiver are properly prepared antiseptically. The median cephalic or basilic vein of each then is exposed by a short incision and the wall of the vein cut so that the cannula may be introduced, pointing toward the centre in the patient and toward the extremity in the donor. The little apparatus is filled with a warm saline solution so that no air will enter the vein, and is put in place and confined there with a bandage, if necessary. Now, by proceeding as indicated, alternately slowly compressing the bulb and again allowing it to expand, the saline solution passes into the vein and is followed by blood. The entire amount of blood may be estimated by counting the compressions of the bulb, it having been determined previously by experiment how much blood is delivered at each movement. The operation is concluded by bringing the edges of the vein together with a fine suture and closing the wound and applying a light compress of gauze with a roller bandage.

Mediate transfusion is a less simple procedure. The blood to be injected is drawn into a bowl and whipped with some twigs in order to remove fibrin and prevent clotting. The defibrinated blood, carefully maintained at a temperature of 100° F., is drawn into a warm syringe and slowly injected through an opening in a vein, as in the preceding method. The most complete antiseptic precautions are required.

Arterial transfusion is rarely performed, although perfectly feasible, as shown by laboratory experiments. The objection is that it involves permanent obliteration of an artery on the part of the donor. A superficial artery, such as the dorsalis pedis, is selected, and, after dissection from overlying tissues, it is divided and a silver cannula inserted, connecting with a rubber tube with its opposite extremity armed with another cannula, which is introduced into a vein of the recipient. The force of the arterial circulation will make the blood traverse the tube, which should be kept warm with hot towels wrung out of bichloride solution.

Milk used for intra-venous injection should be obtained directly from a healthy cow or goat, and poured into a funnel terminating in the tube and cannula as before. A strainer of fine gauze should be placed over the mouth of the funnel to intercept any accidental impurity or foreign body which might have fallen into the milk. Saline solutions may be introduced either in the same manner or with a syringe or aspirator. The following solution is recommended by Hayem as a sort of artificial blood-serum:—

Sodium hydrate,	15½	grains.
Sodium chloride,	80	grains.
Sodium sulphate,	390	grains.
Water, recently boiled and filtered,	3	fluidounces.

Of this from 1 to 4 pints may be slowly injected at a temperature of 100° F. It is important that, as recommended by Potain, the fluid be injected slowly, at a rate of less than an ounce (20 cubic centimetres) per second. The specific gravity of the solution should be about 1020.

Transfusion of blood has been practiced for years as the rational method of saving life where death is at hand from hæmorrhage. In post-partum hæmorrhage, or loss of blood attending abortion, this method has proved successful in many instances, as this is an emergency which finds the physician and attendants somewhat prepared. In other cases, as after surgical injury, where there is an element of shock, or after pulmonary hæmorrhage in tuberculosis, it has not been followed by a flattering degree of success. In intestinal hæmorrhage of typhoid fever, it may be tried with a prospect of good results. The quantity of blood need not be more than from four to eight ounces; it acts as a powerful vital stimulant to the heart, and is capable of tiding the patient over an emergency. In morbid states of the blood, transfusion has been performed, in a limited number of cases, without very encouraging results. In anæmia it has failed, but in the hæmorrhagic diathesis favorable reports are given by Dr. Joseph Buchser, of New York. In carbonic-acid poisoning and phosphorus poisoning, transfusion has been used successfully. It has also been recommended in the treatment of toxic symptoms from unknown drugs, or where there are no known antidotes. In uræmic poisoning it has been resorted to with satisfactory results.

Dr. Hodder, of Montreal, used injection of warm milk successfully in cases of **cholera** collapse, and Thomas, of New York, employed the same expedient successfully in **post-partum hæmorrhage.** Injections of a saline solution, such as that of Hayem, have been very successfully performed in the stage of collapse in Asiatic cholera, or cholera morbus.

The use of the blood of the lower animals, advocated by Gesellius and others, is not to be recommended, on account of the difference in size of the blood-corpuscles and the danger of communicating infectious diseases or introducing parasitic organisms.

The injection of blood into serous cavities, such as the peritoneum, has been recommended by Ponfick and indorsed by Bizzozero and Golgi, and has been successfully practiced. Inasmuch as the rate of absorption is uncertain and the dangers of peritonitis imminent, it cannot be said that peritoneal transfusion is destined to be a rival of the classic form, which has for its chief advantage promptness of remedial action, thus gaining time for other remedial agents to act.

Enteroclysis; Irrigation of the Bowels, Injections, Clysters, and Enemata.—Fluids or semi-fluid substances are injected into the bowels through the anal aperture in greater or less quantity, according to the extent of intestinal surface intended to be brought into contact with or to be affected by the medicament employed. The objects to be attained are the direct local effects upon the bowels, and the indirect or secondary effects, which are caused either by absorption of a portion of the enema into the blood, or by an effect upon the nervous system or upon the temperature of the body. Enemata or injections are given (1) to cause prompt evacuations from the bowels; (2) to affect the thermal, chemical, or bacterial characters of the bowel contents, or act upon its mucous membrane; (3) to introduce certain substances into the circulation and produce systemic effects.

For making injections into the bowel a special instrument is employed, which was formerly called a clyster-pipe; it is now known by the general term of syringe. Various forms of syringes are offered to the profession. The simplest syringe is one with a cylindrical barrel, containing a plunger and piston-rod, to which a ring or other conveniently-shaped handle is affixed, the opposite extremity terminating in a nozzle. The best syringes of this kind are made of hard rubber, which have almost entirely driven those of glass or pewter from the market. For an adult the syringe should have a capacity of from four to eight ounces, which is usually sufficient for a simple enema, although several pints may be required. In childhood, from one to four ounces will prove sufficient, and in infancy from half an ounce to one ounce is ordinarily enough for an opening injection. Continuous-flow syringes are of two kinds: (1) gravity, or so-called fountain syringe, and (2) bulb, or force syringes. The fountain syringe consists of a bag, with a capacity of a pint or more, connecting at the bottom with six feet or more of soft-rubber hose, to the end of which is affixed the usual anal, rectal, or vaginal tube. The bag, filled or partly filled with the fluid to be employed in the injection, is hung at the patient's bedside, from four to six feet above the level of the lower end, when introduced into the vagina or rectum; in this way the fluid gradually is introduced by hydrostatic pressure, without any other force being employed. The bulb syringes are of different shapes, but the principle is almost the same in all. A rubber-ball of cylindrical shape, with tapering ends, and of convenient size to grasp in the hands, is provided at each extremity with a valve, each opening in the same direction. A supply-tube passes from a receptacle of water, or the fluid to be employed in the injection, to one end of the bulb, and from the opposite end passes the delivery-tube, terminating in a nozzle of hard rubber. By alternately pressing and releasing the bulb, a current of fluid is sent along the tubing with as much force as is desired. In fact, there is danger of using greater hydraulic pressure than was intended, and thus causing injury to the bowel, especially when weakened by disease or ulceration, such as occurs in dysentery or typhoid fever. One form of syringe makes use of air-pressure, instead of hydraulic pressure, the fluid being placed in a bottle connected with the delivery-tube and partly filled with the medicament desired to be thrown into the bowel. When air is pumped into the bottle the liquid is forced out through the delivery-tube under less pressure than by the usual plan just described.

(*a*) Some formulæ for laxative enemata are as follow:—

Simple Laxative.

℞ Olei ricini vel olivæ, ... f℥ij.
Add to a pint of soapy water, and use as an injection.

Stimulative.

℞ Olei terebinthinæ, ... f℥ss.
Olei ricini, ... f℥iss.
Add to a pint or two of hot soap-suds, and use as an enema.

Purgative.

℞ Tinct. aloes, ... f℥ij.
Ol. olivæ, ... f℥ij.
In a pint of soapy water.

Evacuant.

℞ Glycerini, ... ♏xx–fℨiv.
Use as a rectal injection.

In cases of obstinate impaction a long tube should be inserted, so as to carry the glycerin into the vicinity of the mass and assist in breaking it up.

For Infants.

℞ Ol. olivæ opt., ... f℥ss.
To be injected into the bowel to produce evacuation.

For Chronic Constipation.

℞ Sem. lini, ... ℥ss.
Make an infusion with a pint of boiling water, and, when cold, strain through muslin. Use each morning, as an enema.

(*b*) Injections administered for the purpose of affecting the thermal, chemical, or bacterial character of the contents of the bowel or to act upon its mucous membrane.

When comparatively large quantities of fluid are thrown into the bowel, the procedure is known as irrigation; and, when they pass the ileo-cæcal valve, as "enteroclysis." Such large injections are not required for simple evacuation of the bowels, but are employed for various purposes connected with the state of the intestine or its contents. Thus, in states of fever, especially typhoid, large injections of cold water may be given, in order to remove the contents of the bowel, to reduce temperature, and for their effects upon the nervous system. In cholera, a form of irrigation is highly praised by Cantani, which is called **enteroclysis,** because by this means remedies are carried, by an antiperistaltic motion, through the ileo-cæcal valve into the small intestine. Tannic acid being very destructive to cholera cultures, and, in the quantities employed, harmless to the human subject, was chosen as the principal agent to be used in the injection. The formula employed by Cantani was as follows:—

℞ Acid. tannic., ... grm. 5 to 20 (ℨj gr. xviij–ℨv gr. viij).
Acaciæ pulv., ... grm. 50 (℥iss).
Vini opii, ... gtt. xxx.
Aquæ (temp. 100° to 104° F.), . litres 2 (4 pints).
M. Sig.: To be used after each evacuation of the bowels.

Out of one hundred and seventeen cases of cholera treated by the above method Lustig reported thirty-four deaths only, which is highly favorable as compared with other methods of treatment. The same plan has been used in cholera infantum and in summer, or sporadic, cholera, with excellent effects. In addition to these injections of tannin into the bowel, Cantani recommended **hypodermoclysis**, which consists in the introduction of a saline solution (3 per cent. sodium carbonate and 4 per cent. sodium chloride), at a temperature a little above that of the body (100.4° to 104° F.), into the subcutaneous connective tissue, by means of a Pravaz, or large hypodermic, syringe. In true cholera, during the algid state, the practice of hypodermoclysis is said to give startling results. Its object is to reduce the tendency to thickening of the blood following loss of watery fluids by transudation. Its advantages over intra-venous injections consist not alone in avoidance of the danger of opening or manipulating veins, but also in the process of absorption being more uniform and natural. In one hundred and eighty-seven severe cases thus treated the mortality was 39 per cent. Enteroclysis is used for the premonitory diarrhœa and the first stage, hypodermoclysis in the algid and typhoid stages; when the treatment is begun with the disease already advanced, both are used.* In some cases, "**peritoneoclysis,**" or injection of saline fluid into the peritoneal sac, was cautiously practiced, without evil results, except slight tenderness and tympanites. Enteroclysis, or irrigation of the small bowel with warm water, is a valuable expedient in catarrhal jaundice and gall-stones. In the treatment of thread-worms, or oxyurides, large injections of salt water or infusion of quassia, or of black tea, are very efficient in dislodging these parasites from their headquarters in the cæcum and large bowel.

Astringent enemata are sometimes employed to check diarrhœa, and anodynes may be thus administered. For instance, laudanum (♏xxx) in starch-water is very useful in relieving pain and tenesmus. Nitrate of silver (gr. ii–viij to a pint of warm water) is used in dysentery, especially if ulceration be present; it may be repeated once or twice daily. Carbolic acid, mercurial salts, and other agents which, if absorbed, would cause poisoning, should not be employed per enema. Very frequently, diarrhœa is kept up by the presence of irritating substances in the intestine. Irrigation of the bowel has been found to be a resource of great value in such cases; and, even in infants, it has given highly satisfactory results.

The mechanical effects of the distension of the bowel are chiefly utilized in the treatment of intussusception of the bowels; but they are

* Annual of the Universal Medical Sciences, 1889, vol. i, D-32.

also active in every case in which the administration of an enema is followed by evacuation of the bowel contents. In some abdominal operations it has been recommended to introduce a rubber bag into the rectum and distend it by the injection of water, so as to lift the organs in front of the bowel higher up in the pelvis, so that they may be more readily encountered by the supra-pubic incision; the expedient just mentioned being of especial application in the case of stone in the bladder.

(*c*) Injections into the bowel for the purpose of systemic effects are of two kinds: (1) medicinal; (2) nutritive. Medicinal enemata of tannin in cholera have been mentioned under the head of "Enteroclysis." In many instances remedies are administered in the form of a suppository of cacao-butter, which is fluid at the temperature of the body; but the same medicaments might be given in starch-water or other vehicle by enema. Quinine may be thus administered to children for malarial manifestations. Bromide of potassium and chloral are useful in reducing restlessness and tendency to convulsions in children; milk of asafœtida is an excellent injection to be administered in a case of convulsions where there is supposed to be indigestible substances in the bowels acting as an irritant. Enemata containing alcoholic stimulants are sometimes administered. Although this method of administration of remedies is attended by some inconveniences, yet it is very useful where the stomach is irritable or the patient is unable to swallow drugs, as in coma, etc. It is capable of being extended in the case of children, who object to swallowing disagreeable medicine. In the treatment of phthisis good results have been reported following the use of sulphuretted waters by enema. The administration of nutritive material by injection into the bowel is of sufficient importance to be considered separately.

Rectal Alimentation and Intestinal Inhaustion.—It is a physiological fact that the absorbing surface of the large bowel may be utilized to support life when the stomach cannot digest food. Experience has shown, indeed, that life may be almost indefinitely sustained by the injection into the bowel of certain articles of food in a physical condition favorable for absorption. In gastric ulcer, for instance, it is necessary to allow the stomach time to heal without being called upon to digest food, not only because of the pain and vomiting following the taking of food and the danger of hæmorrhage, but also because cicatrization will proceed more rapidly if uninterrupted. During this time, therefore, it is of great importance to introduce food by a channel which so fully answers the purpose and which is so closely allied to the normal. The same proximate principles of the food can be introduced into the system when placed in the bowel as when they are taken into the stomach, the chief differences being that the food is not subjected to the same churning process in the bowel as in the stomach, and, of course, no gastric juice is furnished by the mucous coat of the large intestine. The capacity of the rectum is considerably less than that of the stomach. From this, we learn that nutritive enemata should consist of food in form most favorable for absorption and assimilation, and that the quantity should be comparatively small (about 4 to 6 ounces), in order not to excite reflex contractions of the muscles by reflex action and rejection of the enema. It is desirable to set up a tolerance on the part of the bowel to the injections; and they should, at first, be given cautiously and a small quantity at a time, and repeated not oftener than at intervals of four hours. It may be necessary to reduce the sensitiveness of the mucous membrane by a preliminary injection of tincture of opium (♏xxx) in starch-water, or an opium suppository may be introduced. In children, bromide of potassium and chloral may be substituted for the opium, or simple injections of cold water may suffice to render the bowel less intolerant. Cocaine is so uncertain in its action in different individuals that its use is not deemed advisable for this purpose.

The directions for preparing nutritious enemata are very simple. It is more convenient to have the substance in a fluid or semi-fluid condition and strained, so that it will pass through the syringe. Meat suppositories have also been used, but they are less efficient than enemata. The basis of the injection is usually milk, which should be scalded and partly peptonized. To this, meat-extracts, beef-juice, or Bovinine may be added. If desired, a small quantity of brandy or whisky can be added also. The enema should not exceed two ounces at first, and the frequency of administration must be governed by the demands of the system and the tolerance of the bowel. If alimentation can be conducted in this manner every four hours and it is well borne by the patient, this interval should be maintained. In some patients, however, the interval may have to be prolonged to seven or eight hours, especially at the beginning. On a previous page (page 283) of this work directions will be found for peptonizing different articles of food, some of which, on account of the predigestion, might be used for rectal alimentation. The late Prof. Henry F. Campbell, of Augusta, Ga., called especial attention to this method of supporting the powers of life by nutritious enemata, and he maintained, by introducing the food above the sigmoid flexure, that the liquid would be carried backward through the ileocæcal valve into the small intestine by a process of reverse peristalsis due to intestinal inhaustion. He showed that the system could be nourished perfectly and life sustained for many months by nutritive enemata. Milk injections containing the yelks of one or two eggs, with some powdered pancreatin or solution of pancreatin or papoid, will be found the most available and generally efficient. The juice of raw beef, or meat-extract, may be added to the enema after toleration has been established.

This method is to be used in gastritis, some cases of dyspepsia, gastric ulcer, carcinoma of the stomach, insufficient nutrition, persistent vomiting or pain after taking food, and in marasmus and other affections of young children. In special conditions of disease it may also be resorted to with advantage; its utility in skin diseases is sometimes very marked. (See a communication on "Rectal Alimentation and Medication in Diseases of the Skin," by John V. Shoemaker, A.M., M.D. "Transactions of the Ninth International Medical Congress," vol. iv, page 170 *et seq.*) For further discussion of the important subject of alimentation the reader is referred to the section upon "Diet in Disease" (page 270 *ante*), and also to articles contributed by the author to the *Medical Bulletin* for June and July, 1892, entitled "Food and Diet in Health and Disease, including a Review of Many Prepared and Condensed Foods, together with the Treatment of Obesity and Leanness."

Setons and Issues.—These are expedients which had their origin in former ideas of pathology, and, consequently, at the present day, are nearly obsolete. Each depends upon setting up a point of irritation and suppuration on the surface of the body, in order to produce revulsive or counter-irritant effects upon deeper-seated pathological processes. A **seton** consists of a strand of cotton or silk, or other material, passed through a small fold of skin. A piece of silver wire or a strip of sheet-lead may be used. The thread may be carried through by means of a seton-needle, or the skin may first be perforated for the purpose with a bistoury. The seton is allowed to remain in position for several days or even weeks.

An **issue** is made by applying a cauterizing substance, such as caustic potassa, to a spot upon the skin, and, after the slough has separated, a dried pea, glass bead, or piece of orris-root is kept in place over the open surface by a bandage, so as to keep up irritation.

Setons in the neck (nucha) were formerly used in cases of obscure brain or spinal disease and eye inflammations. In infantile hydrocele of the cord, a seton may be inserted for a few hours to set up adhesive inflammation. Issues and setons are now rarely employed, because of the danger of the wound becoming infected with erysipelatous, tuberculous, or other germ disease, and because continued suppuration may lead to septicæmia, Bright's disease of the kidneys, or lardaceous degeneration of other organs.

Suspension in Disease of Spinal Cord, and Nerve-Stretching in Nervous Disorders.—Among the mechanical means occasionally resorted to in medical practice is support of a portion of the body by suspension. Thus, in lateral curvature of the spine, systematic exercise, with suspension more or less complete, by instructing the patient to climb a ladder, or a rope hand over hand, is a highly useful device for strengthening weak muscles and overcoming deformity. The same principle is applied in treating Pott's disease by Sayre's apparatus with a "jury mast."

A suspension belt encircling the elbows so that the patient may sleep in a sitting posture, and a support afforded to the extrinsic respiratory muscles, forms an apparatus of great usefulness in asthma. About 1883, Motschutkowski, of Odessa, published reports of the relief afforded in cases of locomotor ataxia by suspension of the body from the shoulders. This method, it seems, was first applied by Prof. J. K. Mitchell, in Philadelphia, many years before. Motschutkowski and, subsequently, Charcot arrived at favorable conclusions from their experiments, and Prof. S. Weir Mitchell has also published commendatory accounts of his experience with a form of apparatus of his own devising.

The effect of the treatment by the apparatus of Charcot or Weir Mitchell is to take pressure from the intervertebral cartilages and to straighten the curves of the spine. The good effects which have undoubtedly occurred in a number of cases may be due, as suggested by Dr. Julius Althaus, to the fact that spinal meningitis usually is found associated with pathological changes in the cord, especially in the posterior columns. Suspension produces a revulsive effect similar to that of cauterization and to passive motion of joints by which adhesions are stretched or broken and their absorption favored. Since suspension has given the most favorable results in old, advanced cases, it is very probable that this is true. There is no evidence that the spinal cord is stretched by this process; on the contrary, it may be relaxed. There have been some unfavorable results reported; but, considering the character of the cases, such accidents might be attributed to other causes, and certainly do not constitute a bar to the treatment when properly applied. Rosenbaum advises against suspension in pronounced cases of myelitis and in recent paralysis agitans.

The diseases in which suspension has proved beneficial, besides locomotor ataxia, are spastic spinal paralysis and amyotrophic lateral sclerosis and neurasthenia, or functional nerve-prostration. S. Weir Mitchell is especially convinced of its utility in Pott's disease of the spine.

The number of papers published during the last two or three years, upon suspension in the treatment of nervous diseases, has been small, as compared with the large number appearing soon after Motschutkowski's early papers upon this subject. The same reports of improvement and disappearance, in part or entirely, of symptoms, have characterized recent communications. In a small proportion (in five out of twenty-five hundred cases of Rosenbaum) the improvement is remarkable. The lancinating pains are relieved, there is enhanced ability to walk, increase in appetite and bodily weight, and in sleep. The gastric crises, in a few cases, become less frequent, but paræsthesia of hands and feet and ocular symptoms are very obstinate.

Professor Leyden claims that the treatment of tabes by suspension produces no appreciable effect upon the pathological process; that neither on therapeutic nor upon scientific grounds is it reasonable to expect such a curative action, and that practical experience, when viewed with an unprejudiced eye, fails to show such effects; none of the results reported, he says, go beyond the effects of suggestion.

At Charcot's clinical service at La Salpêtrière, the form of suspension is by the chin and occiput, and the instrument employed is Motschutkowski's modification of Sayre's apparatus. Stillman * recommends the upright and recumbent curved-board frames devised for orthopædic purposes.

Benuzzi has tried forcible flexion of the spine as a substitute for suspension, by forcibly flexing the body with the knees bent on the abdomen. A tabetic female treated in this manner showed material improvement. He experimented upon the cadaver and concluded that by this procedure the relation of the spinal cord to the spinal column is so changed that the cord is displaced upward three to four millimetres, and the vertebral column lengthened from one and one-half to three centimetres, the increase in length being due to separation of the processes rather than of the vertebral bodies. The nerve-roots are displaced, but not noticeably shortened, with the exception of the cauda equina; there is lowered tension of the cerebro-spinal fluid. He regards the beneficial effects of suspension as due to traction upon the cauda equina, stretching it and, through it, the spinal cord; this, he thinks, is best accomplished by forcibly flexing the body with the knees upon the abdomen. Cagney, on the other hand, after extensive experiments upon both the dead and living body, denies that it is possible to stretch the spinal cord or nerve-roots by suspension; that instead of extension of the spinal canal, there is a total shortening of it. He inferred that if the cord is benefited by suspension it is by relaxation and not by stretching it.†

* Weekly Medical Review, St. Louis, September 6, 1890.
† Annual of the Univ. Med. Sciences, 1891, vol. ii, p. B-38.

Nerve-stretching is a recently introduced expedient for the treatment of various affections of the nerves attended by pain. As it involves a surgical operation,—the cutting down upon a nerve-trunk, isolating it, and subjecting it to more or less forcible stretchings,—it need not be discussed here. It might be said, however, that in some cases of neuralgia (sciatica, etc.) this has been resorted to with marked relief to the patient, and that it is now an acknowledged surgical *dernier ressort* for such cases.

FORMULARY.

The following recipes for articles of food for the sick are in frequent demand :—

Raw Beef.

Raw, lean beef, free from fat, may be pounded into a pulp in a mortar with some white sugar, and spread upon bread, to be taken as a sandwich by young children or rachitic infants. Or, with a rather dull knife, scrape a piece of tender meat, so as to separate the pulp from the fibrous portion. The soft mass thus obtained may be seasoned with salt and pepper, like sausage-meat, and eaten, spread upon biscuit or bread ; or it may be moulded into small balls and slightly browned on the outside in a hot oven. Meat-pulp may also be rubbed up with half its quantity of granulated white sugar, and in this form is readily taken by young children.

*Beef-Tea, No. 2.**

Prepare a pound of good rump-steak by chopping it in small pieces and removing pieces of fibrous tissue and fat. Place it in a pint of cold water in a covered saucepan. Let it stand in a cool place for three hours, and then place it on the fire, where it may simmer gently for fifteen minutes; season, and decant or strain through a horse-hair sieve. The meat should be as fresh as possible, and the saucepan enamelled upon its inner surface. Beef-tea must never be allowed to actively boil, and in re-heating it should only be raised to the proper temperature for drinking.

Calves'-Feet Broth.

Two calves' feet are to be carefully cleaned and placed in two quarts of cold water, which is then brought to boil and kept boiling until the feet are reduced to shreds; strain the liquid portion off, and add a little salt, and pepper, if desired. When administered to the patient, it is to be warmed. It may be made more nourishing if, to each cupful, a beaten egg and two tablespoonfuls of fresh milk are added, and all brought quickly to a boil before serving. A dash of lemon-juice improves the flavor, and the broth may be taken with some crisp toasted bread.

Clear Brown Soup.

Take a shin of fresh beef, cut it in pieces, and put into a saucepan with enough cold water to cover it. Bring it to a boil, and add a bundle of sweet-herbs, vegetables (a little sliced carrot, turnip, onion, celery, etc.), also pepper and salt to taste. Boil until the meat is tender, then strain, and let it stand in a cold place until the next day. Remove the fat from the surface and heat the broth, adding as much browning as will make the soup a proper color. Beat up two eggs with their shells until quite a froth, and put them into the soup with a whisk. Let it boil gently for ten minutes, when it may be decanted, or, if desired. it can be strained through a cloth, when it will be perfectly clear.

* For other formulæ for liquid dietetic preparations, see page 281.

Consommé, or Bouillon.

Take one or two pounds of beef from the leg, round, or chuck; wash well, cut in pieces, and put on to boil with three quarts of cold water. Skim frequently while boiling, and, when reduced to a quart, take from the saucepan and strain. Return to the saucepan and add a few thin slices of onion, half a pound of lean beef, chopped fine and well mixed with three raw eggs. A few bay-leaves may be added. Beat all thoroughly into the broth, which is to be returned to the fire and boiled for about half an hour. It should be made clear by straining through horse-hair sieve or muslin, and seasoned.

Oyster-Soup.

The desired number of oysters, depending much upon their size, are allowed to drain through a colander for five minutes, and the liquor preserved. A pint of boiling water is then poured over them, which is thrown aside. Add to the liquor already drained a pint of hot water, and put over the fire in a porcelain-lined saucepan. Boil until all the scum has risen and has been skimmed off, then add half a pint of fresh milk, one powdered water-cracker, a piece of butter, and a little salt and pepper. One or two allspice may also be added. Boil for ten minutes, and, just before the soup is served, turn in the oysters from the colander and let them scald for three minutes, and then send to the table in a covered dish.

Chafed or Panned Oysters.

Take a dozen large oysters, drain off the juice, and preserve it. Have a silver chafing-dish or a porcelain-lined vessel over a fire, and place a piece of butter, as large as a walnut, in the vessel. When the butter indicates that the dish is sufficiently hot, the oysters are turned in, and a little salt and pepper added. When the oysters change color and curl up, they are placed in a hot dish. The oyster-juice is now turned into the chafing-dish, with a little cream, and brought to a boil and poured over the oysters. Dry toast may be cut into squares and served with the broth, if desired.

Roast Oysters.

A dozen fresh oysters, not long out of their native bed, in their shells, are placed upon a stove or on a moderately strong fire until the shells open a little. They are then opened, preserving the juice, if possible, and served hot, with a little black pepper and salt, if needed. The tough part of the oyster (cartilaginous portion) need not be swallowed, if the patient be delicate. This is said, by Dr. Henry Hartshorne, from personal experience, to be relished and digested sooner than any other solid food in convalescence after fever.

Vegetable-Soup.

Put two potatoes, a handful of peas, one ripe tomato, and a piece of stale bread into a quart of water, and boil to a pint. Add chopped celery or parsley and salt. Keep in a covered dish. Strain when served, if for a delicate stomach. It may be made more nutritious by adding the yelk of one egg to each cupful, or some meat-extract, like Liebig's or Armour's.

Bread-and-Butter Soup.

A piece of well-baked, rather stale, bread is to be spread with good, sweet butter and sprinkled with salt and pepper. Pour a pint of boiling water over it, and allow it to stand for a few minutes. When cool enough, it may be eaten as an article of low diet by convalescent patients.

Panada.

Two pieces of stale bread, deprived of crust, are to be toasted brown and cut into small squares. Lay them in a bowl and sprinkle with salt and a little nutmeg. Pour on a pint of boiling water, and let it stand to cool.

Toast-Water.

Two pieces of stale bread are thoroughly browned in a hot oven. They are then placed in a bowl or pitcher, and a pint of boiling water poured over them. After standing until cold, the water is poured off into a pitcher and a slice or two of lemon placed on top. If desired, it may be sweetened with some crushed sugar and served cold. Patients are allowed to drink it freely, in place of water.

Tamarind or Currant-Jelly Water.

A refreshing drink may be made for patients, in summer particularly, by placing some preserved tamarinds, free from their shells, in a glass of water which had been previously boiled. Where tamarinds are not to be had, currant-jelly may be used in the same way, in cases of bowel disorder or to allay thirst in fever.

Lemonade.

Take two large, fresh lemons, and wash them clean with cold water. Roll them until soft; then divide each into two, and use a lemon-squeezer or reamer to express the juice into a small pitcher. Remove all the seeds from the juice; to which add four or more tablespoonfuls of white sugar, according to taste. A pint of boiling water is now added, and the mixture stirred until the sugar is dissolved. It should be drunk while hot, and is very effective in producing perspiration. Ice-water may be used instead of the hot water, and a piece of lemon-peel added; if desired, a weaker lemonade may be made by using more water. This is a refreshing, acidulous, and antiscorbutic drink, and is especially refreshing in hot weather. Limes or lime-juice may be used instead of the lemons.

Milk-Jelly.

Dissolve one ounce of gelatin in a cupful of warm water. Heat a quart of milk with a pound of white sugar for about ten minutes, aiding the solution of the sugar by stirring. Let the solution cool, and then add the gelatin solution, the juice of three or four lemons, and half a pint of wine or two wineglassfuls of brandy, stirring the mixture slowly, and pour into glasses or moulds and place in a cool place to stiffen. The object of allowing the milk to become cold is to prevent curdling when the other ingredients are added.

Gelatin.

An ounce of sheet gelatin is dissolved in a pint of warm water, and this brought to a boil. Add one half-cupful of sugar, the juice of one lemon, and the white of an egg. Beat together well, and pour into a mould and keep on ice. Serve a tablespoonful at a time, so as to encourage the patient to ask for more.

Wine-Jelly.

One box and a half of Coxe's gelatin soaked in water one hour, must then have added three pints of boiling water, and one pint of sherry-wine, and two pounds of white sugar. The white of an egg and juice from three lemons are then added, and all strained through a fine sieve. The rind of one lemon is then sliced and put in, or small pieces of orange or other fruit used in place of the lemon-rind. Pour into cups or moulds and allow it to stand until it hardens.

Tapioca-Jelly.

One cupful of tapioca is washed, and then placed in three cupfuls of cold water to soak for four hours. It is then placed in a water-bath and heated until it begins to clear, adding more lukewarm water if too thick. When quite clear add the juice of a lemon, a pinch of grated peel, and sweeten to taste. Pour into moulds. Serve cold with cream flavored with rose-water and sweetened.

Arrowroot-Jelly.

This is made like the preceding, using one cupful of boiling water to two heaping teaspoonfuls of arrowroot, and the same quantity of white sugar. A tablespoonful of brandy or three tablespoonfuls of wine make an agreeable addition.

Restorative Jelly.

One-half box of Coxe's gelatin, one tablespoonful powdered gum arabic; one-half pint port-wine, a tablespoonful of lemon-juice, three tablespoonfuls of white sugar, and two cloves are mixed together and soaked for two hours. The mass is then placed in a bowl in a basin of boiling water, or a water-bath, and the ingredients dissolved by heat and constant stirring. Boil for a minute after the ingredients are melted, and then strain through a sieve or flannel jelly-bag, and set aside to cool. The port-wine may be replaced by any other liquor or beef-juice, if preferred. In the latter case, omit lemon and sugar and use salt. A spoonful at a time is sufficient for very ill patients.

Wine-Whey.

Boil up half a pint of fresh milk and remove any scum that is formed. Stir in a wine-glassful of sherry-wine and boil for a moment longer; strain as soon as the milk is curdled. Put on the ice, or, if used as a warm drink, serve at once.

Milk-Punch (Egg-Nogg).

Beat the white of an egg into a froth and add to a tumblerful of cold, sweet milk and two tablespoonfuls of brandy well stirred in. The yelk of the egg is rubbed up with a tablespoonful of granulated sugar and mixed thoroughly with the other. A little nutmeg on the surface improves the flavor. It should be taken at once, quite cold, and preferably through a straw or glass tube.

Egg-Lemonade.

Take the white of one egg, a tablespoonful of pulverized sugar, juice of one lemon, and one goblet of water and mix them intimately. A useful drink in sore throat.

Sago-Milk.

Put three tablespoonfuls of sago in a cupful of cold water and let it stand one hour. Add three cupfuls of boiled milk; sweeten and flavor to taste. Allow this to simmer on a slow fire for half an hour; serve warm.

Rice-Water. Barley-Water.

The rice, or barley, is washed and added to cold water, in the proportion of a tablespoonful to a pint. Allow it to stand in a warm place for two hours, then boil slowly for one hour, or until the water is reduced to one-half, and strain. If too thick, it may be thinned by adding boiled water or boiled milk. It is very useful in cases of summer diarrhœa, especially in children.

Rice-Milk.

Two tablespoonfuls of rice and one teaspoonful of corn-starch are added to two pints of milk, and boiled in a farina-boiler until each grain of rice is soft and the whole assumes a creamy color. It may be sweetened and flavored as required.

Baked Milk.

If half a gallon of milk be placed in a jar and the top covered by tying writing-paper over it, and allowed to stand in a moderate oven for eight or ten hours, it will be like cream in consistency, and delicious to the taste.

Flour-Ball.

Tie up a quart of wheat-flour in a pudding-bag tightly. Put into a pot of boiling water and keep it boiling for ten or twelve hours. Take the hard mass out of the bag and allow it to dry before the fire. Peel off and throw away the thin outer portion, and grate down the mass with a nutmeg-grater into a powder, as wanted for use. One or two teaspoonfuls of this may be rubbed into a paste with some milk and then stirred into a pint of milk, over the fire. The milk should only be scalded; that is, just brought to the boiling-point without being boiled. This is a valuable article of food in diarrhœa, especially in children.

Egg-Broth.

Mix two ounces of pearl-sago in half a pint of cold water, and let it stand half an hour. Then boil until it becomes smooth and sufficiently thick. Beat the yelks of four fresh eggs, with half a pint of cream; then mix with the sago, and stir the whole well with a quart of beef-tea or chicken-broth, just made, at a boiling heat.

Caudle.

Beat up a raw, fresh egg with a wineglassful of sherry-wine, and add to it half a pint of hot oatmeal, Indian meal, farina, or gruel. Flavor with lemon-peel, nutmeg, and sugar.*

*This and some of the preceding recipes are from "The Trained Nurse," in an article on "The Food of the Sick," by Henry Hartshorne, M.D., LL.D., of Philadelphia.

CLINICAL INDEX.

GENERAL INDEX.