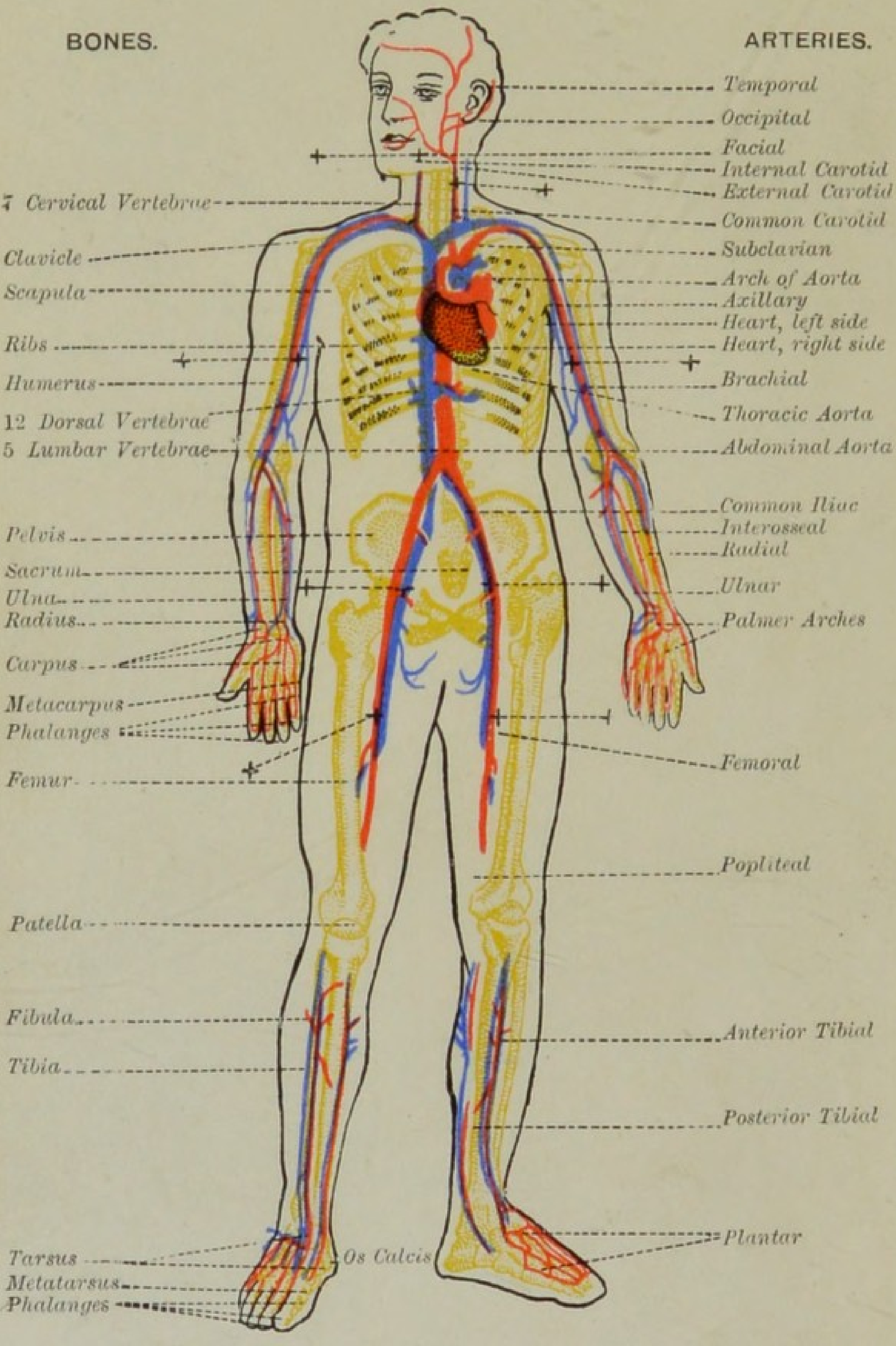
Ambulance

Hand-Book

ST. ANDREW'S AMBULANCE ASSOCIATION

St. Andrew's Ambulance
Association

SKELETON AND BLOODVESSELS.



+ *Points where arterial bleeding may be arrested*

AMBULANCE HAND-BOOK

ON THE PRINCIPLES OF

FIRST-AID TO THE INJURED.

BY

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TWENTIETH IMPRESSION

COMPLETING ONE HUNDRED AND THIRD THOUSAND

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TO THE

PAST AND FUTURE PUPILS

OF THE

St. Andrew's Ambulance Association

THIS HAND-BOOK IS RESPECTFULLY DEDICATED

BY

THE AUTHOR.

"From the time the mother binds her child's head, until the moment when some kind attendant wipes the death damp from the brow of the dying, we cannot exist without mutual help: all, therefore, who need aid have a right to ask it of their fellow-mortals, and no one who has the power of granting can refuse it without guilt."—*Scott.*

PREFACE TO FIRST EDITION.

SEEING that there are already in existence several excellent hand-books on *first-aid* to the injured and to those taken suddenly ill, a word of explanation is called for as to the appearance of another one. The present volume was undertaken in response to the requests of the Committee of the St. Andrew's Ambulance Association, who felt that uniformity of instruction and teaching would be better assured if the Association issued a text-book of its own; while, it was hoped, the sale of such a work might prove to some extent a source of revenue. Accordingly, in carrying out the work, I have taken the syllabus of the lectures of the St. Andrew's Ambulance Association as a guide, and consequently the book contains the gist of the lectures I was in the habit of delivering at one time for the Association. The plan adopted is to give a short account of the anatomy and physiology of each set of organs or system in the body, and immediately afterwards to treat of their affections and injuries with the appropriate *first-aid*. This has been done perhaps more at length than in most of the hand-books already published, but I have felt that in a work for non-professional readers everything should be clearly and fully stated, as it is only in this way that the Ambulance pupil can gain an intelligent knowledge of what he has to do in dealing with the emergencies of every-day life. By thus endeavouring to explain each subject in a plain and simple way, and with the avoidance, as much as possible, of purely technical and medical terms, I am hopeful that the book may prove useful to those for whose special benefit it has been written.

A liberal use has been made of illustrations, with the view of rendering the text more intelligible. Many of these have been prepared expressly for the work, but others have been taken from recognised works in anatomy, physiology, and surgery. To Messrs. Collins of Glasgow, especially, my thanks are due for placing at the disposal of the St. Andrew's Ambulance Association several wood-cuts from their excellent manuals of physiology. I am also much indebted to the Secretary of the National Life-boat Institution for leave to publish their instructions (with illustrations) for restoring the apparently drowned; while Messrs. Chambers of Edinburgh also kindly gave permission for the use of the reduced copy of the St. Andrew's Ambulance Association Triangular Bandage, which appeared in their Encyclopædia. A few errors have arisen in connection with the numbering of the figures in the text, but it is hoped that the errata published, and the explanatory notes appended, will obviate any difficulty that might otherwise arise.

GLASGOW, *September*, *1891*.

PREFACE TO SECOND EDITION.

THE First Edition of this Hand-book being exhausted, it has been found necessary to issue a second one. No change has been made in the subject-matter of the Hand-book beyond the re-arrangement of the order of its contents, and the correction of errors of spelling and numbering of the illustrations that had crept into the first edition. The alterations in this second edition consist in the use of better paper and printing, with the addition of the Syllabus of Lectures of the Association. I hope that this edition may be as favourably received as its predecessor. My best thanks are due to the Secretary of the Association for the very active interest he has taken in the preparation of this edition.

GEORGE T. BEATSON.

7 WOODSIDE CRESCENT,
GLASGOW, *October*, 1892.

PREFACE TO THIRD EDITION

THE rapid sale of the Second Edition has necessitated the publication of a Third Edition of the Ambulance Hand-book. As before, no change has been made in the subject-matter of the book, but a fuller Table of Contents and a Synopsis have been added. These, it is hoped, will increase the usefulness of the Hand-book.

GEORGE T. BEATSON

7 WOODSIDE CRESCENT,
GLASGOW, *December*, *1893*.

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SYLLABUS OF AMBULANCE LECTURES

WITH

CORRESPONDING CHAPTERS OF HAND-BOOK.

First Lecture.

A. Introductory remarks, explaining clearly the scope and object of lay help in ambulance work, special attention being drawn to the need for it, as well as the usefulness and simplicity of it.

(Chap. I.)

B. Short sketch of the general anatomy of the human body, including a brief description of the functions of digestion, absorption, circulation, respiration, excretion, secretion, and innervation.

(Chap. II.)

C. Uses of a bandage—Of the two kinds of bandage, the roller not needed for ambulance work—Description of Esmarch's triangular bandage, pointing out (1) its advantages, (2) method of folding and fastening it, (3) its application in different ways—Hints as to the "first dressing" of wounds by ambulance pupils.

(Chap. III.)

Second Lecture.

A. Short account of the skeleton, with brief description of the structure and varieties of the joints.

(Chap. IV.)

B. (1) *Fractures*—Their varieties, causes, symptoms, and dangers—Their temporary treatment and the apparatus necessary for it. (2) *Dislocations*—How they differ from fractures, and the first-aid in such cases—No necessity for immediate reduction, and the dangers of attempted reduction by non-professional persons.

(Chaps. V. and VI.)

C. Illustrations of the temporary treatment of the following *simple* fractures—(1) collar bone, (2) upper arm, (3) fore arm, (4) hand, (5) thigh, (6) leg, (7) foot, (8) lower jaw.

(Chap. V.)

Third Lecture.

To be devoted to practical work, when the members of the class will exercise themselves in the use of the triangular bandage and the temporary treatment of the different fractures mentioned in the previous lecture.

Fourth Lecture.

A. (1) General description of the circulation of the blood, and the mechanism by which it is carried on—(2) Distinction between arterial, venous, and capillary hæmorrhage—(3) Names of the main arteries of the body, with their situation—(4) Points where arterial circulation may be arrested by pressure—(5) Dangers of hæmorrhage.

(Chap. VII.)

B. General treatment of hæmorrhage: — I. *Internal hæmorrhage*—First aid in cases of (1) bleeding from the nose, (2) spitting of blood, (3) vomiting of blood. II. *External hæmorrhage*—(1) Application of cold, either by water or exposure to air, (2) Elevation of part, (3) Local pressure, (4) Distant pressure on main artery supplying wound, either by hand or tourniquet, (5) Three kinds of tourniquet: elastic, screw, and improvised.

(Chap. VIII.)

C. Show mode of applying elastic or screw tourniquet, and of making an improvised one—Give illustrations of arrest of hæmorrhage from (1) scalp, (2) neck, (3) armpit, (4) upper arm, (5) fore arm, (6) hand, (7) thigh, (8) ham, (9) leg, (10) foot—Give illustrations of temporary treatment of a *compound* fracture, with hæmorrhage in upper or lower extremity.

(Chap. VIII.)

Fifth Lecture.

To be devoted to practical work, when the members of the class will exercise themselves in the arrest of hæmorrhage in various situations, and in the temporary treatment of *compound* fractures.

Sixth Lecture.

A. Short account of respiration, its objects and mechanism.

(Chap. IX.)

B. Fainting, its causes, symptoms, and treatment—Immediate treatment of those apparently drowned, or suffocated by (1) hanging, (2) poisonous gases, (3) choking—First aid in cases of (1) burns and scalds, (2) bites by animals possibly rabid, (3) tears from machinery, (4) crushed and bruised parts, (5) stabs.

(Chaps. X. and XV.)

C. Show mode of performing artificial respiration (Silvester's method), and also the temporary treatment of fractured ribs.

(Chap. X.)

Seventh Lecture.

To be devoted to practical work, when the members will exercise themselves in performing artificial respiration, and in the arrest of hæmorrhage from supposed cases of ruptured varicose veins, stabs, tears from machinery, and gunshot wounds.

Eighth Lecture.

A. Short account of the digestive and nervous systems.

(Chaps. XI. and XIII.)

B. Symptoms and first treatment of shock or collapse.

(Chap. XIV.)

C. First aid in cases of (1) those stunned by a fall or injury to the head, (2) convulsions, (3) epilepsy, (4) sunstroke, (5) persons found insensible, (6) suspected poisoning, (7) frost-bite, (8) lime in the eye, (9) supposed death.

(Chaps. XII., XIV., and XV.)

NINTH LECTURE—For Males only.*

A. Removal of the injured by means of stretchers, special attention being directed to (1) the proper carriage of the stretcher, (2) the manner of placing it, (3) the loading and unloading it, (4) the position of the patient on it, (5) suggestions as to overcoming difficulties on the road, (6) hints as to the conveyance of stretchers by rail or country carts.

(Chap. XVI.)

B. Short account of some of the improvised methods of removing injured persons when no stretchers or regular conveyances are available, as by the two-handed, three-handed, and four-handed seats.

(Chap. XVI.)

C. Give illustrations as to how to prepare and fold up a stretcher.

TENTH LECTURE—For Males only.*

Stretcher drill in presence of and under direction of Lecturer.

* In Ladies' Classes, Lectures on Sick Nursing will take the place of these Lectures.

SYNOPSIS.

Object of Ambulance Instruction.—It is to explain to non-professional persons how they can be of service in cases of accident or sudden illness until medical assistance is obtained.

The Scope of Ambulance Work.—It is not to make amateur surgeons or doctors of the public. It is to save life in emergencies, to lessen suffering, and to prevent harm being done before the doctor arrives.

The Need for Ambulance Instruction.—This is at once apparent when we remember that no inconsiderable proportion of the deaths in our midst are due to accidents, some seventeen thousand dying annually from this cause alone.

The Usefulness and Simplicity of Ambulance Work.—Its *usefulness* lies in the fact that the immediate treatment adopted in the case of any severely injured person has a positive influence and most important bearing on the subsequent progress of the case. Its *simplicity* is due to that being made the leading feature of ambulance work. The temporary nature of the treatment is kept in view, and hence everything is done to make it simple and of such a kind that it can be quickly carried out.

Rules applicable to every case requiring Ambulance aid.—

1. Bring to your assistance "presence of mind."
2. If necessary, remove sufferer out of the way of the traffic.
3. Send for a doctor, and where possible let the message be a written one.
4. Make out a history of the accident.
5. Lay patient on his back.
6. Loosen any tight clothing.
7. Never consent to "bleeding" being resorted to.
8. Examine the patient for any local injury.
9. Observe great caution in the administration of stimulants.
10. Exercise every care and ingenuity in the removal of the injured person.

A Knowledge of the Structure and Functions of the Human Body necessary for carrying out Ambulance Work.—To enable "first-aid" to be rendered in an intelligent manner, it is necessary that the ambulance pupil should possess a knowledge of the general arrangement of the body and of its functions.

General Construction and Arrangement of the Human Body.—The human body is really a very intricate piece of machinery, and the best idea of it will be obtained by looking at it from a structural, chemical, and physiological point of view.

1. *Structural Composition of the Body.*—It is made up of two nearly symmetrical portions, and is naturally divisible into the following parts :—

(a) Head, Neck, Trunk, } *Axial portion*, containing parts essential to life.

(β) Limbs, { *Appendicular portion*, adapted for prehension and progression.

If an examination is made of these various parts it will be found that they are composed of different *structures* or *tissues*, and that in addition some of them contain *spaces* or *cavities* in which are lodged a series of separate *organs* for carrying on the several functions of the body.

The following are the Tissues that would be met with :—

1. *Skin*, which forms a tough, elastic, sensitive, and protective covering.
2. *Fat and connective tissue*, which serve as padding.
3. *Muscles*, which perform movement.
4. *Blood-vessels*, which are connected with the nutrition of the body, the *arteries* feeding the parts and the *veins* draining them of impurities.
5. *Nerves*, which appear as white cords and which have the power of carrying sensation and regulating movement.
6. *Lymphatics*, which are a series of minute, delicate, transparent vessels, and with their *glands* are intimately associated with the repair of the tissues and the removal of waste products.
7. *Bones*, which are dense, firm structures and serve as a frame-work for the body, the soft parts being grouped round them.

Of the several Cavities that exist in the body, the chief are the *head* for the brain, the *vertebral canal* for the spinal cord, the *chest* for the lungs and heart, and the *abdomen* for the essential organs of digestion with their accessory glands. The partition which separates the chest from the abdomen is known as the *diaphragm*.

2. *Chemical Composition of the Body.—Thirteen* of the *sixty-four* chemical elements enter into its composition, and they combine to form a very large number of compounds, as a result of which there is constantly going on in the body a *remarkable display of chemical activity, with, of necessity, a corresponding production of heat.*

3. *The Physiology of the Body.*—Life is the great distinctive feature, and its presence is indicated by (1) *warmth* and (2) *the power to move about,* these requiring material in the form of *food* for their production.

The body possesses (1) a *digestive apparatus* to reduce to fluid the food required for replenishing the blood; (2) an *absorbent apparatus* to absorb the new material into the body; (3) a *circulatory apparatus* to carry the blood after it has been enriched by the new material to every part of the body for the repair of the tissues; (4) a *respiratory apparatus* to ensure the admission of oxygen into the body; (5) an *excretory apparatus* for throwing off waste material, (6) a *secretory apparatus* for the production of fluids to be utilized for special purposes in the economy; and (7) a *nervous apparatus* to serve as a guiding and regulating power in the body. By this plan of constructing the body in a series of systems and arranging that certain organs shall only perform certain duties, there is brought into play the very useful and excellent principle of *the subdivision of labour.* In this way the very complicated machinery of the human body works more efficiently.

The *Locomotory Apparatus* is that by which the body is enabled to move from place to place. It is made up of three distinct parts :—(1) Bones, (2) joints or articulations, and (3) muscles.

The *Bones* consist of animal matter known as gelatine or gristle and mineral matter, which is chiefly phosphate of lime. They serve the double purpose of giving strength and firmness to the body and protecting delicate and sensitive organs. They also furnish a series of levers, as in the limbs, for the muscles to work on.

The bones of the body are of various shapes, and number about two hundred. Collectively they are spoken of as the skeleton, which is divided into an Axial and an Appendicular part.

The *Axial skeleton* includes :—

1. The skull,
   - The cranium, 8 bones.
   - The face, 14 bones.
2. The vertebral column,
   - 24 true vertebræ.
   - Sacrum, 5 bones.
   - Coccyx, 4 bones.
3. The thorax,
   - Sternum or breast-bone.
   - 12 pairs Ribs—7 true, 5 false.
   - 12 Vertebræ behind.

The *Appendicular skeleton* includes :—

1. Upper limb,
   - Shoulder,
     - Scapula.
     - Clavicle.
   - Arm, Humerus.
   - Fore-arm,
     - Radius.
     - Ulna.
   - Hand,
     - Carpus, 8 bones.
     - Metacarpus, 5 bones.
     - Phalanges, 14 bones.
2. Lower limb,
   - Hip, Pelvis.
   - Thigh, Femur.
   - Leg,
     - Patella.
     - Tibia.
     - Fibula.
   - Foot,
     - Tarsus, 7 bones.
     - Metatarsus, 5 bones.
     - Phalanges, 14 bones.

The *Joints* are the points where two or more bones of the skeleton come into contact. There are three classes of them—(1) Immovable, (2) Mixed, (3) Movable.

The structures which enter into a movable joint are—

1. Bone.
2. Cartilage—to render the bone smooth.
3. Ligament—to hold the bones together.
4. Synovial membrane—to enclose the ends of the bone and secrete a lubricating fluid.

The movements of the joints are—

1. Gliding, as in wrist.
2. Hinge, as in elbow.
3. Ball and socket, as in shoulder.

The *Muscles* comprise a large portion of the body, and they form its flesh. It is by them that all *movement* takes place in the body. This is accomplished by their *contractility* or power of shortening themselves. There are two classes of them :—

1. *Striped* or voluntary, because under our control.
2. *Unstriped* or involuntary, because not under the will.

Muscles are made up of bundles of fibres, and when they are placed at any distance from the bones on which they act, they end in fibrous cords, which are known as *tendons* or *sinews*.

FRACTURES.

Definition.—A Fracture is "*the surgical expression for a broken bone.*"

Varieties.—Two chief classes of fractures :—

(i.) SIMPLE = bone broken in one place only, without any wound.

(ii.) COMPOUND = bone broken, with wound leading from skin to seat of fracture

Explanation of certain terms—

1. *Comminuted* = bone broken into several portions at seat of fracture.
2. *Multiple* = when same bone is broken at more places than one.
3. *Complicated* = where there is injury to some important structures in addition to the fracture.
4. *Impacted* = where the broken ends are driven one into the other.
5. *Complete* = where the bone is broken right across.
6. *Incomplete* = where the bone is partially broken and partially bent. This is also known as a "willow" or "greenstick" fracture.

N.B.—The line of the fracture may be *transverse*, *oblique*, or *longitudinal*, and these terms are employed to indicate this fact.

Causes—

(1) *Violence*, direct or indirect.
(2) *Muscular action*.

Symptoms—

(1) Unnatural mobility or movement.
(2) Grating (*crepitus*) of broken ends of bones.
(3) Shortening.

Dangers—

(1) *Simple* ones becoming *compound* or *complicated* by the sharp ends of the bones wounding the skin, blood-vessels, or nerves.
(2) *Bleeding* in compound ones.

"*First-Aid*" *Treatment*.—Consists in the prevention of further damage to the parts. Hence, unless necessary, do not move the patient, but keep the part at rest in as natural a position as possible and await medical aid. If the person has to be moved, attend to the fracture on the spot, getting the fragments into position by gentle manipulation and then securing them there either by bandages or splints and bandages combined. Exercise great care in the removal of clothing from a fractured part, *cutting* it off rather than *pulling* it off. In "First-Aid," splints are best put on outside clothes, which serve as pads. In case of *compound fractures*, arrest any serious bleeding, wash the wound with clean water, or, better, with some antiseptic solution, and then apply a "first dressing," bandages and splints being added in addition. Lastly, take special care in the transport to the hospital or their house of a person with a "broken limb."

Apparatus required for "First-Aid" Treatment.—(1) Bandages, (2) Splints, (3) Padding.

Bandages.—The *Triangular Bandage* is the most suitable in every way for the temporary "First-Aid" treatment of fractures, and indeed for ambulance work generally. It can be used in so many (32) different ways, and so efficiently serves all the uses of a bandage in the matter of keeping dressings on, fixing splints, and making pressure on any particular spot, that the ambulance pupil should rely on it alone, and by frequent practice with the aid of the diagrams upon it should make himself proficient in its use.

Splints.—These are pieces of wood or other firm substance used to confine the broken ends of a bone when set in their proper position. Accordingly, a multitude of things may be used, the locality where the accident happens determining the material used. The choice of splints always calls for ingenuity and reflection on the part of the ambulance pupil.

Padding.—As splints are hard, in cases where they are not applied above the clothing, they require to be padded with something *soft*, which should overlap the edges of the splints on all sides.

Special fractures and their temporary treatment:—

1. *The Skull or Cranium.*—Loosen tight clothing about neck and place person comfortably. Favour reaction. Lessen chances of brain inflammation by quietness in a darkened room, cold cloths to head, and avoidance of stimulants. If removal necessary, let it be done with great caré.

2. *Nasal Bones.*—Arrest bleeding, dress any wound, and await medical aid.

3. *Lower Jaw.*—Bandage lower jaw to upper jaw with triangular bandage or handkerchief.

4. *The Spine.*—Keep flat on back. Treat shock by warmth. Await medical aid. If removal necessary, let it be done with great care.

5. *Ribs.*—Treat shock and limit movements of chest walls by broad bandage or handkerchief firmly applied. Carry home on stretcher.

6. *Breast-bone* (*Sternum*).—Limit movement by bandage, as in case of ribs.

7. *Shoulder-blade* (*Scapula*).—Arm in large sling and fixed to side by a bandage.

8. *Collar-bone* (*Clavicle*).—Put pad in arm-pit, support arm in *large* sling, and bind arm to side just above elbow.

9. *Upper-arm* (*Humerus*).—Apply two or three splints around fractured ends of bone and support arm in *small* sling.

10. *Bones of Fore-arm* (*Radius and Ulna*).—Apply two splints (back and front), bend elbow at right angles, with thumb pointing upwards, and support fore-arm in a *large* sling.

11. *Bones of Hand or Fingers.*—Lay hand on well-padded splint or bend fingers over a round pad in hollow of hand, and secure with bandage. Support hand in *large* sling.

12. *Pelvis.*—Keep person flat on back, treat shock, and apply broad bandage as a support round hips. If removal necessary, let it be done with great care.

13. *Thigh* (*Femur*).—Apply a long splint on outside of limb from arm-pit to foot with shorter splint on inside from top of thigh to knee. Secure splints with bandages round chest, waist, thigh (above and below fracture), below knee and above ankle, having first made gentle extension of injured limb until the same length as the sound one. Tie both limbs securely together and remove person on stretcher, where removal required.

14. *Knee-cap* (*Patella*).—Straighten out the injured limb and fasten it on a back splint reaching from buttock to heel. Tie both limbs together and remove on stretcher, where removal required.

15. *Bones of Leg* (*Tibia and Fibula*).—Apply two splints reaching from knee to ankle, one on inner and one on outer side of limb. Tie both limbs together and remove on stretcher, where removal required.

16. *Bones of Foot.*—If any wound, uncover foot and apply a "first dressing." Support foot by some form of well-padded splint as an angular one, improvised by tying a short and a long one together. Remove on stretcher, where removal required.

As regards the apparatus for "first-aid" treatment, it may be said that there are *three groups* of fractures. In the *first* group, illustrated by fractures of the skull and spine, the ambulance pupil requires no apparatus; in the *second* group, including fractures of the ribs, lower-jaw, collar-bone, shoulder-blade and pelvis, he needs only bandages; and in the *third* group, which comprises fractures of the thigh, knee-cap, leg, foot, upper-arm, fore-arm, hand and fingers, he has to employ both bandages and splints.

In the "first-aid" treatment of *compound* fractures, if they are complicated by bleeding, as from a wound of the artery of the limb, this bleeding must be dealt with before the fracture is attended to. Care must also be exercised as to the "first dressing" applied to the wound, so as not to introduce any dirt into it.

The Ambulance pupil must always remember that the information given above for the management of fractures is not to enable him to "set" them, but only to deal with them *temporarily* until a doctor arrives, as will permit of the person being moved without further injuries which might lead to the loss of the patient's life or limb.

DISLOCATIONS.

They are generally in a limb and always at a joint, for the term dislocation implies that the bones forming a joint are displaced from each other. As no further damage can be done by the smooth end of a dislocated bone, the "first-aid" treatment in these cases is not to attempt reduction but to fix the limb in as comfortable a position as possible and await medical aid. If the pain is severe, the clothes may be carefully removed and warm fomentations applied.

SPRAINS.

A sprain is a violent stretching and straining of the ligaments of a joint.

The "first-aid" treatment is to limit the bleeding into and around the joint by means of

1. Cold applications.
2. Pressure by bandaging.
3. Position.

The same principles are the guide to the treatment of bruises and contusions.

Strains of muscles are to be treated by rest, and warm fomentations to relieve pain.

THE BLOOD AND THE CIRCULATORY APPARATUS OF THE BODY.

Quantity.—The average weight of the blood in the body is about 12 lbs.

Composition.—It consists of plasma and corpuscles.

1. Plasma—a clear transparent watery fluid holding in solution—
   - (*a*) Albumen.
   - (*b*) Fibrin.
   - (*c*) Gases.
2. Corpuscles—two kinds.
   - (*a*) Red—oxygen carriers.
   - (*b*) White—1 to 400 red.

Blood coagulates or clots when withdrawn from the body, owing to the presence of fibrin in it, which becomes solid.

Functions of the Blood.—It serves as a storehouse of nutriment material for the body; the various secretions are elaborated from it, and the waste products are discharged into it, to be ultimately got rid of.

The circulatory apparatus of the body consists of

1. A central organ—the heart.
2. The blood-vessels.

The heart is a hollow muscular organ containing four cavities, viz.—right and left auricle, right and left ventricle.

Functions.—The right side of the heart pumps the impure blood returned from the body to the lungs ; the left side pumps the purified blood returned from the lungs, to the body.

Position.—It lies in the chest between the lungs, more inclined to the left than to the right side, and it rests upon the diaphragm which separates the chest from the abdomen.

It is held in position by the large blood-vessels which spring from it, as well as by the Pericardium or 'Bag of the Heart' which encloses it.

Its base is uppermost, and from it there are eight blood-vessels, six of which convey blood to the heart, viz. :—

Superior vena cava,
Inferior vena cava, } entering the right auricle,

and four pulmonary veins which open into the left auricle, while the other two convey blood from the heart, viz. :—

The pulmonary artery—from the right ventricle, and the aorta—from the left ventricle.

Blood-Vessels.

1. *Arteries* are those which convey blood from the heart.
2. *Veins* are those which convey blood to the heart.
3. Capillaries.

Arteries.

The aorta arises from the left ventricle, and forms an arch from which are given off—

1. The innominate artery.

2. Left common carotid artery.
3. Left subclavian artery.

The innominate artery divides into

1. The right common carotid, which in turn divides into the right external and right internal carotid arteries, giving various branches to supply the head and neck.
2. The right subclavian, which changes its name as it enters the armpit, to the axillary artery, and later to the brachial on reaching the arm. The brachial artery divides into the radial and the ulnar, and these meet again in the palm of the hand and form the palmar arches to supply the fingers.

The left common carotid and the left subclavian resemble those of the right side, except that they arise directly from the arch of the aorta.

The aorta in the chest or thorax is called the thoracic aorta, and it gives off the intercostal arteries.

In the abdomen it is called the abdominal aorta, and gives off branches there to supply the viscera. It then divides into the right and left common iliac arteries, each of which divides into an external and internal iliac.

The internal iliacs supply blood to the various organs situated in the pelvis, while the external iliacs are continued down the thighs as the femoral arteries, becoming the popliteals behind the knee, and these latter end by dividing into the anterior and posterior tibials which supply the feet and toes.

The Veins.

The superior vena cava brings back to the heart impure blood from the head, neck, and upper extremities. The inferior vena cava brings back impure blood from the trunk and lower extremities.

Some veins are distributed superficially under the skin, and some run deeply alongside the arteries and are thus designated "venæ comites" or accompanying veins.

The arteries and veins communicate with one another at their ultimate divisions by means of minute vessels called capillaries. These form a complete net-work, and it is through them that all the different nutritive changes in the body and its numerous organs take place.

Structure and Qualities of the Blood-Vessels.

Both arteries and veins are elastic and contractile, and are composed of three coats—an outer, middle, and inner.

The middle coat contains the elastic and muscular tissues, and there are more of these substances in the arteries than in the veins.

The capillaries are destitute of this middle coat, and indeed their walls are so thin as to consist exclusively of a structureless and delicate homogeneous membrane.

The veins are distinguished further by possessing valves, placed at intervals and usually in pairs, while the arteries have none.

The forces that carry on the circulation are—

1. The contractions of the heart.
2. The elasticity of the arteries.

HÆMORRHAGE AND ITS TREATMENT.

Three different kinds of bleeding :—

1. *Arterial* bleeding—is of a bright red scarlet colour and issues from a divided artery in spurts or jets.
2. *Venous*—is of a dark purple colour and flows in a continuous stream.
3. *Capillary*—consists of a general oozing of blood of a scarlet colour.

Dangers of Hæmorrhage.—In cases of profuse and rapid bleeding death ensues from failure of the circulation. This may occur in a few minutes.

If the loss be gradual, the fatal event may be postponed and the constitutional effects of hæmorrhage have time to show themselves, viz.—blanched face, pallid lips, cold hands, cold perspiration on the brow, and sighing respiration.

When death is not the immediate result of hæmorrhage, recovery is often slow, especially in the old. Children bear sudden loss of blood badly, but generally make good recoveries.

Causes of Hæmorrhage:—

1. Disease—Commonly causes internal bleeding.
2. Injury " " external "

Varieties of Wounds:—

1. Incised—clean-cut edges.
2. Lacerated—torn irregular edges.
3. Contused—with bruising and crushing of the parts
4. Punctured—caused by stabs of knives, swords, etc

The natural arrest of hæmorrhage depends upon the coagulating power of the blood and on the elasticity and contractility of the blood-vessels. If capillaries only be divided, coagulation is sufficient to stop the bleeding, while if small arteries or veins are cut, their retraction within the tissues and the contraction at their orifices on the clots of coagulated blood are sufficient to cause a natural arrest. When a large artery is cut across, it also retracts immediately into the tissues and contracts at its orifice, and as the blood there coagulates it forms an external clot which plugs the artery and stops further bleeding, unless the pulsation of the heart is so strong as to wash it away.

First-Aid Treatment of Hæmorrhage:—

1. Direct pressure on the wound or blood-vessel, either with fingers or with dressing and bandage.

2. Elevation of the wounded part, as in the case of the limbs.
3. Distant compression of the main artery carrying blood to the part, applied either by the fingers or by a tourniquet.
4. Forced flexion—applicable only in upper and lower limbs.

If symptoms of collapse set in :—

1. Keep the patient on his back with the head low.
2. Apply warmth to the body.
3. Elevate the limbs.
4. Give stimulants, but only in small quantities.

As regards venous bleeding, pressure must be applied on the side of the wound *away* from the heart.

NOTE.—When bleeding takes place from a cut or ruptured *varicose vein* pressure should be made both *above* and *below* it, and the limb should also be raised.

INTERNAL BLEEDING.

1. Hæmoptysis—bleeding from the lungs.
2. Hæmatemesis—bleeding from the stomach.
3. Epistaxis—bleeding from the nose.

First-Aid Treatment.—For Hæmoptysis and for Hæmatemesis :—

1. Lay person on his back with head and shoulders raised.
2. Keep him absolutely quiet, not allowing him to move or to talk.
3. Admit plenty of fresh air.
4. Give pieces of ice to suck.
5. Apply cold water cloths or ice over chest or over the stomach.
6. Give styptics internally such as vinegar, turpentine, alum, or cup of strong cold tea.

7. Avoid using stimulants but apply warmth to the feet.

For Epistaxis :—

1. Cold to back of neck or root of nose.
2. Keep patient sitting upright with head thrown slightly back, and not stooping over a basin.
3. Remove any constrictions about the neck.
4. Raise both arms above the head.
5. Keep patient cool by means of fresh air.
6. Sniffing up nostrils (or injecting by a syringe) cold water, vinegar and water, or alum and water.
7. Stuffing nostrils with a strip of lint wrung out of cold water, and applying pressure by the fingers from the outside on the nose.

External Bleeding.

Chief points for the application of pressure in order temporarily to cut off arterial circulation.

1. *Common Carotid Artery.*—Press inwards and backwards against the vertebral column, with the thumb, on a level with the larynx.
2. *Subclavian.*—Compress it as it passes over the first rib, making pressure in a downward direction with the thumb in the hollow behind the collar bone.
3. *The Brachial Artery*—(which commands also the radial and ulnar arteries) may be compressed against the humerus to the inner side of the upper arm.
4. *Femoral Artery.*—By pressure applied in the centre of the fold of the groin. This commands likewise the anterior and posterior tibial arteries, which however may be compressed on the front and inside of the ankle joint respectively, when bleeding from the foot occurs.

RESPIRATION.

This is the process by which oxygen is absorbed into the blood and carbonic acid is given off.

It is of the nature of a combustion, and to allow this to continue a certain quantity of oxygen must be constantly supplied to the tissues. The arterial blood carries oxygen to every part of the body, and the venous blood carries back the waste products of combustion in the form of carbonic acid and other substances.

The *respiratory apparatus* consists of air-passages—the nose, pharynx, larynx, trachea, and bronchial tubes—communicating with an immense number of small sacs, or air vesicles filled with air, and covered externally by a dense network of blood-vessels.

This apparatus is placed within the chest or thorax, which acts like a bellows, alternately contracting and dilating, and thus moving the air in the lungs.

These movements of the chest walls are the result of nerve energy and are usually carried on by the diaphragm and intercostal muscles at the rate of 15 to 18 a minute; but under special circumstances supplementary muscles are called into play and there is an increase in the number of respirations.

At each inspiration about a pint of air (called *tidal*) enters the lungs, and mingles with the air (called *stationary*) that is always present in these organs. The changes in the air thus breathed are that it becomes warmer, gets saturated with aqueous vapour, loses its oxygen and absorbs several harmful substances of which carbonic acid is the chief.

After being in contact with the air in the lungs, the blood in the capillaries surrounding the air cells becomes materially affected, losing heat, aqueous vapour, and carbonic acid, and gaining an increase of oxygen.

If there be an interference in the supply of oxygen to the stationary air in the lungs a condition of asphyxia is induced, which is a kind of suspended animation due to the want of oxygen and the retention of carbonic acid in the blood.

Causes of Asphyxia:—

1. Immersion in water or other liquid medium, as in drowning.
2. Mechanical obstruction of the air-passages from foreign bodies in them, as in choking, or from external pressure, as in hanging.
3. Breathing irrespirable or poisonous gases, as carbonic oxide, sulphuretted hydrogen, etc.

The "first-aid" treatment in these cases is:—

1. Remove all obstacles in the way of breathing.
2. Perform artificial respiration, the four best known methods being (*a*) "Howard's," (*b*) "Marshall Hall's," (*c*) "Silvester's." (*d*) "Schäfer's."
3. Promote warmth and circulation by hot water bottles, friction, stimulants, etc.

Fainting or *Syncope* is a sudden suspension of the heart's action, accompanied by cessation of the respiratory functions, internal and external sensation, and voluntary motion.

Causes:—

1. Breathing the heated impure air of a crowded room with deficient oxygen and excess of carbonic acid.
2. Sudden severe mental impression, as excessive joy, grief, fear, fright.
3. Hæmorrhage.
4. Organic heart disease.

"First-aid" treatment consists in removing the cause where that is possible, and in taking steps to restore the action of the heart.

Keep the patient in the recumbent posture; allow free access of fresh air; remove any constriction of the neck or chest by tight clothing; arrest any hæmorrhage; give small quantities of spirits and water, or sal volatile; apply smelling salts to the nose; dash cold water on the face or upper part of chest.

ON FOOD AND DIGESTION.

The quantity of food required by the body in the 24 hours may be taken on an average to be about 5½ lbs.

The food materials necessary for the support and repair of the body are classed as—

(*a*) *Albuminous or nitrogenous*, represented by animal flesh, the curd of milk, the yolk and white of eggs, the gluten of bread, etc.

(*b*) *Carbonaceous*, represented by fats (oil and butter), starch, sugar.

(*c*) Water.

(*d*) Various mineral salts.

In addition to these essentials, there are "accessory foods," of which tea, coffee, and alcohol are instances.

The process of digestion is a complicated one, consisting of several stages, and is partly mechanical and partly chemical, the aim being to reduce into a state of *solution* all the different articles eaten, so that they may pass through the thin walls of the veins or lacteals, and thus gain access to the blood.

The digestive apparatus consists of—

1. The mouth with lips, teeth, tongue, and salivary glands.
2. The œsophagus or gullet.
3. The stomach.
4. Small intestine with the liver and the pancreas.
5. The large intestine.

The various stages in the process of digestion are as follows :—

1. Introduction of the food or its conveyance into the mouth, accomplished by the hands, lips, and teeth (prehension).
2. Thorough trituration of the food by the teeth through the movements of the lower jaw and the tongue, this latter keeping the food between the teeth (mastication).
3. The incorporation of the food with the saliva (the secretion of the salivary glands of the mouth) and its formation into a bolus or lump (insalivation.
4. The swallowing of this bolus, so as to transfer the food from the mouth to the stomach (deglutition).
5. The disintegration of the food in the stomach by the movements of this organ and its mixture with the gastric juice secreted by the glands of the stomach (gastric digestion).
6. The passage of the food not absorbed by the stomach into the intestines, where it undergoes a further very important elaboration, being acted on by the juices of the intestines, by the bile from the liver, and by the pancreatic juice secreted by the pancreas (intestinal digestion).
7. The expulsion from the body of the in-nutritious portions of the food that have not been absorbed by the intestines as it passed along (defæcation).

WHAT TO DO IN CASES OF POISONING.

Be prompt with treatment, avoiding the appearance of hurry and excitement.

The "first-aid" treatment consists in getting rid of the poison by the use of the stomach pump or by the use of an emetic; the counteracting the effects of the poison by means of the suitable antidote or substance which will render it inert; and the combating the tendency to death by employing stimulants, warmth, artificial respiration, as may be required.

The safest and simplest emetics are:

1. Irritating the back of the throat with the finger or a feather.
2. Large draughts of *tepid* water.
3. Mustard—one tablespoonful in half a pint of *tepid* water.
4. Common salt—two tablespoonfuls in half a pint of *tepid* water.
5. Ipecacuanha—half a teaspoonful of the powder, or two tablespoonfuls of the wine.
6. Powdered alum—a tablespoonful in half a pint of *tepid* water.
7. Smelling salts, containing carbonate of ammonia—half a teaspoonful in half a pint of *tepid* water.
8. Gunpowder—the contents of one or two blank cartridges mixed with *tepid* water.

Where there is no clue as to what the poison is that has been taken, the "first-aid" treatment is to give an emetic of mustard and water, followed by a handful of flour made into a cream with water, or two or three eggs beaten up; vomiting is then to be encouraged by draughts of luke-warm water, and when the stomach seems thoroughly emptied, a cupful of hot strong tea should be administered.

Classification of Poisons.

According to their mode of action or the symptoms they produce, they are arranged into

I. *Corrosives*—a special group of irritants which destroy or corrode all the parts with which they come into contact, and hence often leave marks or stains around the mouth when swallowed.

II. *Irritants*—because of the irritation they cause to the lining membrane of the alimentary canal.

III. *Narcotics*—inducing sleep which passes eventually into stupor and death.

IV. *Narcotico-irritants*—giving rise to delirium with spectral illusions accompanied often by convulsions, and followed by death.

"First-Aid" Treatment.

I. *Corrosives.*

1. *Acids.*—Give magnesia, chalk, soda, or an alkali well diluted, followed by soothing demulcent drinks such as milk, oil, thick gruel, etc., and apply warm linseed poultices to the abdomen.
2. *Corrosive sublimate.*—Give the whites of eggs beat up with water, and encourage vomiting, by an emetic, if necessary.
3. *Alkalies.*—Give a dilute acid such as vinegar and water; or lemon or orange juice, and soothing drinks subsequently.

II. *Irritants.*

1. *Arsenic.*—Give an emetic, then administer magnesia freely or equal parts of sweet oil and lime water; warmth to the extremities; stimulants; and hot linseed poultices to the abdomen.
2. *Baryta.*—Give Epsom salts or Glauber's salts; so also in carbolic acid poisoning.
3. *Cantharides* (Spanish fly).—Give emetics with demulcent drinks subsequently.

4. *Copper.*—Encourage the vomiting; administer freely milk and raw eggs; relieve abdominal pain by linseed meal poultices.
5. *Croton oil.*—Give an emetic followed by large quantities of demulcent drinks; hot linseed poultices to the abdomen; free stimulation by brandy, whisky, or camphor.
6. *Iodine.*—Give starch freely in the form of starch and water, or arrowroot, or gruel, or raw eggs, etc., and subsequently an emetic.
7. *Lead.*—Give an emetic; then two tablespoonfuls of Epsom salts dissolved in water; a demulcent drink; and warm linseed poultices to the abdomen.
8. *Nitrate of silver* (lunar caustic).—Give an emetic of salt and water.
9. *Phosphorus.*—Induce vomiting and administer magnesia freely; avoid giving ordinary oils and fats.
10. *Strychnine.*—Give an emetic at once and speedily induce vomiting; artificial respiration if suffocation be imminent.
11. *Tartar emetic.*—Encourage vomiting; give tannin in the form of strong tea; warmth, and stimulants.
12. *Zinc* (as in 'Burnett's disinfecting fluid').—Give large quantities of warm water with soda dissolved in it, followed by milk and raw eggs with tepid water.

III. *Narcotics.*

1. *Alcohol.*—Give an emetic and encourage vomiting; external stimuli to rouse the nervous system, such as slapping with a wet towel; dashing cold water on the head; smelling salts to the nose; hot strong coffee if the patient can be got to swallow; warmth to the body, and artificial respiration should the breathing seem shallow.

2. *Belladonna.*—An emetic, stimulants, and warmth; artificial respiration.
3. *Camphor.*—An emetic, warmth, and stimulants.
4. *Chloral.*—Stimulants freely; heat to the body; mustard over the heart; prevent patient sleeping; artificial respiration.
5. *Chloroform.*—Large quantities of baking-soda dissolved in water; then stimulants as in chloral poisoning.
6. *Ether.*—Same as in chloroform poisoning.
7. *Opium*—as laudanum, chlorodyne, infants' 'soothing syrups,' morphia, etc.—causes nearly as many deaths as all the other poisons together.—Give an emetic; induce vomiting; rouse the person by walking him about, flapping him with towels; douches of cold water over the head; smelling salts to the nostrils; hot black coffee internally; artificial respiration.
8. *Prussic acid* (hydrocyanic acid).—Cold douches; stimulants; artificial respiration.

IV. *Narcotico-Irritants.*

1. *Aconite* (monkshood).—An emetic; free stimulation; warmth to the body; mustard over the heart; recumbent posture; artificial respiration.
2. *Digitalis* (foxglove).—Encourage vomiting by an emetic; stimulants repeatedly; recumbent posture; mustard over the heart and to the calves of the legs.
3. *Laburnum.*—An emetic; stimulants; mustard over the heart and to the calves of the legs; artificial respiration.

Tainted meat.—Emetic or laxative (as castor-oil); stimulants; turpentine fomentations, or mustard poultices.

Poisonous fungi.—Emetic at once, followed by an ounce of castor-oil; stimulants; warmth to the limbs, and poultices to the abdomen. Tincture of belladonna as an antidote.

Mussel poisoning.—Similar treatment to that for poisonous fungi.

THE NERVOUS SYSTEM.

I. The sympathetic nervous system consists of a number of small round masses of nerve tissue called ganglia, situated in two chains, one on either side of the vertebral column, while others are disposed in various parts of the head and in the cavities of the trunk. These various ganglia are connected by means of cords of nerve tissue, and they send out branches which form networks or *plexuses* round the great organs or viscera in the chest and abdomen, such as the lungs, heart, stomach, liver, and intestines, as well as *vaso-motor nerves* which spread round the walls of the minute blood-vessels of the body and regulate their calibre.

The sympathetic system in man corresponds to the nervous system in lower invertebrate animals, and while it may be looked on as practically independent, it is yet to some extent connected by nerves with the rest of the nervous system.

Its great function is to regulate and control the action of all the other organs of the body, associated with nutrition.

II. The cerebro-spinal nervous system consists of

(*a*) *The brain*—including cerebrum, cerebellum, medulla oblongata, and the basal ganglia.

(*b*) *The spinal cord*—lodged within the cavity of the vertebral column.

(*c*) *The nerves*—cranial or spinal, twelve pairs of the former, and thirty-one pairs of the latter.

The nerves contain sensory fibres which transmit sensations to the brain, and motor fibres which convey impulses from the brain to the muscles or other parts.

The spinal cord is the great channel of nervous communication between the brain and the rest of the body, and it is also an independent centre for reflex action.

The brain is the great centre where motor impulses originate, where sensations are perceived, and it is the seat of the higher intellectual faculties.

THE DISEASES OF THE NERVOUS SYSTEM.

Shock or Collapse:—the result of some severe bodily injury, or deep impression on the nerve centres.

It is evidenced by weakness of the heart and circulation and depression of the vital powers.

The "first-aid" treatment is:—attention to any injury causing it; arresting hæmorrhage if present; warmth to the body and internal stimulation until *reaction* set in.

Concussion of the Brain:—as when a person is stunned as the result of a blow or a fall on the head.

"First-aid" treatment.—Keep the person on his back with the head slightly raised; loosen any tight clothing specially about the neck; apply cooling applications to the head such as a handkerchief steeped in cold water. Should the symptoms not speedily pass off, and the insensibility remain, then adopt the "first-aid" treatment advised for shock, only avoiding the internal use of stimulants, and let medical aid be sent for.

Head Injuries:—In addition to concussion of the brain, blows and falls on the head may cause laceration of the brain; compression of the brain from hæmorrhage; wounds of the soft parts covering the skull; and fractures of the skull itself either of the vault or base.

The ambulance pupil cannot be expected to make an accurate diagnosis in a case of severe injury to the head, but the "first-aid" treatment to be adopted in all these conditions is the same, viz., keep the patient lying quiet on his back with the head slightly raised; loosen all tight clothing from the neck and body, apply some form of cold to the head, and warmth to the feet; prevent the administration of stimulants, and secure medical aid as soon as possible.

If there be a wound, let it be dressed, and if the patient has to be moved let it be done with great care and caution.

Infantile Convulsions may arise in connection with teething, the presence of worms, or indigestible food, as well as may be the prelude to some more serious affection, as of the brain, or scarlet fever, etc.

"First-aid" treatment.—Place the child in a hot bath to which one tablespoonful of mustard has been added; and apply cold cloths to the head. If it be known that any indigestible food has been taken, give an emetic of ipecacuanha wine as soon as it can be swallowed. Should the convulsions continue or recur, send for medical aid.

"*Epilepsy*," "*Fits*," or the "*Falling Sickness*."

"First-aid" treatment.—Rescue him from any dangerous position in which he may have fallen, placing him on his back with the head slightly raised, and loosening all tight clothing specially about the neck. Force open the mouth and see that there be nothing in the mouth which can obstruct breathing, using the handle of a key or other resisting substance to open the jaws and prevent the tongue being bitten.

Guide and control the convulsive movements of the arms and legs, removing any hard objects around that might do harm if the limbs came against them. When the convulsions have ceased, if the patient seem drowsy and inclined to sleep let him do so.

If he be weak, give some beef tea or light stimulant.

"*A Fit of Hysterics.*"—Check at once any sympathetic attention on the part of those around, and get them to leave the room.

Deal gently, yet firmly, with the patient, letting it be clearly seen that the nature of the attack is thoroughly understood and has created no alarm.

Sunstroke or *Heat Apoplexy.*

"First-aid" treatment.—Remove the patient to a cool, shady spot. Raise the head and upper part of the body; remove the outer clothing; and douche the head, neck, chest, and spine, with cold water.

In severe cases, envelop the body in sheets wet with cold water, and apply mustard to the nape of the neck.

If the depression be great, administer a little weak stimulant.

Insensibility:—may be due to

1. Injuries of any kind in any part of the body, } Shock or collapse.
2. Injuries to the head, { Stunning or concussion. Fracture of skull. Compression of brain.
3. Diseases of brain, { Apoplexy. Epilepsy.
4. Fatigue, fright, bleeding, debility, etc., causing failure of the heart's action, } Fainting.
5. Poisoning, { Intoxication. Opium. Kidney disease.

The "first-aid" treatment of such cases should be:—

1. Send for medical assistance.
2. Loosen all tight clothing.
3. Place the body flat upon the back with the head slightly raised, so as to favour the breathing.

4. Apply cold to the head, with warmth to the feet and legs.
5. Ensure a plentiful supply of fresh air, with rest and quietness.
6. Give nothing to drink by the mouth, and avoid stimulants internally.
7. Observe and note the position of the body, especially as to the state of the clothing, whether torn or disarranged; also the immediate surroundings.
8. Examine cautiously for wounds, fractures, bleeding, etc.
9. Observe the state of the pupils and the character of the breathing.
10. If the person has to be removed, let it be done with the greatest caution, and carry him rather to the hospital than to the police-station, if there is any suspicion of illness.

BURNS AND SCALDS.

Sun-burns:—Bathe the parts affected with hot water; lry them, and dust with zinc or violet powder.

What to do when the Dress catches Fire:—Let the sufferer .t once be made to lie down and roll or move on the loor to extinguish the flames.

This may further be aided by enveloping the person in . coat, or shawl, or table cover, etc., and then rolling him r her from side to side. Then thoroughly saturate the lothing by pouring cold water upon it.

In removing the remains of burnt clothing, let be lone with the utmost gentleness, cutting rather han pulling and tearing, and soaking them with warm water r olive oil.

In the treatment of burns and scalds the chief points to .ttend to are:—

1. The relief of pain.
2. The treatment of shock.

As protective coverings, the best applications are flour, starch, oxide of zinc, cotton wadding, olive oil, carbolic oil, carron oil, vaseline, glycerine, fresh lard, dry carbonate of soda, and powdered boracic acid.

In burns from corrosive acids, dust on whiting or powdered chalk.

In burns from caustic alkalies (potash, soda, quick-lime, ammonia), apply vinegar and water; failing this, any of the fixed oils or fats.

In scalds as the result of children trying to drink out of the spout of a kettle containing boiling water, the child should be wrapped in a warm blanket, hot flannels or sponges applied to the throat externally; some slight stimulant given if the shock be great, and pieces of ice or small quantities of water for the thirst.

Injuries from Lightning.—As in shock from other causes apply warmth, artificial respiration if the breathing be shallow, and stimulants until "Reaction" shows itself.

Parts Frost-bitten.—Do not apply heat to them. Use frictions of very cold water or snow for some time so as to gradually restore the circulation.

In Cases of Bites or Tears from Animals—treat as for any torn wound, viz., a warm water dressing until medical assistance be obtained.

If it be suspected that the animal is rabid at the time of inflicting the bite, grasp the part above and apply a ligature between the wound and the heart. Let the bitten person, if possible, suck the wound and encourage the bleeding by bathing with warm water.

Next, the wounded part should be freely cut out, burnt or cauterized.

Insect Stings.—Extract the sting, if possible, by pressure ith a watch key; then apply some alkali such as sal olatile and water, or solution of soda.

REMOVAL OF THE INJURED.

(*a*) When assistance cannot be obtained—

1. Patient may be carried by taking him in a sitting posture in your arms.
2. He may be carried across the shoulders or on the back.

(*b*) When assistance is available, hand-chairs may be mprovised, suitable when the patient is conscious:—

1. Two-handed seat with back support of two arms.
2. Three " " " one arm.
3. Four " with no back support.

(*c*) When patient is insensible, the "fore-and-aft carry" s the best.

Mechanical appliances— { 1. Stretchers or litters. 2. Ambulance waggons.

Improvised or "extemporary" stretchers may be made rom whatever materials are at hand, *e.g.*, doors, window-hutters, boards, ladders, etc., while blankets, rugs, coats, acks, etc., may be converted into litters by being carried y the four corners.

In lifting a patient on to a stretcher or litter, one takes he chest, another the pelvis, and a third the legs. Lifting nd lowering must be done in unison, whilst the apparatus s laid under the patient.

Improvised waggons may be obtained by using a country cart, a barrow, or four-wheeled carriage, with a uitable quantity of hay, straw, or other soft substance on which the patient may be laid.

AMBULANCE HAND-BOOK.

CHAPTER I.

INTRODUCTORY.

Friendship's blind service, in the hour of need,
Wipes the pale face—and lets the victim bleed.
Science must stop to reason and explain;
Art claps his finger on the streaming vein.

O. W. Holmes, vol. i., p. 316.

ANY one conversant with the history of medicine knows that it is a long unbroken record of difference of opinion as to the nature and treatment of disease, the fashionable theory and line of practice of one day being on the morrow replaced by something diametrically opposite. Our own age furnishes many illustrations of this fact. We have had our periods of blistering and bleeding, of hydropathy and homœopathy, and at present we are in the midst of a controversy as to how far the invisible world of germs, with its microbes and bacilli, is or is not the cause of many of the ills that flesh is heir to. Under these circumstances it is pleasant to be able to refer to one matter on which there is unanimity amongst the members of the medical profession, and that is the advisability and propriety of enlightening the general public on subjects pertaining to health. On this point all are agreed; and, accordingly, we find that one of the most characteristic features of modern medicine is the great effort that is being made to awaken people to the fact that a great deal of the disease which desolates their homes and overclouds their lives is, in reality, self-imposed, and springs from preventible causes. So successful has this movement been that already excellent results have been attained in many quarters; and we are face-to-face with one of the most remarkable extensions of sanitary knowledge amongst the masses of the people that any generation has yet seen.

But of the dangers to which human life is exposed disease is not the only one. No inconsiderable proportion of the deaths in our midst are due to accidents; and it is calculated that in Great Britain 17,000 die annually from this cause alone. When we remember that these only form a minority, compared with those who are permanently or temporarily disabled, we are led to realize that the grand total of accidents in the year must be very large. According to one basis of calculation, it has been put down at about 1,500,000.

As to the causes of these accidents, no doubt our numerous industries, with their complicated and powerful machinery, are responsible for a large percentage, but not, perhaps, to the extent that we are inclined to think. A very large proportion of the accidents of everyday life occur apart from any hazardous occupation, and may befall people while travelling by rail, or traversing the streets of a crowded city, or engaging in such amusements as boating, bathing, hunting, bicycling, or skating. And it is also well to bear in mind that a certain number of accidents seem inevitable; that notwithstanding every care and precaution accidents *will* nappen. This has been brought out and commented on by Sir Edward Watkin, M.P., in a small pamphlet recently published, and entitled, "Is Accidental Death inevitable?" In it he says, "I have at last come to the conclusion that a certain amount of accidental death is as inevitable as the measles. All the education in the world will not avail to stop accidents which may end fatally."

With this fact before us, that be as careful as we like a certain number of accidents must annually take place in our midst, it is our duty to reduce them, by human foresight and care, to the smallest number possible, and also to lessen and mitigate as much as lies in our power the suffering and bad effects of those that do occur notwithstanding. Now, if there is one fact more recognised than another by medical men, it is this, that the immediate treatment adopted in the case of any severely injured person, has a positive influence and most important bearing on the subsequent progress of the case; in short, that the interval that elapses between the occurrence of an accident and the arrival of a medical man is often fraught with much moment to the unfortunate sufferer. Especially is this the case when that interval is considerable, as it may be in certain situations, such as in thinly peopled districts, in retired villages, in vessels at sea, in mines, in country excursions, or in climbing hills. Under these conditions the treatment of the person hurt has to be directed by the common sense, backed by the kindness, of those around. There is an old saying, that time is money. It is equally true that time is often life. When speaking of fires, Captain Shaw, says; "The first five minutes are the most important;" and the same remark holds good in cases of accident and sudden illness. It is possible the right thing may be done, but it is just as likely that the proper aid may not be applied, and that serious harm may follow, or even a valuable life may be lost. Every medical man could, from his own experience, give instances where this want of elementary knowledge has led to increased suffering and subsequent harm to the injured person, and even to unnecessary loss of life. Cases of drowning, choking, and accidental poisoning are instances where lives are often sacrificed from want of knowledge as to what should be done; and the popular treatment of burns and scalds furnishes ample illustration of how suffering may be needlessly increased and aggravated by unsuitable and injudicious applications. Impressed by the importance of these facts, and also aware that the ignorance which existed amongst the general public as regards the treatment of injured persons was one for which some sympathy should be felt, as it was really due to the fact that no means were open to the people of obtaining the necessary knowledge, the St. John's Ambulance Association in London, as far back as the year 1877, took steps to meet the want, and arranged for the holding of classes of instruction in which the pupils were taught what was the proper aid to render to injured persons until medical aid can be obtained. The movement met with very great success, and was taken up by the public with much enthusiasm, so that ere long all the important towns and districts in England had joined the Association, and instances were soon forthcoming in which lives had been saved and pain lessened by its members. The work was also extended to Scotland, in 1879, by the St. John's Association; but the formation in 1882 at Glasgow of the St. Andrew's Ambulance Association, with exactly the same aim and objects as the parent Society, really removed the necessity for further action on the part of the English Association, and has practically resulted in the former carrying on the bulk of the ambulance work in Scotland. A glance at the reports of the St. Andrew's Ambulance Association will show that this has been done with great success, and that each year sees the sphere of the Society's operations increasing. I myself believe that no small amount of this prosperity is due to the fact that its work has gone on on exactly the same lines as the English Association, whose perfect organization and plan of instruction has been a most excellent model to imitate and follow. No one is more sensible than myself of the benefits that we owe to the St. John's Ambulance Association; and I think it only right, that when an opportunity like the present occurs, public acknowledgment should be made of our indebtedness to it.

From what has been said it will, I think, be quite evident what is meant by Ambulance work, and what it aims at. It is to teach non-professional people how to render proper assistance to injured persons until the arrival of a medical man, so that the suffering of an accident, bad enough in itself, may not be rendered doubly worse by injudicious treatment, or that in emergencies, such as choking, bleeding, fractures, or poisoning, a life may not be sacrificed by the want of a little elementary knowledge on the part of the bystanders. It will also, I think, be quite apparent that Ambulance training does not aim at making amateur surgeons or doctors. It simply desires to explain to the general public how its members can be of good service in an emergency while waiting for the doctor. The work of the Ambulance pupil is essentially of a *palliative* nature. *It is to lessen suffering and prevent harm being done.* It is none the less valuable or important on that account. Sometimes, no doubt, it is more of a *curative* kind, where life is in immediate jeopardy, as from hæmorrhage, or suffocation, or where some poisonous substance has been swallowed; but even here there need be no clashing with the medical profession. Medical aid will be at once summoned, and until it arrives the Ambulance pupil will do his best for the sufferer, giving way immediately the doctor arrives to his authority and directions, whether the pupil understands the aim or object of them or not. It is satisfactory and encouraging to find from the experience of some years of Ambulance work, that, as yet, the public has shewn no disposition to usurp the functions of the medical profession, and take upon themselves the responsibilities of treating accidents with their limited Ambulance knowledge.

So far I have spoken of Ambulance work as being specially called for in connection with accidents, but it should further be stated that it is often of service in cases of *sudden illness.* This is well illustrated by those lamentable instances that from time to time occur of persons being found insensible in the streets, taken up by the police as drunk, and lodged in the cells. Here they have died, subsequent investigation shewing that they were not drunk at all, but were overcome by sudden illness. An incident of this kind is of an extremely painful nature for all concerned, and the first impnlse is to blame the police. With that censure I cannot agree. Steps are very seldom taken to instruct the police as a body that insensibility may arise from many causes apart from drink, and that even if the person is drunk it does not prevent him being seriously ill as well, in fact, rather predisposes him to being so. Now, Ambulance instruction includes such cases as these. It gives directions for dealing with *insensible* persons, dwelling on the fact that as this symptom may be due to serious illness a medical man should be at once summoned to decide the important point as to what is wrong, and that, meanwhile, the person should be kept quiet and warm. Seeing that the police are those who are most frequently the first to be brought into contact with cases such as these, I may here say that it seems to me they are a class that should have Ambulance instruction made compulsory as part of their training, and that no policeman should be allowed to take up duty in the public streets until he has passed a successful examination in Ambulance work.

It may not be out of place to say a word here as to the fear which is often expressed by some people that the instruction given in a course of Ambulance lectures is beyond their power of comprehension. I write advisedly when I say that there is not the slightest ground for this apprehension. Every care is taken to adapt the instruction given to the intelligence and education of the members of the different classes. It is always kept in view that pupils have had no previous knowledge whatever of the subject, and both the theoretical and the practical parts of the lectures are brought down to their level and comprehension. I am aware also that there is a very prevalent idea that all surgical dressings and apparatus, even those of a temporary nature, are so complicated, that it is impossible to apply them without a surgeon being present. It is only necessary to go through an Ambulance course to find that the *provisional treatment* of injured persons is of the simplest kind and of such a nature that it can be quickly carried out, and that in everything that is advised the temporary nature of the treatment is kept in view. Indeed, simplicity in the first dressing of wounds, and in any retentive surgical apparatus that may be needed, is the leading feature of

Ambulance work; and no opportunity is lost in the lectures of pointing out how the things that the circumstances and locality of the emergency may place within reach, can be made available for use on the occasion. The tools and instruments that surround the artisan at his work, the umbrellas, walking sticks, and newspapers of everyday life, the truncheon of the policeman on the beat, and the rifle and bayonet of the volunteer, may all be enlisted into the service of the Ambulance pupil should need arise; while in every house there are to be found substances which can be utilized for removing the first imminent danger attendant on poisoning, or for lessening the suffering that accompanies all severe cases of burns and scalds. Ambulance instruction in every way strives to develop and cultivate among its pupils the faculty of improvising what is needed in each case of emergency, for the conditions that endanger life are, as we have seen, often met with most unexpectedly and when we are quite unequipped to deal with them, so that much has to be accomplished with imperfect materials and scanty means. No doubt the talent of improvising is a gift; but it may be largely increased by previous schooling and exercise, such as is gone through in the practical part of the Ambulance lectures.

I fancy, however, that I hear some of my readers saying, this is all very well. It may be quite true that it is easy to acquire the knowledge of how to arrest temporarily the bleeding which so often accompanies accidents, and how to resuscitate those apparently drowned; but few people possess the requisite coolness and presence of mind necessary to meet the various demands made by a case of severe injury or sudden illness. No doubt there is something in this. All have not the same nerve, and there are a certain number of persons who, on occasions such as these, when they might be of great assistance, will begin to scream or run wildly about, and after getting into everybody's way end by fainting or going into hysterics, or, I should rather say, pretending to do so. Hood, in one of his witty ballads, paints the amusing side of the confusion which so frequently attends any of the emergencies of every-day life, when he describes an ordinarily sane person, under the terror caused by a fire, casting crockery and other brittle ware into the street from a height to save it from the fire!

> Only see how she throws out her *chaney*,
> Her basins and tea-pots and all;
> The most brittle of her goods—or any;
> But they all break in breaking their fall.

In a large majority of cases it is ignorance of what to do that makes the by-standers at an accident so panic-stricken that they either do nothing at all or act with a reckless officiousness, as if under a kind of delirium. I hold very strongly that it is in these circumstances that *knowledge is power*, and that the very best way to cultivate the necessary coolness and presence of mind is to spread abroad the information that is taught in every course of Ambulance lectures. A little force of will and determination, backed by Ambulance training with its simple and ready rules, will soon overcome any natural timidity, and the most nervous Ambulance pupil will find himself helping the sufferer and forgetting all about hysterics and the proper method of swooning away. A great deal of the noblest work in life has been done with trembling hands and a fainting heart. May it always be so, for therein lies the greater honour; and we have a further proof of that common bond of humanity whose attributes are gentleness and kindliness to others. In truth Ambulance instruction merely tends to direct aright that natural impulse or instinct that we all feel to help a fellow-creature in distress and suffering, whether that be mental or bodily. Without that instruction people are apt to work, as we have seen, in a wrong direction. Unquestionably there was a time in man's history when his natural instinct would have led him to act more prudently in a case of accident than he would do now under our present state of civilization;

for there is no doubt, as shewn by the rude medicine and surgery practised by inferior human races, that he shares with animals an innate knowledge, born of experience, of what to do in sickness and injury. If space allowed, a most interesting amount of matter might be penned in connection with the subject of how animals doctor themselves, not only in diseases, but also in cases of accident; and it would appear that amongst them surgery of an admirable kind is not unknown. Thus it is said that the chimpanzee, when wounded, stops the bleeding by placing its hand on the wound, and dressing it with leaves or grass, while animals with wounded legs or arms hanging on usually complete the amputation with their teeth. Facts like these shew that animal surgery and medicine are not beneath our notice, and I cannot refrain from mentioning here the two following incidents taken from the daily papers :—The first one happened to a farmer, who discovered a bird's nest in his barn and found in it two young swallows. Upon taking one bird in his hand he was astonished to find one of its legs very thoroughly bandaged with horsehair. Having carefully removed the hairs one by one, he was still more astonished to find that the poor nestling's leg was broken. Upon visiting the patient next day the leg was bandaged as before. The bird surgeon was not again interfered with, and in about two weeks it was found that the hairs were being cautiously removed, only a few each day, and at last, when all were taken off, the callus was distinctly felt and the union of the bone evidently perfect, as the bird was able to fly away with the other. The second occurrence is recorded in the pages of the *Pall Mall Gazette*, and is the subject of the picture called "The Out-Patient," exhibited at the Royal Academy in London. The narrative states how on Sunday morning, the 1st of August, 1887, the hospital porter at King's College Hospital heard a dog barking at the door. On going to drive the dog away he found two white and tan terriers standing upon the top of the flight of steps, while a long-haired collie lay beside them wounded and in a thick pool of blood. The moment the good porter showed his face the two terriers bolted, leaving their lame comrade at the door. On examination it was found that the dog had an artery cut on his right foreleg, with a gaping wound three inches long. The hæmorrhage was arrested, the leg was dressed and bandaged, and the dog lay outside the hospital on the grass for a couple of hours and then went away. This touching incident made considerable sensation at the time, and some were very sceptical about its genuineness, but further investigation into it only served to elicit several facts of further interest. It was found that the two terrier dogs lived in the vicinity of the hospital, and probably often saw patients conveyed into it by a certain door. The wounded collie was also frequently in the vicinity of the hospital, as his master constantly drove his cattle that way, and he was, in all likelihood, known to the other dogs. By tracing the blood on the streets the scene of the accident was found, the pavement at one place showing a large pool of blood and a bit of glass, which had evidently inflicted the wound. It is surmised that the three dogs were playing together, and that when the collie cut his leg or paw his little friends induced him to follow them to the *out-patient's door* of the hospital, and the interesting point elicited by the track of the blood was that the dogs took their shortest cut through the various alleys past the back entrance to the hospital to the door in *front*, where they had no doubt constantly seen patients carried in. The late Mr. Yates Carrington, the eminent dog painter, has made the incident the subject of a picture which he exhibited in the London Academy some years ago. It cannot but increase our admiration for the almost human sagacity shown by these members of the canine race; but I have mentioned it here as it seems to me to embody in a most striking manner the true principles of Ambulance work, for it shows kind and intelligent sympathy for a comrade in distress while losing no time in obtaining for him medical aid.

It is unnecessary to dwell here at any length on the plan of instruction that is followed by the St. Andrew's Ambulance Association. All necessary information can be obtained in the Pamphlets published by the Association, "How to form a Centre," "How to form a Class." It is sufficient to say that the Syllabus of Lectures is a most comprehensive one, and combines both theoretical and practical work. These are carried on consecutively, the latter helping to render the former clearer and impressing it more on the memory. Separate evenings are chosen for the practical work, as being less fatiguing to the lecturer and not so much of a strain on the attention of the pupils. In carrying it out, it is customary to divide the class into groups of four, each member being numbered respectively 1, 2, 3, and 4,—No. 4, for the time being, taking charge of the group when attending to any supposed accident. In this way the members are taught to act together in dealing with accidents, and yet under some directing authority. This arrangement also permits of the practical work being done on the members themselves, the numbers being changed from time to time, and each one of the group taking his turn at serving the part of the injured person. Such a plan facilitates the training of a number of pupils at the same time. Another point that I should mention is, that the St. Andrew's Ambulance Association does not confine its instruction to male pupils only. It very properly recognises the need for female classes, and already a great number of these have been held with most gratifying success. As has been well remarked, the "touch of a gentle hand" will not be less gentle because guided by knowledge, nor will the safe domestic remedies be less anxiously or carefully administered.

I wish it were possible to give some short and comprehensive classification of those accidents or emergencies in which calls may be made upon the Ambulance pupil for assistance. This is not very feasible, but, speaking generally, we may group them into the four following classes :—(1) Cases that may happen in everyday life in the streets, house, &c.—such as broken bones, cuts, bruises, burns, &c.; (2) cases of poisoning; (3) cases of death from suffocation, as from foul gases, or from choking, &c.; (4) cases of sudden illness, as from fits, apoplexy, sunstroke, fainting, &c.

I am somewhat averse to burden the memory of the Ambulance pupil with a large number of rules to be observed when dealing with any case of emergency; but there are some hints and suggestions upon several points that are more or less applicable to every case requiring Ambulance aid, and by stating them here in this introductory chapter it may obviate the necessity of going over them later on when special directions are given for particular kinds of injury. I leave out of consideration those cases of accidents where the injuries inflicted are mere abrasions, or simple flesh wounds unaccompanied by any bleeding, in which really no temporary treatment is necessary beyond a mere kindly word of assurance that nothing seems wrong. I will suppose that the case is one where the person is rendered more or less helpless and dependent on the assistance of those around him, and where some provisional treatment is required.

(1.) In the first place, bring to your assistance that self-control and coolness which go by the term "presence of mind," and which you will find has been very considerably strengthened by your course of Ambulance instruction. Remember, too, that you have presented to you an opportunity of materially assisting an injured fellow-creature, and that you may be the means of even saving his life. Do not wring your hands and mentally wish you had been miles away from the occurrence, like that school who hold the very comfortable doctrine, that in cases of accident "absence of body" is far preferable to "presence of mind."

(2.) If the accident has happened in any very crowded and busy thoroughfare, it will be necessary, of course, to get the sufferer removed out of the way of the traffic, and this must be done with every attention to those details which will be pointed out to you in the lecture dealing with the removal of injured persons.

(3.) In any but the most trivial cases see that a doctor's services are requisitioned, and, as the doctor will not come unless he knows he is required, send a messenger for him. While you are waiting for his arrival carry out what you consider the necessary first aid. And here I may say, that whenever it is possible a written message should be sent to a doctor giving him some information as who the sufferer is, whether child or adult, and some idea of the injury, as to whether it is the leg or arm that is hurt, and which side of the body. Especially is this the case in retired country districts, for then the doctor may have an idea what to bring with him, and valuable time is saved. It is remarkable, too, how garbled a message becomes that has, perhaps, been passed by word of mouth from one person to another. By the time it reaches the medical man, the plain statement of an ordinary accident has developed into the proportions of a complete tragedy, and the doctor wonders if he has not by mistake got the message that apparently would be more appropriately delivered to the undertaker.

(4.) If you have not yourself witnessed the accident, make out as exact a history as you can of it from the patient, or, if he is insensible and unable to speak, from any of the bystanders that were near. And here I would remind you that sometimes it is the lot of a non-professional person to be called to give assistance in a case where, afterwards, the question of murder or suicide may have to be decided. Under these circumstances note the attitude, position, and condition of the body, the state of the dress and of all surrounding objects, and do not allow any vomited matters or liquids that have been spat out to be thrown away.

(5.) As to the patient's position, it is better to keep to the recumbent position that has probably been involuntarily assumed at the time of the accident. If that is not so, lay the person on his or her back on the ground or floor. Where the breathing seems embarrassed, let the position be a partially sitting one, with proper support for the back or head; and, in cases of insensibility, I think the person is best placed with the head slightly raised so that it may be placed on the same level as the body, and lying over to or directly on one side. This facilitates breathing.

(6.) Loosen any clothing which may be pressing tightly on the neck, chest, or abdomen—the necktie and collar being removed, and other things unbuttoned or split up if necessary. Another point that may be mentioned here is the management of the clothing in cases of street and other accidents. In a large proportion of these cases it is not necessary to *remove* any clothes at all for rendering first aid. If a person has incurred a *simple* fracture, temporary supports can be placed outside the clothing. The only circumstances that can call for interference with the clothing are to remove any of the constrictions mentioned above, or to expose a wound in the case of bleeding. Both these classes of cases can be met by merely opening up the clothes without removing them. Thus, in the case of a wound of one of the extremities, the stitching of the seams of the sleeve or trousers, and of any under garment, could be quickly ripped up, by means of a knife, to the necessary extent. The complete removal of all clothing should not be attempted until the injured person is safe in hospital or in his own house, and every care should be taken neither to destroy, needlessly, any clothing—a matter of importance to the poor—nor to remove anything more than is absolutely necessary, for to do so in a cold season may inflict mischief on the sufferer. This may seem a small matter, but it may materially affect the patient's ultimate welfare. I know that in some cases of severe bleeding, there may not be time to slit up clothing. Under these circumstances, pressure should be made in the proper situation, and others should do the work of slitting up the clothing. This applies to such situations as the femoral artery in the groin, and the subclavian artery passing over the first rib, where, in the latter case, pressure is made in "the bird's nest" behind the collar-bone. To sum up the matter briefly, I would say never allow the thought of the clothes to interfere with what is of consequence to the patient, but spare no trouble or pains in order to avoid injuring clothing more than is absolutely necessary. When speaking of fractures, I will give directions for the best method of removing separate articles of dress.

(7.) Never consent to any bystander bleeding an injured person with the view of preventing subsequent inflammation. It is an erroneous and harmful doctrine, which is not supported in the present day by the medical profession.

(8.) Next examine the person for any local injury, but always let it be understood that this preliminary examination should be merely of a cursory kind, that it should be conducted with great care and gentleness with a marked freedom from roughness, and that its aim is not to make that exact diagnosis of the injuries which is the duty of the doctor. Further, let it always be conducted with as much expedition as possible, so as to enable the sufferer to be removed to the hospital or his own home without delay. Bear in mind this general rule, which is equally applicable to every case of injury that requires to be touched, *handle firmly and gently*. There is no greater cause of suffering to patients than moving or handling them in a hesitating and uncertain way. Examine one by one the limbs, especially manipulating the prominent bony parts, and noting any change of outline or swelling which may indicate fracture. Perhaps, however, the most important object of an examination is to ascertain whether bleeding is going on, or whether there is any risk of its occurrence, should it be deemed advisable to move the injured person before he is seen by a doctor. In a case where bleeding is going on, it must be arrested immediately according to the rules laid down for hæmorrhage. The question of bleeding having been definitely settled, the next thing is to see how you can improve the general state. If there is a wound, what can be done to diminish its danger and pain; if there is a fracture, how it can be supported so as to prevent its being aggravated in any way by movement, should it be decided to take the patient home or to hospital; if there is shock and collapse, how it can be met by favouring the return of warmth; if there is insensibility, how the tendency to death can be lessened and the functions of the nervous system restored.

(9.) In the administration of stimulants to those who are injured great caution and care should be observed. Just as bleeding was the panacea for all diseases or injuries a few years ago, so now-a-days alcohol is regarded as the sovereign remedy in all the events of life, and when an accident overtakes one it is made the occasion by the good Samaritans gathered around of pouring in more oil and wine than is at all needed. When the conditions of shock and collapse are treated of, directions will be given for dealing with the nervous prostration which is their leading characteristic; but it may be laid down as a general rule, that when alcohol is administered to persons in a state of faintness and nervous depression it should be given *in small quantities and diluted*, the frequency of the administration depending on the effects produced. I cannot do better than quote the advice given on this point by Professor George Buchanan, in his lecture on Surgical Emergencies and their Management, delivered some years ago as a Health Lecture. He speaks as follows :—"It is very delicate and difficult to know when to give brandy or whisky, and when not. But, I say, if he is very exhausted—pale, cold, breathing with difficulty—it is well to give a small quantity of stimulant. By a small quantity I mean *drops*. I do not mean a glass of whisky or brandy. If I were to give him a glass of cold brandy, and he in the condition I have described, I would be just doing the same thing as if I were to put a shovelful of wet coals on a fire which had almost burnt out. If you wish a little ember of red cinder to recover, you take a small piece of shaving or paper and put it on the ember, blowing upon it. Next you put in a little piece of wood, then a bit of cinder, and gradually, by placing on pieces of coal, the little ember becomes a blazing fire. Suppose instead of following the course described, you had placed a bucket of wet coals upon the ember, then the little fire that existed would instantly have been extinguished. Well, the same course should be pursued in the case of a wounded person in a state of exhaustion. If you take a half teaspoonful of brandy, and put the same quantity of boiling water amongst it, and allow the injured person to swallow the stimulant, it will act like the piece of paper which was placed on the dying ember. Supposing the patient to be almost unconscious and unable to drink from a cup or spoon, put your finger into the brandy and rub the inside of the cheek with your finger. The vapour of the stimulant will do some good, and will help the person to revive a little till he is able to swallow voluntarily."

The advice conveyed in the above paragraph I hope every Ambulance pupil will take to heart, and act up to it. It is not sufficiently remembered that while alcohol is a stimulant that enlivens and whips up the powers it is also a narcotic that produces sleep and stupor and is accordingly capable of producing paralysis of the great nerve centres of the body, especially in the conditions of shock and collapse following on severe injuries. Further, the effect of alcohol varies with the sex, men bearing it better than women, and also with age, the old bearing it better than the young, while habit has a powerful influence in modifying its effect. Avoid, then, I would say, the routine use of stimulants in cases of injury, unless you see that they are absolutely needed. Remember the restorative power of a little cold water sprinkled over the face and forehead, or given in small quantity as a drink, and if you have to use alcohol, administer it according to the principles stated above. In connection with the giving of stimulants to injured persons, it should not be forgotten that the very condition of shock or collapse is, at times, a life-saving action of nature. This is well seen in cases of bleeding, where the heart, weakened in its action, is unable to drive the blood along with any force, so that the process of coagulation has time to take place at the mouth of the severed vessel and the hæmorrhage is thereby arrested.

(10.) The removal of the injured person is another matter that will tax, to a considerable degree, the ingenuity and skill of the Ambulance pupil, should it fall to his lot to carry it out. It is an undertaking of no small difficulty. Only those who have had the handling of a person rendered helpless by an accident can fully realize all that it entails. I often envy the strength and skill of the men of fiction who, when the heroine sprains her ankle, as she almost invariably does at some critical moment when no possible assistance is at hand, take her in their arms with the greatest ease and carry her any distance into safety, as if flesh and blood were airy nothings. In the chapter on the transport of the injured directions will be given for dealing with the various contingencies that may have to be faced in the town, the country, or at sea; but the Ambulance pupil, once he has got his patient into a place of safety, should be in no hurry to take upon himself the further responsibility of removing him, if there is an early prospect of medical assistance arriving. In fact, in the case of a broken leg occurring in a house, it would be almost better to have the patient made comfortable, if possible where he has fallen, than move him about before the doctor comes. As a general rule it may be laid down that if it is an upper limb that has been broken, and the amount of shock has been slight, the person will get along more comfortably if he walks than if he is subjected to the jolting of a cab, while in the case of any injury to the lower limbs he should be carried in one of the ways that will be subsequently described. It is never advisable to allow any person who has been severely injured about the head or trunk to mount a horse or sit upright in a vehicle.

I think the above general directions, which are equally applicable to the emergencies of the city, the country, or the security of home, will serve as a useful code of rules to act by. One other point that I would draw attention to, as I consider it of some importance, is the advisability of being always prepared, to some extent, for accidents and sudden illness, in the way of having ready at hand whatever is likely to be wanted in a hurry. In every household there should be a box or cupboard, kept under lock and key, but with the key always available for immediate use, in which there should be placed any medicines or Ambulance materials that may be suddenly required. Let the exact whereabouts of this box or cupboard be known to all, and it might not be a bad plan to have written there the addresses of the nearest doctors, as well as that of the family medical man. As to the contents of this emergency box or cupboard, I need not enter here. At the end of a course of Ambulance instruction, a very fair idea will be got of what is absolutely necessary. I would merely observe that there should not be an over-abundance of articles, as this is apt to lead to confusion, and that I would have no other contents but these things. The St. Andrew's Ambulance Association has tried to impress upon all the advisability of being prepared for emergencies by furnishing Ambulance boxes for use in public works, railway stations, etc., and Ambulance baskets for private houses, hotels, etc. These contain all the necessary appliances for first aid, and have already, in many instances, proved exceedingly useful. I believe that the adoption of this plan in every household would be productive of great benefit, by saving time on occasions when that element is of the utmost importance, and that it would aid in the right materials being applied from the very first.

I wish I had time and space to sketch the rise and progress of Ambulance work. To do so would shew us that it took its rise in the army out of the necessities of the battle-field, and that the word "Ambulance" originally meant a covered waggon or vehicle, usually drawn by mules, which was employed by armies for the conveyance of sick or wounded soldiers. In the wars of Napoleon we find Ambulance organization making great advances under the talents and energy of the eminent surgeons Barons Larrey and Percy; and to the credit of the great Napoleon it must be said that he ably seconded their efforts in this direction, just as we read in the pages of Homer of the kings and generals there vying with one another in bringing aid to their wounded warriors. With the downfall of Napoleon came a long period of peace and the subject of Ambulance work was correspondingly neglected, so that the Crimean War found Britain, as a nation, quite unprovided in this branch of warfare, and it was only the sufferings and calamities of our troops that awoke the country to a sense of its duty upon this point. I believe I give honour where it is due when I say that it is to the gentle heroism and devotion to duty of Florence Nightingale that we owe the altered and improved organizations that now exist for the benefit of the British sailor and soldier in time of war; and this fact alone has always seemed to me a strong one in favour of conferring the benefits of Ambulance instruction on women as well as men. The European Geneva Convention of 1864, brought about largely by Britain's influence, by rendering inviolate and sacred against injury all those connected with the Ambulance organization, has further helped on the good cause; and it robs the battle-field of some of its horrors to think that there is one spot, at least, where, beneath the Red Cross Banner of St. George, the wounded soldier, be he friend or foe, will find kindly succour and aid.

I have already pointed out how the St. John's Ambulance Association has developed the idea of introducing into civil life the same humanitarian care with the view of lessening the sufferings and dangers of those who fall hurt and wounded in the battle-field of our every-day existence. To the promoters of this work every praise is due. If imitation is the most sincere form of flattery, then we in Scotland, by founding our St. Andrew's Ambulance Association, have paid them the highest compliment we could. With what success we have done so our last annual report shews. But we must not rest here. We must aim at still further extensions, and this we can only do by every one in the community interesting himself and herself in the work. I think I have shewn the need for it, and that it is suitable for all to engage in. I had recently a very convincing proof of this in the excellent examination passed by the ambulance detachment of one of our Glasgow Boys' Brigade Corps, the members of which ranged from 11 to 16 years old. Their answers were admirable, and shewed that the instruction was not beyond lads of even their youthful age. There is, in fact, no longer any excuse for people remaining in ignorance as to how to meet ordinary emergencies. They have only to enrol themselves in one of the numerous classes held by the St. Andrew's Ambulance Association, and they will have all necessary information given them in "first aid." They will never regret doing so, for though it may not fall to their lot to put into actual practice the life-saving assistance they will be instructed in, yet the course of lectures will in themselves furnish much food for reflection, and will impart to them an amount of physiological knowledge that cannot but be useful in every-day life. It will, of course, be necessary to refresh the memory from time to time on many points of detail, so as always to be prepared for the unexpected; but once the leading principles of "first aid" have been grasped it is not a difficult matter to do this by occasional periods of study. I would also advocate the careful noting of all the hints met with from time to time in the course of one's reading, especially in the columns of the daily newspapers, where one often comes across valuable suggestions on every kind of untoward event. To keep up the interest of Ambulance pupils in the work, the St. Andrew's Ambulance Association has very properly devised a course of re-examinations for attaining this end. My own experience so far has been that these incentives are not specially needed, and that the work itself has such an attraction about it that those engaged in it every year get fonder of it, as they feel its advantages and see its usefulness. I quite admit that it brings those engaged in it no personal reward, and nothing of what the world calls wealth ; but it often carries with it what is the pleasantest and most gratifying return any one can receive, and that is the warm shake of the hand from some suffering brother whose pain you have perhaps lessened, or it may be whose life you may have saved, and who will always think of you through long years of health with gratitude and affection.

CHAPTER II.

GENERAL ANATOMY.

"What a piece of work is a man! How noble in reason! How infinite in faculties! in form and moving how express and admirable! in action how like an angel! in apprehension how like a God! the beauty of the world! the paragon of animals!"—*Hamlet, Act ii., Scene ii.*

WHEN the words which head this chapter were penned, there was a very limited acquaintance with the structure and internal arrangement of the human body; and it is probable that Shakspeare's exclamations arose more from admiration and awe than from any special anatomical knowledge that he possessed. But even in the present day, with all our educational advantages, the ideas of the general public on the subject of human anatomy are very vague, and they are contented to rest satisfied with the pulpit admonition that we are fearfully and wonderfully made. If one is to judge from what one hears in ordinary conversation, it would seem as if the greater and more important organs of the body are in the habit of breaking loose continually from their moorings, and cruising about in a most reckless manner. The wanderings of the liver are of most frequent occurrence, and hardly a day passes without the heart rising into the mouth, while that much dreaded complaint "a circulation of the blood" claims many a victim. No doubt the teaching of physiology in our schools will help to remove this prevailing ignorance, but as it is imperative that the Ambulance pupil *must* know something of the structure and functions of the human body before he can successfully apply his skill in "first aid," the St. Andrew's Ambulance Association has deemed it advisable to incorporate, in its course of lectures, a certain amount of instruction under these heads; and I consider this a very wise step, although

I am aware that some hold an opposite view, and would reduce the teaching of anatomy and physiology to a minimum.

The human body may be studied from a *structural*, a *chemical*, and a *physiological* point of view; and I think it best to consider it briefly under these three heads, and in the order named.

I.—STRUCTURAL COMPOSITION OF THE BODY.

To become acquainted with the structural composition of the body is really to learn its anatomy, for anatomy is the science of structure; and when we say that we have a knowledge of the anatomy of anything, we indicate that we know its structure, or how it is put together. There are, however, several divisions of Anatomy, and the one with which we will be entirely concerned may be designated *Descriptive Anatomy*, for it will deal with the situation, form, and relation of the organs and parts composing the human body as they can be seen by the unaided eye. Before examining the body in detail from an anatomical point of view, a good deal might be said about it as representing a link in the chain and gradation of animal life, and some pages might be devoted to a consideration of the question, whether, as in the opinion of Darwin, man has been slowly evolved through the various grades of animal life, or whether, as the Bible tells us, he was placed by a special act of creation on our globe just as we know him at the present day. I prefer to adopt the Scriptural theory, that the origin of man was man, and that our first parents were man and woman, as the Biblical narrative tells us. Taking up this position, we can at once proceed to a consideration of the subject, for it is unnecessary to dwell on the marked differences that exist among the various races of men, or on the individual variations that are abundantly apparent among the several members even of a community, so that we speak of some as deformed and misshapen, and of others as handsome and beautiful. For

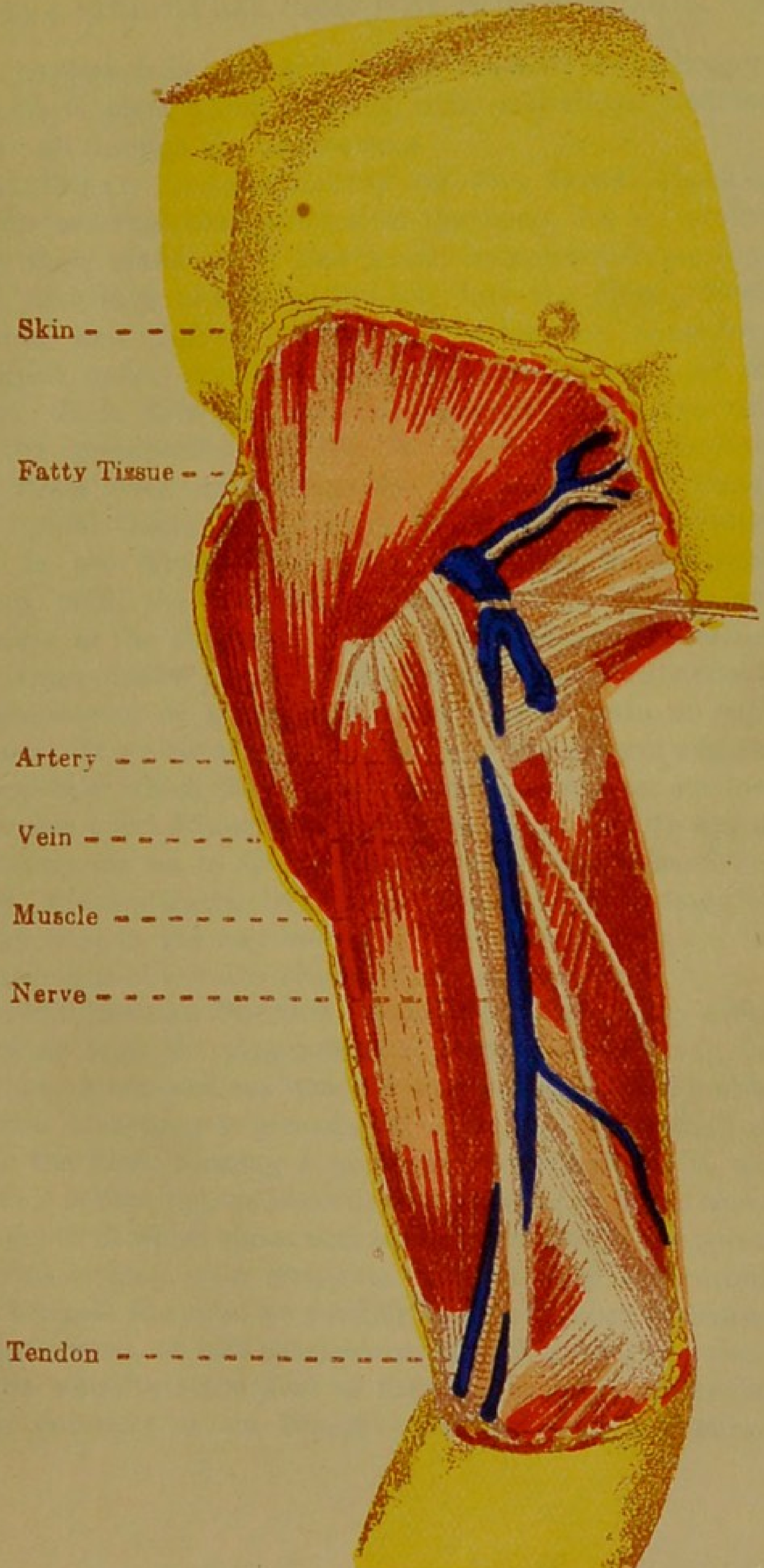

Fig. 1.—Structure of the Arm.

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our purpose it is sufficient to view the body as built up on a definite plan, which extends, with only slight modifications, all through the human race.

EXTERNAL CONFIGURATION OF THE BODY.—Looking at the external configuration of the body, we see plainly that it is made up of two nearly symmetrical portions, and that it is naturally divisible into the Head, Neck, Trunk, and Limbs. The first three are sometimes grouped under the heading of the *Axial portion of the body.* It is this part that contains the organs essential to the preservation of life, for in the Head we have the Brain with its prolongation into the Spinal Canal, the Spinal Cord; in the Neck, the gullet and windpipe; and in the Trunk, the heart and lungs in the chest above, with the stomach, intestines, liver, spleen, and kidneys in the abdomen below. The Limbs are known as the *Appendicular portion*, but they are simply instruments of prehension or progression, and they contain no vital organs. If we are to comprehend fully the several systems of organs of which the body is composed, every one of which possesses special functions and duties of its own, it will be necessary for us to survey generally the mechanism of the body, and, separating it into portions, take it to pieces bit by bit, just in the way one would do if trying to learn the construction of a watch or any other machine.

APPENDICULAR PORTION—STRUCTURE OF ARM.—Commencing with the *Appendicular portion* of the body, let us take an arm and see what its anatomy is, in other words, of what structures it is made up. (Fig. 1.) First of all we have the *Skin*, forming a protective covering over it, and when it is removed, we come down to a layer of *Fatty tissue*, the depth of which varies very much, according as the person is stout or lean. On stripping off this fatty layer which lies beneath the skin, we see displayed a number of distinct fleshy masses, of soft consistence, and of a reddish colour. These constitute the *flesh* of the arm, but they are known more correctly as the *Muscles;* and we shall see, subsequently, that they are entirely the organs of motion, owing to their possession of a peculiar property of contractility, by which they shorten themselves. Their red colour is mainly due to the numerous blood-vessels which they contain. By a little careful handling the individual muscles can be separated one from another, and we find that they are arranged in layers, and that they are all connected with bone, either directly by their broad surfaces in some instances, or, in other cases, by the intervention of bluish-white cords or bands known as *tendons* or *sinews*. These last are evidently composed of different material to the muscles themselves, and are usually long and cord-like in the limbs, while in other parts of the body they may be broad and flat. Both the muscles and their tendinous cords for attachment to the bones are clearly seen in the accompanying coloured illustration, (Fig. 1.) There will be more to say about the muscles when we come to speak of the bones and the locomotory apparatus of the body.

While engaged in separating the muscles one from another, there will have been seen some white softish threads which not only lie among the muscles, but send branches into them. These are the *Nerves* of the arm. They are the organs of sensation, and the regulators of every movement; and we shall see, afterwards, that every one of these white delicate cords can be traced to the Brain or Spinal Cord, so that nerves are really branches of nervous material prolonged out from the Brain or Spinal Cord either to distribute the orders issued from these organs, or to convey to them impressions from without. In this way the nerves may be likened to telegraph wires, which carry messages to and from any large central exchange.

In addition to the nerves there will also be found other tube-like structures lying under and between the muscles. One set of these will be of a reddish black or purple colour, and if pricked will give out a small quantity of dark blood. These are the *Veins*, and it will be shewn afterwards that they are canals or tubes for conveying blood *to* the central organ of the circulation,—viz., the Heart. The other set of tubes lie close alongside the veins, and are of a pinkish-red colour during life; but, after death, they lose this tint and become palish white. They are known as the *Arteries*, and their work is to distribute the blood *from* the heart to all parts of the body. Taken collectively the veins and arteries are spoken of as the *Blood-vessels* of the arm, although the duties they discharge in carrying on the circulation are separate and distinct.

Having proceeded so far in our examination of the arm, we have only to separate still more the muscles, and we will be able to verify the fact I have already mentioned, that all the muscles are attached to bone, for in the middle of the arm we will come upon a dense firm structure which we will have no difficulty in recognising as such. While, then, these are the chief structures composing the upper limb, there are still two that we must not omit to mention. The first of these are the *Lymphatics* or *Absorbents* as they are sometimes called. They are connected with the nutrition of the part, and are common to every portion of the body. They are slender vessels of such delicate calibre that they are not apparent to the naked eye, but require special preparation to demonstrate them. They contain a thin colourless fluid, the Lymph, and their function is to take up or *absorb*, so as to re-convey it into the blood, any excess of nutritive serum that may be brought to the tissues and which they are unable to use up. In this way all waste of nutriment is obviated. If we were to trace these Lymphatics to their ultimate ending, we should find that they are connected at intervals with certain small oval-shaped bodies known as the *Lymphatic Glands*, and that eventually they join the *Lacteals*, which are closely connected with the digestive process, and play a very important part in the nutrition of the body. The other structure I must briefly allude to is one that is also somewhat insignificant, and might escape notice in the process of separating and isolating the muscles, blood-vessels, and nerves of the arm.

In fact its presence is only made clear if we try to re-arrange all the different structures that we have pulled apart in our investigations. We would find that they will not lie as smooth and neat as before, and that there is something awanting to fill up the various crevices and spaces. This substance is the *Connective tissue.* It is made up of a number of fine filaments of a fibrous nature, collectively forming a stringy but soft and delicate packing for the parts around, just as we would lay in cotton wool any fragile substances that we wished to preserve from damage, and which might require to be moved from place to place. There are various other names by which this substance is known, such as the *fibrous*, the *areolar*, or *cellular* tissue, but the most suggestive term is that of *Connective tissue*, because it serves to bind or connect together all the structures that lie around it. It is present not only in the arm but in every other part of the body, subserving the same useful ends.

To briefly summarize what has been detailed somewhat at length, the arm may be said to be made up of a central *Bone*, attached to which, and grouped round which, are a number of fleshy masses with tendons known as *Muscles.* Lying between these are two sets of tubes, the *Veins* and *Arteries*, together with the white cords called *Nerves.* All of these are imbedded in a soft and delicate material, the *Connective tissue* which serves as a packing for them and to bind them together, while enveloping them all is a layer of *Fatty tissue*, with an outside protective covering, the *Skin.* It is customary to speak of these different structures as the *Tissues* of the arm.

As they are exactly the same in both arms and in both legs, it follows that our description of the arm is equally applicable to these other parts, so that, by investigating a limited portion of it, we have practically made acquaintance with the general anatomy of the whole *Appendicular* part of the body, and the Ambulance pupil, if asked to state of what tissues the appendicular part of the body is made up, should have no difficulty in enumerating them.

SHEWS THE POSITION OF SOME OF THE MOST IMPORTANT THORACIC AND ABDOMINAL CONTENTS, ON LAYING OPEN THESE CAVITIES, WITHOUT ANY FURTHER DISSECTION.

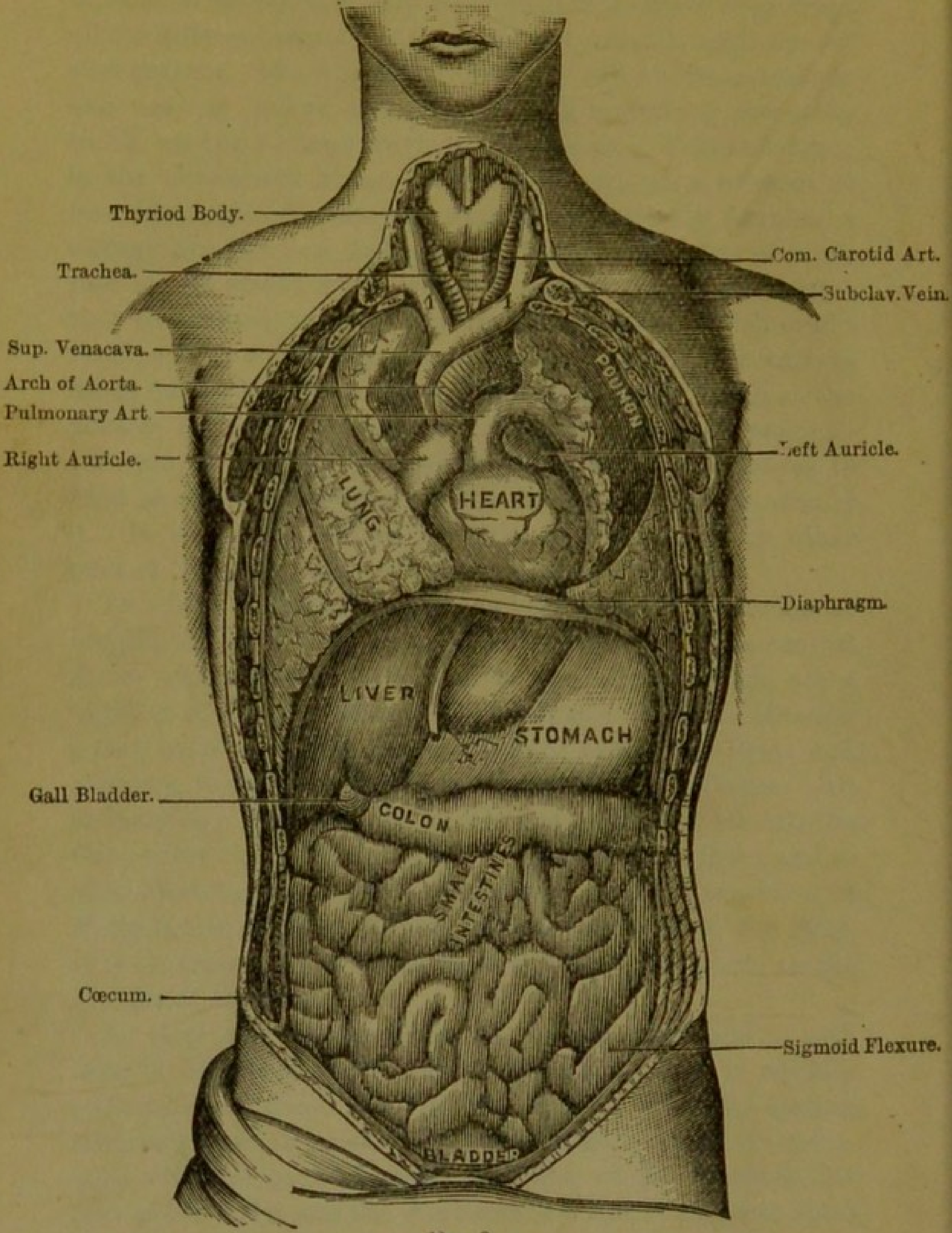


FIG. 2.

CONTENTS OF ABDOMEN AND THORAX.
SUPERFICIAL ANTERIOR VIEW.
Figures 1 and 1 are on Innominate Veins.

Axial Part.—Proceeding next to the *Axial part* of the body with its three great divisions of the Head, Neck, and Trunk, we find that there are present in it the same structures as in the limbs,—viz., muscles, blood-vessels, and nerves, but that it is marked by a very characteristic feature peculiar to itself and which distinguishes it from the limbs. I refer to the presence in it of a number of *Spaces* or *Cavities* in which are lodged a series of separate *Organs* for carrying on the various functions of the body. These *Cavities* are formed mainly by certain modifications of the bony framework of the body, which not only serves as an axis of support, but also plays the part of a protector to the important organs placed within it. The chief *Cavities* are three in number,—viz., those of the *Head*, *Chest*, and *Abdomen;* but there are several subordinate ones in the face, and an important one in the backbone for the Spinal Cord. As the cavities of the Chest and the Abdomen are both situated in the Trunk, we had better first direct attention to them.

The Trunk—Cavities of Chest and Abdomen.—To get a clear view of the contents of the Trunk, let us commence by removing the whole of the front wall, as has been done in the annexed figure. (Fig. 2.) In doing so we will cut through muscles, blood-vessels, nerves, and the bony ribs, and it will be at once apparent that the Trunk is not a complete osseous box with firm unyielding sides, but that its walls, while strengthened here and there by bone, as by the long thin hoop-like ribs, are sufficiently pliable to admit of varying alterations in size. A careful examination of the cavity would reveal that it was divided by a vaulted or dome-shaped partition into an upper and a lower portion, the former being the smaller of the two. Special names have been assigned to these two divisions, the upper one being known as the *Thorax* or *Chest*, and the lower one as the *Abdomen* or *Belly*. The dividing partition is called the *Diaphragm*.

Thorax.—The contents of the chest are mainly the organs of respiration and circulation, and their arrangement is very much as follows :—On either side, and occupying the larger part of the thoracic cavity, are the two pink spongy bodies, the *Lungs.* They lie in separate compartments, formed by a moist serous membrane, the *pleura,* which covers them and facilitates their movements as they glide to and fro within the chest. Between the lungs is a central space, in which is placed the *Heart,* enclosed in its moist serous bag the *pericardium,* and having attached to its base the great blood-vessels, veins and arteries which are connected with the general circulation of the body. Behind the heart the *Wind-pipe* bifurcates into two bronchi,—one for each lung; and there lies the longest part of the *Gullet* on its way to perforate the diaphragm, and end in the stomach. At the very back of all is the *Vertebral Column,* helping to form the posterior wall of the chest, and close beside it is the chief trunk of the absorbent vessels the *Thoracic duct,* passing upwards from the abdomen to the neck to pour its fluid into the blood-current. This last structure is not very easily seen, but it is an important one, as it receives the contents of the lacteal vessels from the intestines and the lymphatics of the lower limbs.

ABDOMEN.—Just as the chief contents of the chest are the heart and lungs—the great central organs of circulation and respiration—so the abdomen is largely occupied by the organs of digestion. In the upper and right hand corner we have a solid reddish organ, the *Liver,* the upper surface of which is moulded to the vault of the diaphragm, while from its under surface there projects a small bag, usually of a bright green colour, and termed the *Gall-bladder.* Close to the liver and overlapped by it is the larger part of the front surface of that dilated portion of the alimentary canal called the *Stomach,* into the upper portion of which opens the gullet, after it has traversed the chest and passed through an opening in the diaphragm. At the extreme left of the stomach is the *Spleen,* but it is so completely hidden by the curve in the abdominal walls, that it is not visible in the accompanying figure. Below the liver and stomach are grouped the

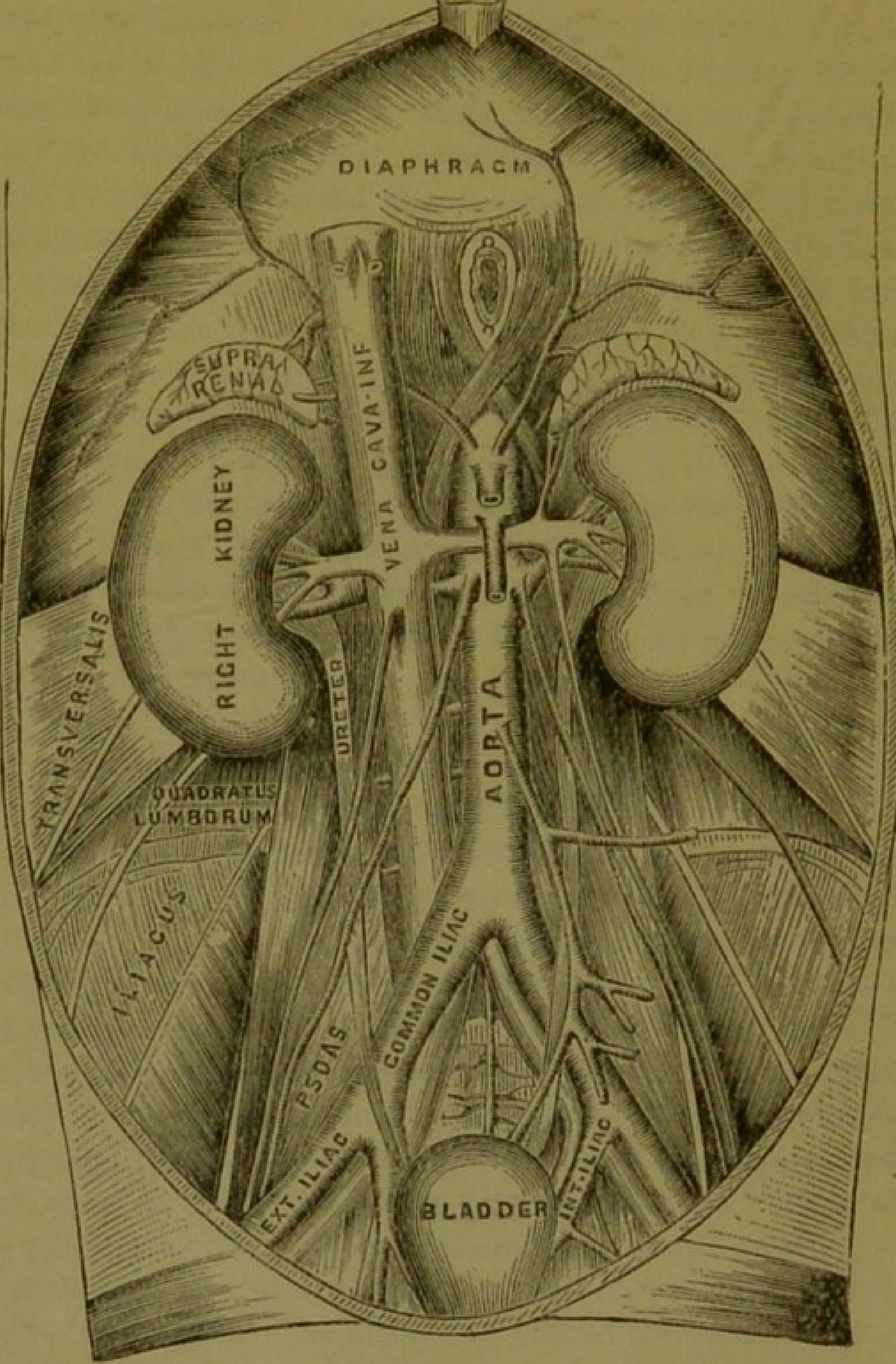


Fig. 3.—Contents of Deeper Part of Abdomen.

Intestines or *Bowels*, the coils of the *Small Intestine* being in the centre, bounded on each side by the *Large Intestine* or colon. At the most dependent part of the abdomen is placed the *Bladder*, the receptacle for the secretion of the kidneys. By a little manipulation it would be easy to demonstrate that the upper part of the small intestine, called the *Duodenum*, is connected with the outlet of the stomach, and that the lower part of the large intestine ends in the rectum.

Such is the view of the abdominal contents that mere removal of the anterior abdominal wall would reveal to us without any further dissection; but, to complete our knowledge of the part, it is necessary to take out the great organs or viscera and the intestines. In doing so we would come across a white glandular organ called the *Pancreas* or sweetbread, which is attached to the bent portion of the duodenum and stretches across to the left. Then we would have revealed to us the structures that lie in the deeper part of the abdomen, of which Fig. 3 is a sketch. First of all we have two brownish masses, one on each side. These are the *Kidneys*, with their ducts, the ureters, leading from them to enter the bladder, while surmounting them are the small cocked-hat shaped bodies, the *Supra-renal Capsules*. Next, in the middle line, would be seen the great blood-vessels, the *Abdominal Aorta* and the *Inferior Vena cava*, both giving off numerous branches; and then, passing one's finger down the back of the cavity, we would find the *Vertebral column*, serving, as in the chest, as a firm axis of support, enabling the body to maintain its erect attitude. This deeper dissection of the abdomen enables us to get a more thorough view of the cavity. We at once notice that its walls are very deficient in any bony support, especially as compared with those of the chest, and that they are mainly made up of soft parts, which, by their elasticity and suppleness, adapt themselves to the varying capacity of their contents. In Fig. 3 we also get a good view of the vaulted diaphragm, which, as it were, roofs in the abdominal cavity, and separates it from the thorax above; while below the parts are received into the basin-like pelvis, the floor of which is, in its turn, formed by a sheet of muscles. These allow of the passage through them of various structures, while they prevent the contained viscera falling out, as they would otherwise do. In one respect the abdomen differs from the chest or thorax in that it contains no separate compartments, but is one large and general cavity, the lining of which is a smooth glistening membrane like the pleura. It is known as the *Peritoneum*; and it not only serves as a covering for the bowels and the contained organs, but it forms folds for the support of the bowels, and ligaments for slinging the various viscera, as the liver, bladder, etc. Briefly, the abdomen may be said to contain *in front* the essential organs of digestion, with certain accessory glands, while *behind* these lie the large blood-vessels and the excretory organs, the kidneys.

NECK.—We are now in a position to examine the *Neck*. On removing the skin and the superficial fascia, and on separating the various structures, we are very much struck with the resemblance it presents in many points to the arm that we first examined. In the centre of it is a bony mass, the vertebral column, and round it are grouped muscles, blood-vessels, and nerves, while there is an absence of ribs, and, consequently, of any cavity as exists in the trunk. There are, however, two structures that were not seen in the arm. Both of them are hollow tubes, one of them having rigid, and the other flaccid walls. The latter is the *Gullet* for the passage of the food, while the former is the *Wind-pipe*, which lies quite in front of the neck, and, as we have seen, divides in the chest, behind the heart, into the two *Bronchi*, one for each lung. The position of the food tube, just at the back of the chief air-passage of the body, renders the possibility of choking ever present, as, for instance, when some portion of food sticks in the gullet, and by pressure on the wind-pipe causes obstruction to the breathing.

HEAD.—From the neck we pass naturally to the *Head*, which in man is placed at the top of the trunk, as if to indicate that it is the noblest part of the body. It is customary to regard the *Head* as made up of a *cranial* portion, which forms a covering for the *Brain*, and is known as the *Skull* or Brain-case, and of a *facial* portion, which furnishes a number of *Cavities* or recesses for the protection of the various organs of special sense—namely, the ears, the eyes, the nostrils, and the tongue. Both the *Skull* and the *Face* have their coverings of soft parts, those of the skull being known collectively under the general term of the *Scalp*, while those of the face are characterized by containing the numerous and delicate *Muscles of expression*, by the action of which all the varying emotions of the mind can be so vividly portrayed. The head is placed on the top of that vertebral column or backbone with which we have already made acquaintance in our examination of the thorax and abdomen, and it is important to remember that not only is the inside of the head hollow to contain the *Brain*, but that there is also a hollow all the way down this vertebral column, to hold and protect the *Spinal Cord*. By means of a large aperture at the base of the skull the brain and the spinal cord become continuous, so that by many the two are regarded as one and the same, the latter being merely an elongation or prolongation of the former, modified to meet special requirements. We thus see that the skull is not a closed box or covering for the brain. Its base or floor has a number of other small openings or apertures for the passage of blood-vessels and nerves, several of which go to those organs of special sense which are lodged in the cavities of the face, and are, as it were, all grouped together in the immediate neighbourhood of the Brain above them. I shall have more to say about the *Vertebral column* or backbone when I deal at length with the bony skeleton of the body; but, from the short description of it already given, it will be clear that we have in the head and trunk of all *Vertebrates*—which is the general term for all animals possessing a vertebral column—two cavities or tubes, one in front of the other. That *in front* is made up of the thorax and abdomen, with their partition the diaphragm between them, and that *behind* is composed of the skull and spinal cord, which are in no way separate one from the other, but form one continuous whole. Accordingly, if we were to make a cross slice or transverse section, as it is called, of the trunk, we would have behind the narrow canal of the spinal cord, and in front, according to the level at which the section was made, the broad cavity either of the thorax with its surrounding ribs, or that of the abdomen with its enveloping muscles.

Such, then, in brief, is the anatomy of the human body, which may be correctly described as an intricate piece of machinery, composed of a number of different *Organs* and *Tissues*. When we come to consider the body from its physiological point of view, we will find that these different organs have each their own duty or function to perform, and that they work, not for their own individual good, but for that of the body generally. Further, we will see that they are grouped together into *Systems*, each system being an assemblage of all those organs which concur to the same end, and which serve for the accomplishment of the same function. As a result of this arrangement we have a locomotory system, a digestive system, a circulatory system, and so on.

II.—THE CHEMICAL COMPOSITION OF THE BODY.

CHEMISTRY OF THE BODY.—Having briefly surveyed the manner in which the body is built up, it may not be out of place to allude cursorily to its chemical composition. Taking a man of the average weight of 154 pounds, or 11 stone, we find that some *thirteen* of the *sixty-four* chemical elements enter into his composition, of which *five* are gases, and *eight* are solids. Of these 13 elements, *Oxygen* is the one that occurs in the largest amount, from 80 to 90 pounds of it being present in a man of 154 pounds.

Of the other gases there are several pounds of *Hydrogen*, 4 pounds of *Nitrogen*, 26 ounces of *Chlorine*, and 3¼ ounces of *Fluorine*. Of the solids, *Carbon* stands at the head of the metalloids, with 40 pounds, while *Phosphorus* comes next with 26 ounces, and then *Sulphur* with 3¼ ounces. The most abundant metal is *Calcium* or *Lime*, of which there is more than 3 pounds. Then we have *Potassium*, 2½ ounces, *Sodium*, 2¼ ounces, and, lastly, *Iron*, 1¼ ounce. There are two or three other elements of which traces may be found, but not to such an extent as to be taken into calculation. It must be remembered that these chemical elements do not exist alone in the body, but combine, in varying proportions, to form a very large number of compounds, as a result of which there is constantly going on in the body *a remarkable display of chemical activity, with, of necessity, a corresponding production of heat.* It is unnecessary to recapitulate all the classes of substances so formed; but there is one fact that should always be borne in mind, and that is, *the large amount of water that exists in the human body.* Of the 154 lbs., which is the average weight of a full-grown man, no less than 109 lbs. are water. If we deduct the 11 lbs. of bone-earth which give solidity to the skeleton, we have only 143 lbs. left; and thus we realize the rather startling fact, that the flesh, blood, fat, skin, brain, and other soft parts only contain 34 lbs. of dry solids. This fact brings home to us the importance of water in the human economy; and when we come to speak of those organic functions which occur in the living frame, we will recognise that, while we do not, as many other organisms do, live in water, our tissues are constantly bathed by watery fluids, and that it is through the medium of water that many of the essential vital processes of life, such as digestion, absorption, and removal of waste substances, can alone take place.

III.—THE BODY FROM A PHYSIOLOGICAL POINT OF VIEW.

PHYSIOLOGY OF THE BODY.—We have considered the human body from an *Anatomical* and a *Chemical* aspect, and we must complete our survey by a short sketch of its *Physiology;* in other words, we must study shortly the different phenomena exhibited by the body when in a state of health; for the body, being a machine, has work to do, and we ought to understand—first, what this work is, and, secondly, how all the various organs accomplish it, so that, in consequence of their harmonious action, we exist as living, acting, and thinking beings. This cannot be done here at any length, nor is it necessary, as in succeeding chapters all the more important functions of the body will be considered in detail.

Life is of course the great distinctive feature between the organized kingdom of plants and animals on the one hand, and the inorganic or mineral kingdom on the other. Let us then glance at the various actions or functions which indicate its presence in man.

One of the things that must often have appeared strange to us is the *Warmth* of the body under the most varying conditions. On the coldest winter's day, if we are seasonably clad and sufficiently fed, we feel, as we move about, a glow and warmth which are in strange contrast to the ice and snow around. Then, again, how soon our body warms the cold bed we lie down in at night to seek repose after the day's work is done. From facts like these it is clear that the body *produces heat* and gives it out, just as the fire in a room sends out heat and warms every person or thing near it. But it is only while life lasts that the body does so, and hence we regard *warmth* as one of the characteristics of life, by which its presence is revealed or its absence made known. We do not exactly know how this heat is produced, but we are safe in concluding that it results from that constant series of chemical changes which go on in our bodies in connection with the combustion or burning up of the tissues of the body and of the food we eat. By means of the *Circulation of the blood* this heat is carried all over the body, and though at times our hands, or feet, or skin, may feel cold, the interior of our body, as long as we are in health, always shews the same amount of warmth—viz., 98·4° Fahrenheit,—a fact which explains how people can live in both extremes of climate, be it amidst Arctic snows or under the burning sun of India. It is only in diseased states of the system that we get variations in the body's heat, and no doubt, to a medical man, they are of great assistance in judging of the course of an illness; but so much importance is being attached to them in the present day by the general public that in all probability, in a few years, the general salutation will be, not—How are you? but—What is your temperature?

Warmth, however, is not the only manifestation of life. The other most striking condition of our existence is *The power to move about of our own accord from place to place.* Unlike inanimate objects, we are not dependent on external agencies for the motion of our bodies. Should we wish to pass from one place to another, we have only to desire to do it, and it can be done, provided our *Locomotory apparatus* is in proper working order. As soon, however, as life leaves the body, heat and the power of motion also depart, so that we rely on them as tests as to whether or not life has fled. Thus, if we came across a bird lying still upon the ground and unmoved by our approach, and on taking it in the hand found that it was quite cold, we would be sure that it had been some time dead, and that no efforts of ours could restore it to life.

Although warmth and the power of movement appear merely as the leading characteristics by which we recognise the presence of *Life*, there is a closer association between them than appears on the surface. The truth is that we are able to move because we are warm, in this respect resembling a locomotive on the railway. As long as its fire keeps bright, and converts, by its heat, the water into steam, so long will its piston work the various cranks and wheels, and keep the whole machine in motion. But let the fire burn low and no fresh fuel be added in the form of coal, and we find that steam ceases to be generated, the engine gets cold, and soon comes to a stop. It is this similarity in the sequence of events that has led to the human body being so frequently compared to a *Locomotive engine*, the machinery of which is represented by the bones, muscles, and other organs of the human frame. In some respects the simile is a good one, and it may help us to understand the working of the body if we take the locomotive as our standard of comparison and note the points in which the two resemble one another. One of the first things that strikes us about the engine is, that the power which moves it does not exist in its iron frame, but in the *coals* which lie heaped up on the tender. It is the burning of these in the furnace, by the aid of the Oxygen in the air, that produces the *heat*, which, in its turn, changes the water in the boiler into steam, the passage of which into the machinery of the locomotive sets it in motion. The *Steam*, then, is the motive power which moves the engine, and thereby the train attached to it; and the amount of the steam generated depends entirely on the quantity of heat which the coals give out. Were the engine to work continuously, there would require to be a constant supply of coals and a replenishing of the water in the boiler, otherwise the fire would go out, or steam would cease to be produced, and all movement would cease. The *Human body* works under very similar conditions. The chemical changes in its interior produce *heat*, which, in turn, gives rise to energy and force; and it is this *Vital force* which keeps active the various functions and processes of the body, just as the *Steam* does the machinery of the engine. But we pointed out that the locomotive requires fresh supplies of fuel and of water, and that, if these were not forthcoming, it would cease to work. It is just the same with the human body. The chemical changes going on in it require material for the production of heat and the energy that springs from it; and this it gets in the form of *Food*, which may be said to represent the coals or fuel supplied to the engine. Were no food supplied, the body would, for a time, burn up its own tissues, and as soon as they were used up life would depart. This is what takes place when death results from starvation, the body being literally consumed away. At the same time, the food of the body fulfils other ends besides serving as fuel to be burnt up. It goes to repair that waste of the tissues which takes place in the human body itself, just as the framework of the locomotive deteriorates daily while in use. Farther on we shall see that we take various kinds of food, some of which serve to build up the body, and are called *Tissue-food*, while others serve for combustion, and are known as *Fuel food*; so that the human body stands, in this respect, in marked contrast to the locomotive, in that it is *self-repairing*.

Nothing, however, could be more dissimilar to the food material we take into us than the blood and the various tissues of the body. Accordingly, we find that the body possesses a *Digestive Apparatus*, whose work is to reduce the food we eat into a white milky fluid called *Chyle*. This is taken up by the absorbents, and being poured directly into the blood, serves to replenish it. We speak of the work done by the digestive apparatus as *The process of digestion*. It is made up of several stages, and is partly mechanical and partly chemical in its nature; but by it all the different articles of food are changed into the fluid chyle, which is capable of being absorbed and carried into the blood. It matters not what kind of food is eaten, it is ultimately converted into the same substance; so that the costly viands and wines of the rich man's table make, in the end, the same blood as does the poor man's frugal fare of milk, cheese, and bread.

The taking up or absorption of all this new material into the body is rather a complicated matter, and to accomplish it there are one or two agents at work. Thus the *Veins* of the alimentary canal materially assist, especially in absorbing any watery and saline ingredients; but the bulk of the work is done by the *Absorbent Apparatus*. This may be said to consist of two chief divisions, one of which is connected with the digestive organs, and the other with the general tissues of the body. In both of them we have a series of minute, delicate, transparent vessels, which join with one another to form a network, and after passing through a number of small ovoid bodies, called *Glands*, pour their contents into a joint receptacle at the lower end of the vertebral column. From this receptacle or reservoir of nourishment there springs a tube which passes up alongside the spine, and has received the name of the *Thoracic duct*, owing to its going through the thorax or chest, at the top of which it opens directly into one of the large veins at the root of the neck, and thus pours its contents directly into the blood. As the absorbents connected with the digestive organs are mainly concerned in taking up the opaque milk-like mixture of oily and fatty particles, termed *Chyle*, they have received the special name of *Lacteals*, while the other division of the absorbents which spring from the general tissues of the body, and whose function is to take up any superfluous fluid or *Lymph* which may transude during the process of nutrition and return it into the blood, are known as the *Lymphatics* of the body.

After the blood has been enriched by this new material containing all the elements required for the repair of the tissues, it is necessary that it should be conveyed to every part of the body. This is done by the *Circulatory Apparatus*, which consists of a pumping organ, the Heart, and a series of tubes or pipes connected with it for the conveyance of the blood. When we describe in detail the course of the circulation we will point out the exact arrangement of these tubes, and explain why some of them are called Arteries, some Veins, and others Capillaries. Meanwhile, we must bear in mind that when we speak of anything *circulating*, we mean that it goes round and round, and comes back sooner or later to the point from which it started. This is exactly what happens in the Circulation of the Blood. This fluid is driven, *by the contractions of the heart*, through the complicated network of vessels which permeate the body, and after it has bathed and nourished every smallest bit of almost every part, it is once more brought back to the heart, so as to allow of its impurities being removed and it rendered fit once more to be sent out on its journey through the tissues.

When speaking of *Warmth* as one of the characteristics of the living body, we showed that it was due to the internal fire which is continually present within us, and which burns up or consumes the tissues of the body so that they require daily renewal by means of the food we eat. Now we know that for a fire to burn properly, air is necessary, and very simple experiments would show us that it is the *Oxygen* in the air which is the active principle. The internal fire in our bodies is no exception to this rule, and it must have air containing oxygen if it is to continue to burn. The means taken for ensuring this entrance of air into the body are known as the *Respiratory Apparatus*, which is composed of the Larynx, Windpipe, and Lungs. By these organs the function of *Respiration* is carried on. Afterwards we will have to consider the process more minutely, when we will find that the oxygen of the air which enters the lungs is extensively brought into contact with the blood, and is there taken up by the small bodies in the blood known as *Corpuscles*, and by them conveyed into all the recesses of the body. The blood corpuscles may therefore be termed the *Oxygen carriers* of the body, and if they ceased to work, or were unable to get their supply of oxygen in the lungs, very serious consequences would ensue, resulting, perhaps, in the cessation of the important processes of life, or in other words, of death, just as a lighted candle would at once go out if placed in air that contains no oxygen.

Having, then, grasped the fact that life results from the *heat and consequent vital force developed in the body*, we must remember that we cannot have this burning up of the bodily food and tissues without a certain amount of waste products being produced. The coal that the locomotive burns is not absolutely pure, but leaves a certain amount of residue or ashes, which must be removed, or the furnace would get choked and would be unable to work. The same state of things takes place in the working of the vital processes in our bodies, and a considerable amount of waste material has to be got rid of. The chemical processes which accomplish this are very complicated; but we find that the waste substances ultimately resolve themselves into Water, Carbonic acid, Ammonia, and certain Salts. No matter how intricate the changes in the body may be, these are the waste products that invariably result, and which must be removed, just as the ashes of our ordinary coal-fire must be. To attain this the body has been provided with an *Excretory Apparatus*, which comprises three distinct portions,—the Lungs, the Kidneys, and the Skin. The *Lungs*, while largely engaged in introducing Oxygen, also give off carbonic acid, and a certain quantity of water. By the *Kidneys* there escape a large amount of water, ammonia, and salts; while the *Skin*, in the form of perspiration, also removes a great deal of water, with some salts and carbonic acid dissolved in it. By this process of *Excretion*, carried on by these different parts of the excretory apparatus, the blood is kept clear of waste matters and goes on its rounds fresh and pure, laden with nutriment for the tissues and oxygen to keep the fire of life burning. Were it not for this process of purification, the blood, traversing every part in a vitiated and unhealthy condition, would be quite incapable of furnishing the oxygen, which is so necessary for combustion, that without it the various chemical changes could not go on.

Closely resembling the process of *Excretion* is that of *Secretion*. It is somewhat unfortunate that there should be such similarity in the terms, for though both indicate that there has been a separation or sifting of some matter from the blood, there is this important difference between them, that the product *secreted* is used again in the system for some special purpose, while that *excreted* is a waste, and even harmful substance, which is thrown entirely out of the body. The urine and the perspiration are instances of

Excretions, while the saliva of the mouth, the gastric juice of the stomach, and the synovia or joint-oil of the joints are typical *Secretions*. The excretions, in short, are already formed in the blood as a result of the nutritive processes; while the secretions are manufactured or elaborated by certain structures or organs from the blood, and are then utilized for some special purpose in the economy. Important as the function of secretion is, it is unnecessary to go farther into the process here, than to say that the mechanism by which it is effected is very similar in every case. The active factors in it are *Cells*, which are placed on one side of a structureless basement membrane, while on the other side of the membrane is a plexus of small blood-vessels, and out of the blood the cells elaborate the special elements characteristic of their secretions. There are a considerable number of secretions in the human body, and they all differ, but the apparatus by which they are produced is built on the plan mentioned above, although it may take the form of *Membrane*, such as the pleura or peritoneum, or of *Glands*, such as those of the stomach and intestine.

So far our description shows the intricate piece of machinery known as the human body to consist largely of various *Organs*, all of which are engaged in carrying on some special work. It is, however, absolutely essential that there should be some guiding and regulating power over them, just as the locomotive needs the guiding and regulating hand of the engine-driver. This has been supplied to the body in the shape of a delicate mechanism called the *Nervous system*, which rules the body and its work and makes man the active, reasoning being that he is. There are four distinct parts which make up this nervous system. They are the *Brain*, the *Spinal Cord*, the *Nerves*, and the *Sympathetic System of Nerves*. They each require a few words of explanation. The Brain occupies the skull, and is the seat of intelligence. In it all sensations are perceived, all ideas are formed, and the will or wish to do anything originates. In short, it is the organ of what we call the *mind*. The

Spinal Cord, as its name shews, lies inside the spinal column, or backbone. It is a long thick cord of nervous matter, which may be looked on as the main trunk of the nerves,—for from it thirty-one pairs of spinal nerves branch off into all parts of the body. Above, the Spinal Cord is continuous with the Brain, so that it serves to connect the nerves with that organ. Besides, however, being the conducting medium between the brain and the nerves, the Spinal cord has the power of acting independently itself, and it is specially the seat of that class of movements which are ranged under the head of *Reflex* ones, of which swallowing, coughing, and sneezing are instances. The *Nerves* are rounded or flattened white cords, which are distributed through the body like the branches of a tree. They are all connected with the brain, although they do not go directly to that organ, but pass first through the spinal cord. There are two classes of them; first, the *Motor*, and, secondly, the *Sensory* nerves. The former are so called because they carry messages *from* the brain, and consequently produce motion. Thus, if we wish any part of our body to move, the brain sends the wish by a Motor Nerve to the muscles, which act on that part, and the desired movement takes place. Then, as the brain is the seat of all our sensations, and as with it we are made conscious of pleasure and pain, and could not without it feel heat or cold, or perceive odours, or hear sounds, it is necessary to have nerves to carry messages *to* the brain. These are the Sensory Nerves, or the nerves of sensation, and they are the channels by which the brain, or in other words, the mind, is kept informed of what is taking place in the world around. To facilitate this some of these sensory nerves are very highly developed into special sense organs, of which the eye and the ear are instances. Lastly, we have the Sympathetic system of nerves. It is, to some extent, connected with the spinal nerves, but its distribution is chiefly to the heart, stomach, and other internal organs of the body. It is made up of a number of *Ganglia*, which lie on each side of the spinal column. These ganglia are all connected with one another, and they send out large networks of nerves, which spread themselves over the organs contained in the chest and abdomen, regulating in every way their working. As they send no impressions to the brain, we are not conscious of what goes on inside us as long as there is nothing wrong. In fact, the Sympathetic system occupies, to some extent, an independent position, even though it is a part of the Nervous system, so that we have a sort of dual government, in which the Brain, with the spinal cord and the nerves, is the supreme power, while the Sympathetic system occupies a minor and subordinate position, its duty being to carry on the work of the body. To use an analogy, we might say that in Great Britain the Sovereign and the Houses of Parliament represent the Brain, devising and planning what is best for the people, while the carrying out of what has been ordered rests with the various Local Authorities, who are therefore represented by the Sympathetic system.

This short account of the nervous system brings to a close our survey of the human frame. We have not, it is true, looked at it from a *Microscopical* point of view, so as to see the cells of which it is composed, but we have gained some idea of its structure, of its chemical composition, and of the functions or work it does. These last may be conveniently grouped in three divisions :—

1. *The Nutritive functions,*—namely, digestion, absorption, blood circulation, respiration, assimilation, animal heat, secretion and excretion. These all have for their object the preservation of the life of the individual.
2. *The Animal functions,*—namely, locomotion, sensation, language, and all other mental manifestations. It is these that bring the individual into relationship and communion with the world around him.
3. *The Reproductive functions.*—These are the means by which the race is preserved and increased in number.

For the carrying out of all these functions there are a great variety of Organs, and those that are grouped together for the accomplishment of the same function we designate an Apparatus, so that we have the following in the human body:—

1. Locomotory Apparatus.
2. Digestive ,,
3. Circulatory ,,
4. Respiratory ,,
5. Excretory ,,
6. Secretory ,,
7. Nervous ,,
8. Reproductive ,,

By this arrangement of certain organs performing only certain duties we have very well illustrated the principle of what is called *The division of labour*. It is one that pervades all the higher animals. They have all lost the simple condition of body that we see in the lowest forms of life, and the labour or work they do has become allocated to certain portions of the body. This, of course, leads to the structure of the animal becoming more complicated; but it has its advantages, for each Apparatus, though, of course, to some extent mutually dependent on its neighbour, having only its own work to do, carries it out more satisfactorily, just as it has been remarked that the work of a house is better done by a trained cook, a trained house-maid, and a trained table-maid, than by three general servants.

Admirable, however, as the structure of the body is for carrying out the work it has to do, we must never forget that complicated machinery such as it possesses will soon get out of working order if badly or improperly used. If we neglect it, or put it to uses that it was never intended for, it will soon cease to work smoothly, and disease and suffering will be our lot. To each one of us has been confided the care of his own body, and it is our duty to use it well and acquaint ourselves with a knowledge of those laws of health on which its proper working depends. If we do so, we will each find ourselves blessed with that greatest of earthly blessings—a healthy mind in a healthy body.

CHAPTER III.

THE BANDAGE.

"I 'll fetch some flax and whites of eggs to apply to his bleeding face."
—SHAKSPEARE, *King Lear*, *Act iii.*, *Sc. vii.*

OUR present word *Surgeon* is the modern and more agreeable sounding title for the old one of *Chirurgeon*, although this latter expresses more clearly what the general idea of a surgeon was, for being from two Greek words χειρ = a hand, and εργον = work, it indicated that he was one who healed diseases through external applications *applied by the hand*. This is still to a large extent his work, and as the Ambulance pupil may have occasion to act instead of the surgeon until he arrives, there is a certain amount of practical work that he must be ready to do. The most frequent application he will have to make is that of a *Bandage*. This term is from the French word *bande*, and it implies anything used for binding up or fastening an injured part. The subject of bandaging is one that is too extensive to treat exhaustively here, and I must confine myself to a few general remarks on the uses, classification, &c., of bandages.

The Uses of a Bandage are as follows:—

1. To keep dressings in their place.
2. To fix splints or other apparatus.
3. To make pressure on any particular spot.
4. To allay muscular action or irritation.

The Classification or Varieties of Bandages.—They have been called after their authors, their forms, their uses, and their resemblances to various articles, but none of these systems of nomenclature have held their ground, and we practically recognise the two classes of (1) *Roller* and (2) *Triangular* Bandages.

The *Roller Bandage* is so called because it is made of a strip (usually of unbleached calico), which is *rolled* up on itself so as to facilitate its application. To apply a *Roller* bandage well requires a great deal of practice and judgment, and it is quite easy to recognise the difference between one well and another badly applied. The former lies so smooth and regular, so compact and well fitting, that it seems to have been put on by machinery, and no matter how the patient moves about every turn of the bandage keeps its place firmly and evenly. The latter looks bungled from the first and hangs so loosely that, on the first movement of the patient, it comes undone and fails entirely in accomplishing the purpose for which it was used. Hence the *Roller* bandage, though a powerful instrument for good in the hands of those who have been thoroughly and practically instructed in its use, is not suitable for the emergencies of Ambulance work, and something is preferable that can be more easily and rapidly applied. This is found in the *Triangular Bandage*, which we really owe to Mr. Mayor, a surgeon of Lausanne, in Switzerland. He recommended his *Handkerchief Bandages* as far back as the year 1832, but they did not come into general use until attention was again directed to them by Professor Esmarch of Kiel, who shewed how applicable they were, especially in the exigencies of civil and military practice, and that by following the principle which underlies them you can adapt almost anything to the purpose until a better dressing can be obtained. In his "First Dressing on the Battle Field" Esmarch gave a description of the Triangular Bandage and the mode of using it, and he also suggested that it should be issued with illustrations printed on it, shewing its application for injuries of different parts of the body,—a suggestion which has been acted on by the St. Andrew's Ambulance Association. As a consequence of his powerful advocacy of it the bandage has come into general favour, and though originally proposed, as I said, by Mayor of Lausanne, it is now almost universally known as "Esmarch's Bandage."

The accompanying diagram illustrates it clearly (Fig. 4).

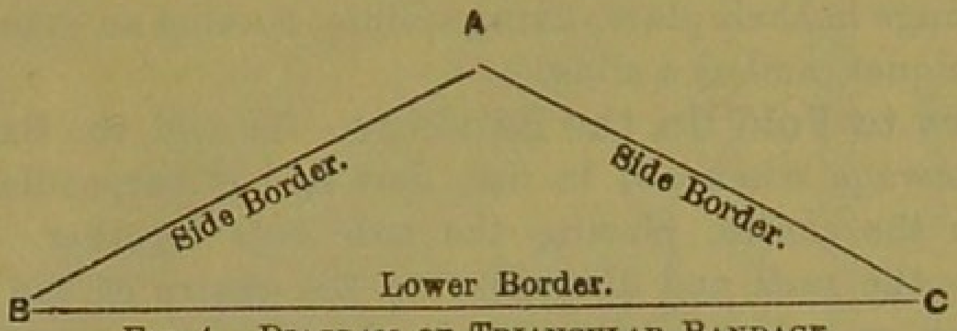


FIG. 4.—DIAGRAM OF TRIANGULAR BANDAGE.

Description of Esmarch's Triangular Bandage.—As shewn in the above outline, it is a triangular piece of linen or calico, the base of which measures about 40 inches and is known as the *Lower border*, while the other two are the *Side borders*. Of the three corners, the upper one A is the *Point*, the other two, B and C, the *Ends*. To make the bandage, take a piece of linen or calico, 38 inches square and cut it diagonally, that is to say from one corner to the other, into two pieces, and two bandages are at once made.

The Advantages of the Bandage.—To appreciate these we must remember that the *temporary* treatment of injured persons should be of the simplest kind and of such a nature that it can be quickly carried out. Any elaborate dressings requiring considerable time for arranging them, and any voluminous bandaging to retain them in position, are to be avoided, for they will all have to be removed as soon as the case comes under the care of a medical man either at the hospital or the patient's own home, and this removal takes up valuable time, is a needless extra trouble to the doctor, and in many cases cannot be done without suffering and pain to the patient. Now, Esmarch's Bandage meets all necessary requirements. It is always at hand, for one can be made by cutting or folding a pocket handkerchief diagonally across. Then, with the aid of the diagrams upon it, very little practice makes one proficient in its use, and it is found that most temporary dressings can be as well, and many better applied by it than by roller bandages. Lastly, it can be used in no less than *thirty-two* different ways, so that it is specially adapted for Ambulance work, as it can be made to answer every purpose, such as retaining dressings in their place, fixing splints, making an extempore tourniquet, and as a sling.

How to Fold Up the Bandage.—To fold the Bandage for stowage when not in use, first fold it perpendicularly down the centre, placing the two *ends* together. Then bring the *ends* and the *point* to the centre of the lower border or base of the perpendicular line, so as to form a square. This square should be folded in half, and again twice, till it assumes the form of a small packet, 6 × 3 inches.

Mode of Using the Triangular Bandage.—This will, of course, vary with the part of the body to which it may have to be applied; but, speaking generally, it may be said to be used in one of three ways,—viz., (1) *unfolded*, (2) *folded broad*, (3) *folded narrow.*

To fold the bandage *broad* or *narrow*, spread it out and commence by carrying the *point* over to the *lower border;* still work from the direction of the point, and when it is required *broad* fold it lengthways twice, and when *narrow* three times. To fasten the bandage after using it in one of its many numerous ways, either pin the ends together or knot them, using the reef or "sailor's knot," which is less liable to slip than the "granny," or woman's. See figures 5 and 6 on the handkerchief.

The following are the directions for applying the triangular bandage to the different parts of the body, and the references given in the text are to the numbered figures on the bandage issued by the St. Andrew's Ambulance Association :—

Wounds on the Top of the Head (Scalp).—Cut the hair from about the wound, cleanse it, lay on the "first dressing," and apply the bandage as follows :—Lay the middle of the bandage on the head, so that the lower border lies crossways before the forehead, the point hanging downwards over the nape of the neck. Carry the two ends backwards above the ears, cross them at the back of the head, bring

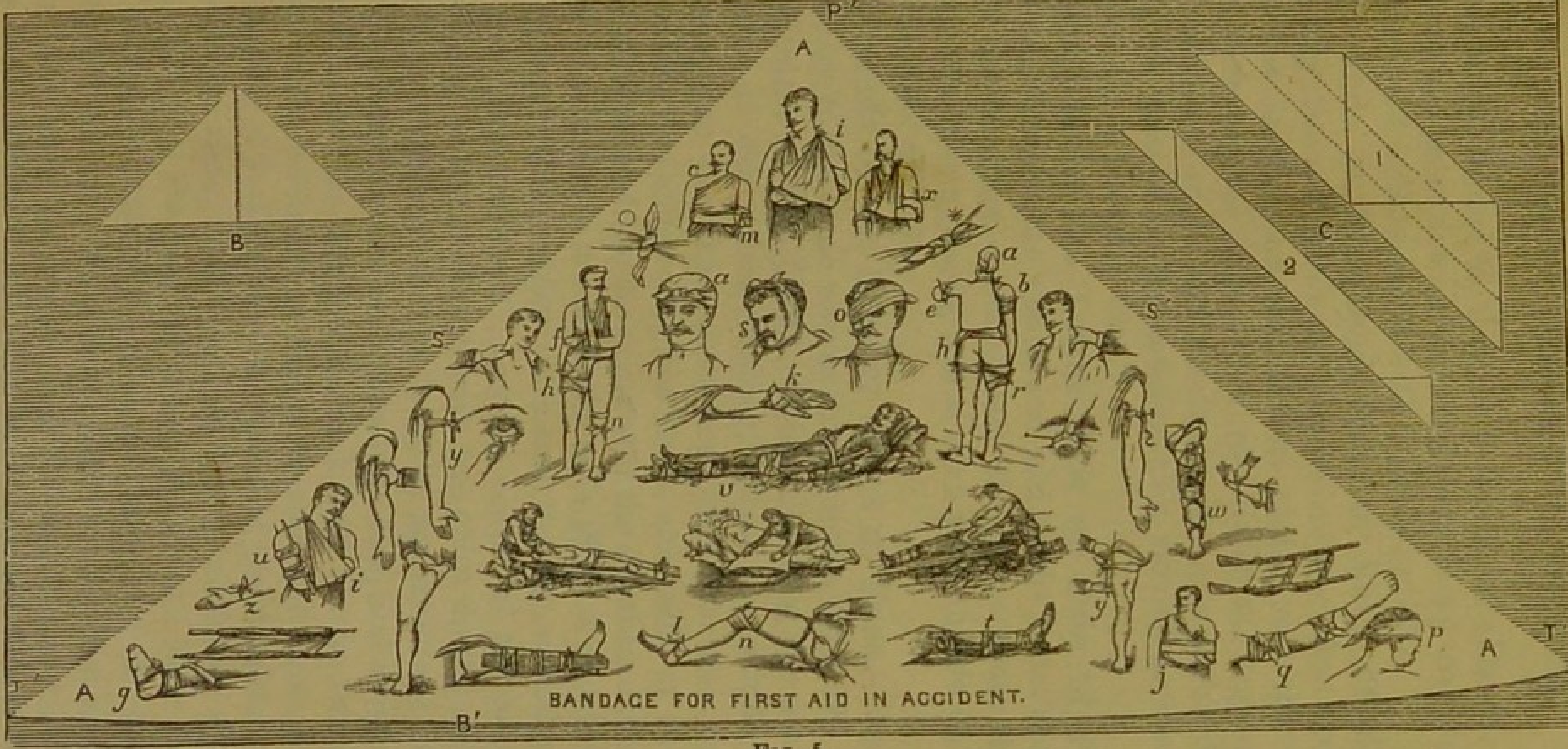


Fig. 5.

Reduced copy of the St. Andrew's Ambulance Association Triangular Bandage. Taken by permission from "Chambers' Encyclopædia."

them forwards, and tie them on the forehead (Fig. 7). Then stretch the point downwards, and turn it up over the back of the head, and fasten it with a pin (Fig. 17).

Wounds on Forehead, Side, or Back of Head.—Having cleansed the wound and laid on the "first dressing," fold the bandage *narrow*, lay its centre over the wound, and, carrying the ends backwards, tie at the opposite side of the head; or, if the bandage be long enough, the ends may be crossed at the opposite side, carried forward, and knotted in front (Fig. 50).

Wounds of the Lower Jaw or Side of Face.—Having cleansed the wound and laid on the "first dressing," fold the bandage *narrow*, place the centre under the chin, carry the ends upwards, one at each side, and tie on the top of the head (Fig. 9).

Wounds of the Eyes or Front of Face.—Apply the bandage in the same way as the foregoing (Fig. 10).

Wound of the Chest.—After cleansing the wound and laying on the "first dressing," place the middle of the bandage on the chest, with the point over one shoulder, carry the two ends round the chest, and knot at the opposite side; next draw the point over the shoulder downwards, and tie or piece it to one of the ends (Figs. 4 and 19).

Wound of Shoulder.—Cleanse the wound and place on it the "first dressing." Lay the centre of the bandage on the point of the shoulder, with the point up the side of the neck, and the lower border lying on the middle of the upper arm. Carry the two ends round the arm, and crossing them on its inner side, bring them back, and tie on the outside. Take a second bandage, fold it *narrow*, and make a smaller arm sling of it, then draw the point of the shoulder bandage under the sling, fold it back on itself, and fasten with a pin on the top of the shoulder (Figs. 11, 16, and 18).

Wound of the Hip.—Cleanse the wound and lay on it a "first dressing." Fold a bandage *narrow*, and tie it round the body for a waist-belt. Lay the centre of a second bandage on the wound, with the point upwards; pass the ends round the upper part of the thigh, cross and carry to the front, and knot them together. Next pass the point under the waist-belt, and fasten it with a pin (Figs. 13 and 20).

Wound of the Arm.—Cleanse the wound and apply the "first dressing." Place the centre of a broad folded bandage on the front of the limb, carry the ends round to the opposite side, cross them, bring them back, and knot them together (Fig. 49). Next take a second *broad* folded bandage, throw one end over the shoulder on the wounded side, carrying it round the neck so as to be visible at the opposite side; then bend the arm carefully, and carry the wrist across the middle of the bandage hanging down in front of the chest. This done, take the lower end over the shoulder on the sound side, and knot the two ends together at the nape of the neck. This is called *The smaller arm sling* (Fig. 16).

Wound of the Fore Arm.—Dress and bandage the wound as in last case (Fig. 49). Then take a second bandage, throw one end over the shoulder at the sound side, and carry it round the back of the neck so as to be visible at the opposite side, where it is to be held fast; place the point behind the elbow of the injured arm and draw down the end in front of the patient. Next bend the arm carefully and place it across the chest on the middle of the cloth. Then take the lower end upwards over the shoulder on the wounded side, and knot to the other end at the nape of the neck. This done, draw the point forward round the elbow and fasten it with a pin. This is called *The larger arm sling* (Fig. 1).

Wound of Elbow.—(Fig. 3).—Dress as for knee.

Wound of the Hand.—Cleanse the wound and dress it. Take a bandage, spread it out and lay the wrist on the lower border with the fingers towards the point. Next turn the point over the fingers and carry it up on the wrist. This done, carry the ends round the wrist, fixing the point, cross them, carry them back again, and knot together.

Wounds of the Thigh, Knee, or Leg.—Dress and bandage in the same manner as was directed for wounds of the upper and fore arm (Figs. 21, 14, and 15).

Wounds of the Foot.—Cleanse the wound and dress it. Take a bandage, spread it out, and place the sole of the foot on its centre, with the toes in the direction of the point. Draw the point upwards over the toes and instep of the foot; then take the ends forward round the ankle, cross on the instep, carry them downwards, and knot them together on the sole of the foot; or, if the bandage be long enough, cross them, bring them forward again, and knot on instep (Fig. 43).

Limb Torn Off.—After stopping bleeding, and dressing the wound, take a bandage, lay its lower border under the limb, above the end of the stump; then draw the pointed portion upwards over the stump, and, carrying the ends round the limb, tie them together so as to fix the point (Fig. 18½).

To Secure Splints.—Ordinary or improvised Splints may be applied to a broken limb and held in position by taking two triangular bandages, folded *broad* or *narrow* according to circumstances, and tying them securely one above and the other below the fracture (Figs. 1, 2, and 44).

To Improvise a Tourniquet.—Fold the Triangular Bandage *narrow* and tie it round the limb over a firm pad placed above the course of the main artery; then insert a stick under the bandage and twist it until such pressure is brought to bear upon the artery that the circulation of blood through it is stopped (Figs. 30 and 40).

The first Dressing of Wounds.—In cases of accident where there is a *Wound* some dressing must be applied to this before the triangular bandage is put on. The consideration of this point opens up a very important question, for it brings us face-to-face with the great changes that have of recent years taken place in the surgical treatment of wounds. It would be out of place to go into these fully, but I must say a few words on them, so that the Ambulance pupil may see *the importance of what is applied to wounds*, *and may learn how to avoid doing harm.* Modern wound treatment, or the *Antiseptic system* as it is called, is founded on the germ theory of disease, which attributes certain morbid processes to the presence of living organisms. All the facts are strongly in favour of this view. It is very generally admitted that the process known in wounds as *Decomposition* or *Putrefaction* is a fermentative one and arises from the development of a certain micro-organism or germ, which, in its turn, produces products which are extremely irritating to the living tissues, and set up or excite acute inflammation with its heat, pain, redness, swelling, and subsequent formation of matter. If a wound can be kept free from these germs it usually progresses without any inflammation or pain, and terminates satisfactorily. But the difficulty is to accomplish this, for these minute organisms are universally present in the air, and in water, and on all the surrounding objects; and it is only perhaps in the air coming from the highest part of glaciers that putrefactive dust is absent. At present the efforts of surgeons are all directed to the exclusion of these active ferments from the discharges of wounds, and fortunately we have the power of doing so, thanks, in great measure, to the efforts and teaching of Lord Lister. To show how the growth of these small organisms in wounds is prevented, would necessitate a full description of how surgeons treat wounds in the present day. That would be out of place in such a work as this, but speaking generally, it may be said that the antiseptic treatment of wounds implies *the most scrupulous cleanliness and the use of some substances, known as antiseptics, which have the power, when brought into contact with these minute organisms, of destroying them, and arresting the fermentative processes which they either initiate or promote.*

From what has been said the Ambulance pupil will understand that the kind of application he makes to the wound may materially affect its future progress, and that he must keep away from it every source of impurity. Thus he would not bring into contact with it dirty sponges, soiled linen, or sticking-plaister that has been lying about, and is probably covered with septic dust; nor would he allow it to be dressed by any one with dirty hands. He would also see that all dirt that may have got into the wound, and on the surrounding parts, is carefully washed away with clean water and clean linen rags. Of course, if circumstances allow of it, some antiseptic, such as a little Condy's Fluid, or a few drops of carbolic acid, or some crystals of boracic acid, should be added to the water, and then a bit of clean rag soaked in this antiseptic fluid should be laid over the wound, and secured on gently by the triangular bandage. Any one treating a wound so would have done good service, inasmuch as he had done no harm. In time of war we see the same principle carried out in furnishing every soldier with a 'first dressing," composed, in part, of some antiseptic material. If no antiseptic is available, then the "first dressing" should be limited to a piece of clean lint or rag, moistened with *clean* water after the removal of all blood and dirt from the vicinity of the wound. A bit of *oil-silk* or *gutta-percha* tissue could advantageously be placed above the lint to keep it moist. This procedure is recommended as being preferable to dry lint or rag, which is apt to be irritating, and also, by becoming hard, to cause pain and trouble in its subsequent removal by the surgeon when he comes to examine the wound. Should, however, one be so placed that none of the above things are obtainable, then no bad substitute as a "dressing" may be found in a fleshy leaf, especially in hot weather; and we have Shakspeare's authority for it, that "your plaintain leaf is excellent for a broken skin."—(Romeo and Juliet, Act I., Scene ii.) I shall have more to say of the treatment of wounds when I come to describe them, but I have indicated broadly the principles on which to work; and, in concluding, I would say, never tie anything tightly over a wound, unless circumstances such as bleeding compel you, as it only gives rise to throbbing and pain, owing to interference with the circulation.

CHAPTER IV.

THE SKELETON.

Behold this ruin! 'twas a skull,
Once of ethereal spirit full.
This narrow cell was life's retreat,
This space was thought's mysterious seat.
What beauteous visions filled this spot!
What dreams of pleasure long forgot!
Nor hope, nor joy, nor love, nor fear,
Have left one trace of record here.

From "Lines to a Skeleton."

THE LOCOMOTORY APPARATUS.

IN the introductory sketch of the general anatomy of the human body I shewed that one of the chief characteristics of a living being was the power of motion. Now there are many kinds of movement, such as bending down, standing up, turning about, carrying our hands to our mouth, opening and shutting our eyes, all of which are accomplished by various *muscles* of the body; but there is one class of movements which have special interest for us, inasmuch as by them we are enabled to move from place to place. They are called *the movements of locomotion*, and the means by which they are effected are known as the *Locomotory Apparatus*. This is made up of three distinct parts :—

1. Bones.
2. Joints or Articulations.
3. Muscles.

1. THE BONES.—The study of the bones of the body has received the special name of Osteology, from the word "Osteon," which is the Greek for a bone. Collectively the bones of man or any other animal are known as the skeleton, which is from another Greek word signifying to *dry*, and it implies that the bones have been freed from their soft parts and then deprived of all moisture by exposure to the air.

Prepared so, the bones become hard and white, and we are apt to think that their study must of necessity be dry and unattractive. The truth is the very reverse is the case, and that, if undertaken in a proper spirit, Osteology is a most attractive pursuit. As one writer has said, "While following it we become acquainted with mechanical forces and mechanical contrivances of infinite beauty and simplicity, which far surpass our most complicated inventions in their effects, and in principle often anticipate the novel discoveries of our acutest mechanicians," (*Wagstaffe.*)

The number of bones in the skeleton is variously stated by different books, and it varies with age, for bones that are separate in early life become united together into one as the person grows. It may be said generally that there are about 200 bones in the human body.

Various shapes of bones.—All these 200 bones are not alike in shape any more than are the bones of a chicken, or any other animal. It is customary to classify them into different divisions according to their shape, and we speak of the bones of the body as falling into one of the following classes :—

1. Long bones.
2. Short bones.
3. Flat bones.
4. Irregular bones.

Another point that may be mentioned here is, that owing to the body being made up of two similar halves, some bones in the middle line of the body, such as the breast bone, are *single*, while others, as those of the arms and legs, are *double*. Hence we may say that the bones of the body are made up of two great divisions—(1) Single bones; (2) Double bones; and these again may be further arranged as (*a*) Long, (*b*) Short, (*c*) Flat, and (*d*) Irregular.

The constituents of bone.—Although they differ in shape, bones are all alike in their composition. By this is meant that the constituents of bone, or the substances which go to form it, are the same all through the body, just as flour, water, salt, and yeast, are the materials of which bread in its different forms is composed. It is necessary to know the composition of bone, and fortunately it can be demonstrated by two simple experiments.

First experiment.—Fill a flat vessel with strong vinegar and in it lay a bone, such as the thigh bone of a chicken. Having done so you will soon see some bubbles of gas escaping, and if you leave the bone long enough in the vinegar you will observe, on taking it out, that its hardness has disappeared, and that though it retains its size and shape, it is now so soft and pliable that it can be bent in any direction or even tied in a knot. The reason of this is that the acid has dissolved out all the *earthy* matter of the bone, and has left the *animal* part of it. This latter is called gelatine or gristle, and is a soft and yielding substance.

Second experiment.—Take another thigh bone from a chicken, and burn it to a white heat in a fire. When it has cooled down, it will resemble a bit of white chalk, and on examining it you will see that it is full of minute holes and canals. You will notice also that it is so brittle that if handled with any force it would crumble away. This whitish mass is the *mineral* matter of the bone, and the pores and spaces in it are the cavities that were filled with animal matter or gelatine.

These two simple experiments demonstrate the existence in bone of two distinct substances which can be easily separated, but are so intimately combined as to give to bone its well known characteristics. I have said that the *animal* matter is known as gelatine or gristle, and I should mention that the *mineral* matter is chiefly *phosphate of lime*, which, in its turn, is composed of phosphorus, lime, and oxygen, and is hence much sought after for obtaining the phosphorus, or *bone-earth*, as it is consequently called, which is the active principle in so many of the artificial manures. There is also in bone a small quantity of *carbonate of lime*, so familiar to us in the shells of the sea-shore and in the framework of the corals. Its presence is demonstrated by the bubbles of carbonic acid gas which escape when a bone is first placed in vinegar.

Although fully-formed bone consists of animal matter (gristle) impregnated with earthy matter (phosphate of lime), this last has not always been present in the bone. In early infancy it is almost quite absent, but it makes its appearance as the child grows older, and every year of life the bones become more and more impregnated with it. From this follows the important fact that young children's bones are soft and pliable, and under violence are more likely to bend (green-stick fracture) than to break completely through, while the opposite is the case with grown-up people, and in old age there is such brittleness of the bones that they give way sometimes under the slightest falls and injuries. Then, again, if anything interferes with the deposit of the mineral matter at its proper time, as occurs in the disease called *rickets*, the bones remain soft and yielding, instead of becoming hard, and they are, accordingly, bent by forces that they would otherwise resist. As a consequence, we have such deformities as bow-legs and knock-knees, owing to the lower limbs not being able to bear the weight of the body. These facts shew us how careful we should be with the food of a growing child, for it is by it and it alone that the gelatine, lime, and phosphorus of our bones is introduced into the body. We are too apt to think that we are chiefly dependent on the water we drink for the supply of lime to the blood. It is not so. Plants absorb moisture from the earth by their roots, and thus the sap becomes impregnated with the mineral ingredients of the soil in which they grow. We eat these plants, or the flesh of animals that have fed on them, and thus by an interesting cycle of events the phosphate of lime which was once in the rocks, and by the agency of the forces of nature had got mingled with the ground, finds its way into our bodies. Watch, then, I say, carefully the food of the growing child; and though the water that it drinks be as free from lime as our own Loch Katrine, be comforted by the reflection that in a plate of porridge and of milk there is as much lime as in gallons of the hardest water.

The structure of bone.—To understand this we have only to cut across the thigh bone of a rabbit, or look at the bone which sticks out from the middle of a round of beef. In either case we see that the middle part of the bone is *hollow* and encloses a canal, the walls of which are *hard* and *dense* while the interior is filled with a pulpy yellowish substance known as marrow. In short, the bone is a kind of tube, a form which is characteristic of all long bones both in man and in animals. It is unnecessary to inquire here why the shafts of all long bones are built according to this plan of a tube; but it could be shewn that they have been constructed on the most approved mechanical principles, and that they have been fashioned after the ideal type of the engineer, which aims at yielding "the greatest strength with the least material." Were we, however, to make a section of one of the short or irregular bones, we would not find a central hollow. The cut surface would shew a number of apparently irregular plates or fibres, so placed as to form numerous square meshes arranged with great regularity and order. This has led to the tissue being compared to a network or a honeycomb, and to its being designated "spongy." This last is not a very appropriate name, and a preferable one is "*cancellous*," from a Latin word which signifies lattice-work; for when closely examined it is easily seen that the bone owes its porous appearance to the plates of which it is composed cutting each other at right angles, and thereby enclosing truly rectangular spaces, which are filled with a reddish marrow similar to that in the long bones. From this description it will be apparent that we have two varieties of bone in the skeleton—namely, the *dense* and the *cancellous*. And yet, different as they are to the naked eye, they really have much in common in their structure, owing to their being built with the same object in view, which is to offer the greatest possible resistance to the forces that act on them. As regards the situations in which these different kinds of bone are found, the *dense* variety occupies the shaft of the long bones, and the *cancellous* the interior of all short and irregular bones and the ends of the long ones where they expand to form the joints.

If space allowed a most interesting account might be given of the structure of bone, as revealed by examining a thin section of it under the microscope. In fact, this is the only way to get a correct idea of it. Without going into details, the microscope reveals to us the important information that bone, even in its densest parts, is tunnelled and permeated by channels and tubes which convey bloodvessels and nerves through it, and allow of the circulation of nutriment all through its substance. Bone, in short, as it exists in the living body, is not an inert substance, but one endowed with vitality and active nutrition. This, of course, renders it subject to disease and pain, but it also provides for the repair of injuries. If it were not so, a bone, when broken, would not mend, and the not uncommon accident of a "broken arm" would become a very serious occurrence.

The blood supply of bones.—This is very abundant, and comes from several sources. Each bone has usually a nutrient artery, which passes through a channel in the bone and supplies the marrow, but a very great number of vessels are furnished by a strong fibrous membrane which covers all the outside of each bone, and serves for the attachment of the muscles which are fixed to it. This membrane has received the special name of Periosteum.

The growth of bones.—Bones grow in *thickness* by new bone being deposited by the periosteum, but the growth in *length* is connected with a layer of cartilage which exists in the ends of all long bones. On one side of this layer we have ossification, and on the other growth. As John Hunter puts it, "on one side the cartilage is being gradually absorbed by the advancing bone, but on the other side it is as rapidly forming new cells, so that what is lost in one direction is more than made up in the other."

The ossification of bone.—The process of ossification, or bone formation in the body, is a very interesting one, but all that can be said about it here is that the shape of the future bone is at a very early period laid down in cartilage or membrane, and that then, through the agency of young *bone-cells* which make their appearance, this fibrous framework is infiltrated with salts of lime in the form of minute granules.

THE SKELETON.—With these introductory remarks we are the better able to take up the study of the Skeleton, which in its dried state, as we are in the habit of studying it, cannot be said to possess any great beauty. This no doubt is due to the fact that it is not meant to be seen, all its angles, eminences, and bony prominences being clothed and covered with soft parts. It will help our consideration of the Skeleton if we remember that it has the three following objects to accomplish :—

(1) To serve as a *protection* for important organs, as the skull for the brain, &c.

(2) To serve as a *support*, as the vertebral column for the erect posture.

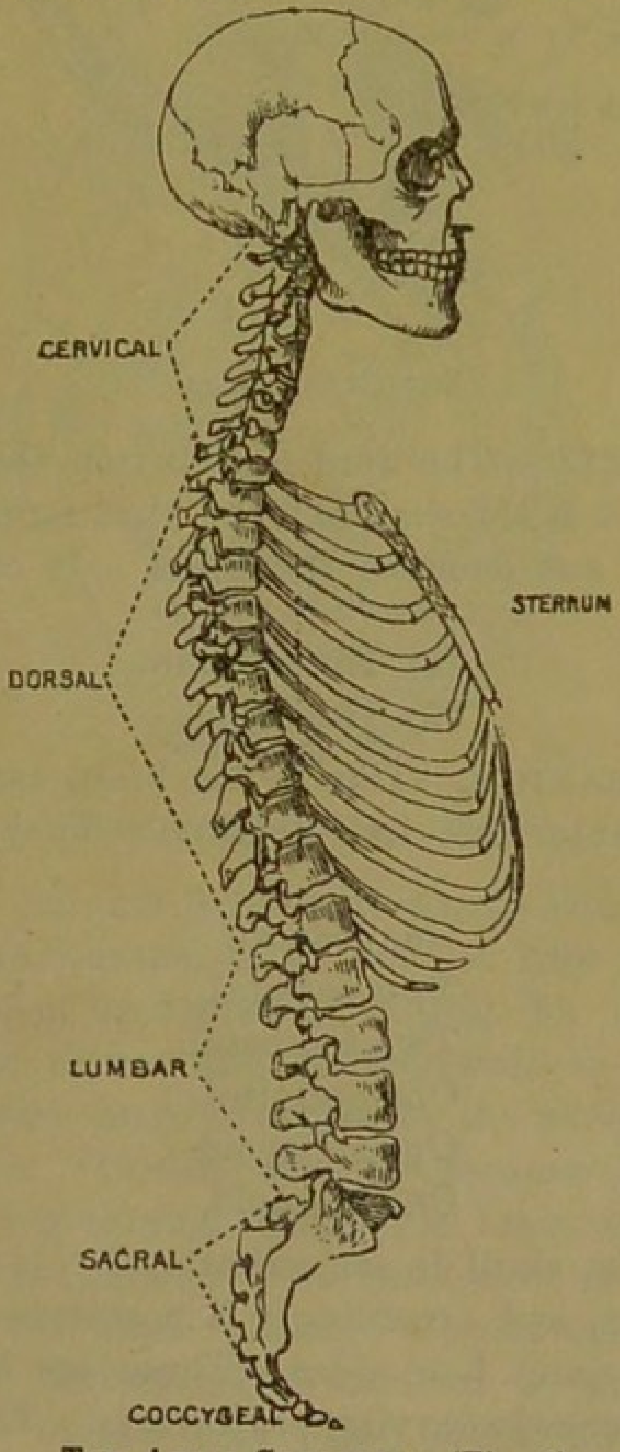
(3) To furnish a series of *levers*, as in the limbs, for the muscles to work on.

This fact explains why we have such different shaped bones in the body, some being flat (skull), some long (limbs), some short (carpus), and others irregular (vertebrae). As already stated there are about 200 bones in the adult. In learning them, the three points that every ambulance pupil should remember about each bone is its (α) *Name*, (β) *Position*, and its (γ) *Shape*, for he will find in a future chapter that the main blood vessels run under shelter of the bones, and are named after them. For convenience of description we will divide the Skeleton into the *Axial* and *Appendicular* portions.

THE AXIAL SKELETON.

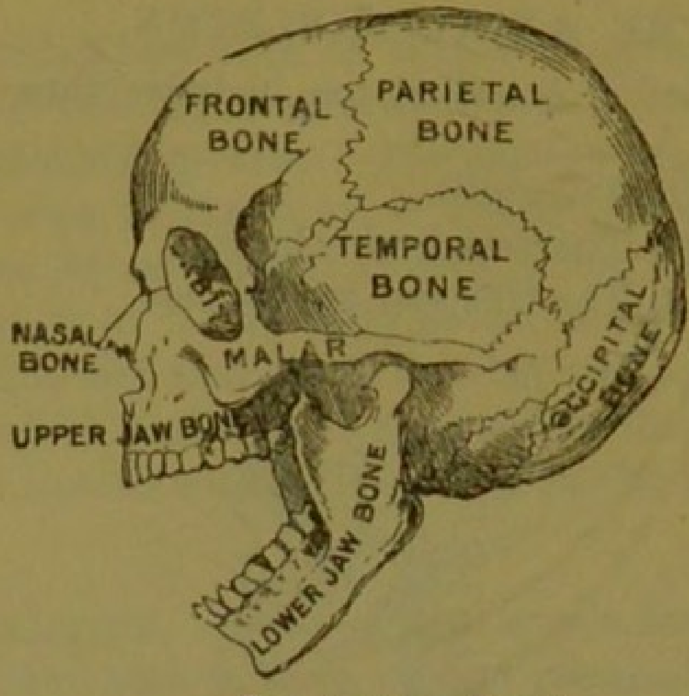
The Axial part of the Skeleton includes three separate parts, viz.:—

(1) The skull.
(2) The vertebral column.
(3) The ribs and breastbone.



THE AXIAL SKELETON. (Fig. 6).

The accompanying figure shews these different parts, and it will be best to take them in the above order. Only a brief sketch or outline of their chief features will be given.



THE SKULL.—FIG. 7.

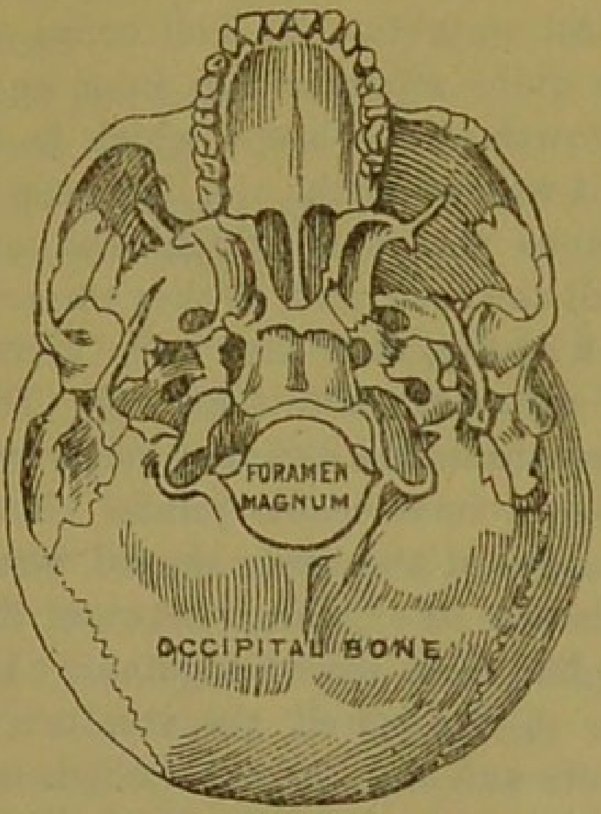
1. THE SKULL.—The word *skull* is from the Danish *skall*, a shell, and it is the shell of bone that forms the exterior of the head and encloses the brain. It consists of two portions:—

(1) The cranium.
(2) The face.

(1) THE CRANIUM.—This is the brain case proper, and eight bones enter into its formation. They are named as follows —

One frontal.
Two parietal.
Two temporal.
One occipital.
One sphenoid.
One ethmoid.

In shape the skull is somewhat oval. It has been compared to a box, and accordingly it possesses a lid or roof, a base or floor, and four sides. These are formed by the above eight bones in varying proportions. Thus the *frontal* closes in the front of this cranial box, the two *parietal* form the roof and part of the sides, the two *temporal* complete the side walls, and the *occipital* occupies the back wall. All of these are flattened bones. The floor of the box is made up of the lower part of the *occipital*, of the peculiar-shaped *sphenoid*, and the small sieve-like *ethmoid*. This last bone contains the organ of smell, and lies at the root of the nose.



BASE OF THE SKULL. (Fig. 8).

Though the cranium is a box, it is not a completely closed one, for an examination of its floor or base shews that it has a number of apertures in it (Fig. 8). These are for the passage of nerves and blood-vessels to and from the brain. One very large aperture in the occipital bone attracts attention. This is called the *foramen magnum*, and it is the opening through which the brain and the spinal cord become continuous. On each side of the foramen magnum are two small elevated smooth convex surfaces, which fit into corresponding cavities in the first vertebra and allow of the head being poised on the vertebral column.

The following facts in connection with the cranium are of interest:—(1) In life the whole of the floor of the skull is carpeted, so to speak, with a strong fibrous membrane called the *dura mater*. It is closely attached to the bone all over it, and sends off partitions which pass into the several divisions of the brain, and support them. (2) The dome-like shape of the skull imparts strength to it, just as the arch-shaped bridge is the one that is the best able to bear the heaviest weights. (3) The bones of the cranium in infancy are quite separate one from another, so as to allow of the growth of the brain, which in one year grows twice the size it was at birth. (4) Between the bones are clear membranous spaces in which the pulsations of the brain can be felt and seen, and, as they resemble the welling up of water in a spring, they have been given the name of "fontanelles," or small fountains. (5) To increase the strength of the cranium the different bones are, in the adult, welded together by immoveable joints. These are formed by having the edges of the bones shaped like the teeth of a saw, and so close is the joining between them that they look as if they had been sewed together. Hence they are called *sutures*. (6) How well the cranium is adapted for resisting pressure and injury from without is shewn by the fact that the *only* way to separate any individual bone, and not damage the others, is by applying force from within. This is done by filling the cavity of the skull with peas. On moistening these with water, they expand and break up the cranium into its several bones. (7) The structure of the cranial bones is a further source of protection to the brain. They are made up of three layers—an outer compact and tough, an inner hard and more brittle, and an intermediate one softer and spongy—so that we have a case which may be roughly "compared to one made of wood outside, porcelain inside, and soft leather between the two." (*Holden*). (8) Lastly, the power of the skull cap to resist shocks is increased by certain groins of bone and buttresses which support its respective parts.

(2) THE FACE.—Passing next to the bones of the *face* we find that they number 14, and that the leading object in the architecture of this part of the skull is the formation of

protecting cavities for the delicate organs of smell, sight, and taste. The following are the bones of the face:—

Two nasal,
Two spongy,
Two lachrymal,
One vomer, } These all combine to form the nose.
Two upper jaw bones.
Two palate bones.
Two malar or cheek bones
One lower jaw bone.

It is unnecessary to describe all these bones in detail. They either form sheltering cavities, such as the *orbits* for the eyes, the *nasal fossæ* for the delicate membrane of smell, and the *mouth* for the organ of taste, or prominences as in the cheek or malar bones. Bounding the mouth we have the two upper jaw-bones, each of which is immoveable, and carries 8 teeth, while below them is the single horse-shoe-shaped *lower jaw* carrying 16 teeth, and moving up and down by a special joint in front of the ears.

2. THE VERTEBRAL COLUMN.—This is a jointed column which is made up of a number of separate bones called vertebræ, from the Latin *verto* to turn, and it is so constructed as to combine strength, mobility, elasticity, and lightness. It is the presence of this structure which is the distinguishing feature of the VERTEBRATES, the highest class of creatures in the animal creation. It serves as a pillar of support for the body, and gives it its erect attitude and dignified bearing, so that when we speak metaphorically of a man without backbone, we indicate one deficient in manliness and independence, and who goes through life a pliant pulpy mortal. Other names for the vertebral column are the *spine* or *backbone*, though this last term is scarcely a correct one, for we have not to do with a single bone, but with a great many separate bones joined together, which individually have very little motion between them, but

collectively are capable of a considerable amount of movement.

The number of these vertebræ is 33 in early life, but subsequently the 9 lower ones become amalgamated together and form 2 bones—the *sacrum* and *coccyx*. In consequence of this we have only 24 *true* vertebræ, the other 9, which become welded together, being known as *false* ones. Although these bones are all constructed on one uniform type, they present marked differences in certain parts of the spine, so that it is usual to arrange them in groups. Of the *true vertebræ* we distinguish three regions:

(1) Those of the neck (*cervical*).
(2) Those of the back (*dorsal*).
(3) Those of the loins (*lumbar*).

If reference is made to the figure of the trunk or axial skeleton, it will be seen that in the neck there are 7 vertebræ, all of which are free. The first two, known as the *atlas* and *axis*, are specially modified to allow of the articulation of the head and of its being turned round from side to side. It is amongst the cervical vertebræ that the greatest amount of movement takes place. In the back there are 12 vertebræ, each of them bearing a rib on either side. In the loin the vertebræ number 5, and they resemble those in the neck in being quite free. They largely form the posterior wall of the abdomen.

Below these lumbar vertebræ we have the *sacrum*, which consists of 5 bones welded together. It is wedged in between the haunch bones, and supports the spine, so that the weight of the body is transmitted through it. Lastly, we have the small bone, the "coccyx," which is so called from its resemblance to the beak of the cuckoo. It is made up of four rudimentary vertebræ, which are the relic of the tail of primæval days, or of the fabulous "tailed men" of Borneo of more recent times, who are currently reported to have to cut a hole in the ground for the reception of their tails when they wish to sit down. With us in the present day matters are not so inconveniently arranged; but there is no doubt that we do possess a caudal appendage, so curved forwards, however, as not to incommode our sitting down.

The shape of the vertebræ varies considerably in the different regions, but they all contain the same essential parts, and are well seen in the accompanying figure of a lumbar vertebra (Fig. 9).

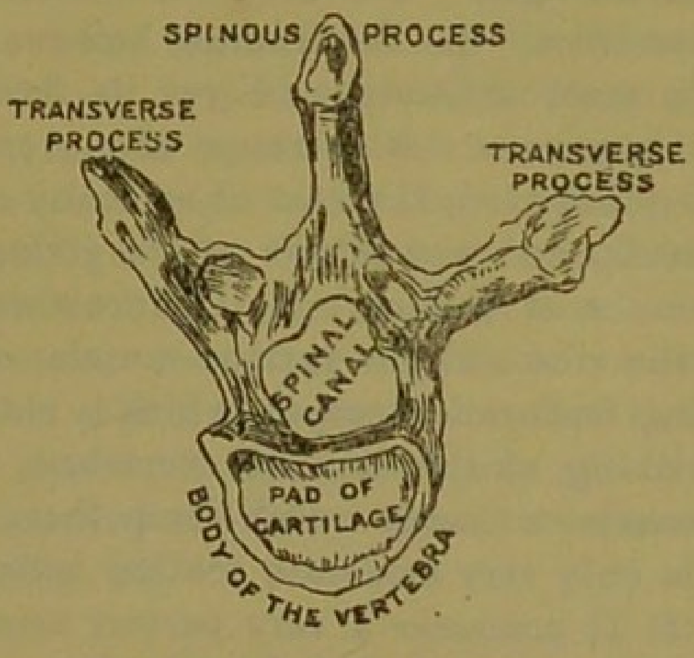


FIG. 9.—A LUMBAR VERTEBRA.

The following are the characters common to all vertebræ:—

(1) A *body*, which is a solid cylindrical portion, and lies in front.

(2) An *arch*, which lies behind, and springs from the posterior part of the body.

(3) Several *processes* for the articulation of the different vertebræ and the attachment of muscles.

(4) Several *notches* for the passage of the spinal nerves between the vertebræ.

When in position the *bodies* of the different vertebræ are placed one above the other so as to form a column of support in front, while the *arches* behind lying one above the other make a continuous canal, which serves to lodge the spinal cord and to protect it, while through the notches between the vertebræ the spinal nerves emerge.

So far we have considered the vertebræ separately; but we should fail to grasp the salient features of this part of the skeleton did we not look at the spine as a whole. It is only then that we realize how efficiently it performs duties that almost seem incompatible with one another, and that it is no exaggeration of language to describe it "as a wonderful piece of mechanism which has excited the admiration of anatomists in all ages." (*Holden*). The following are its chief characteristics:—(1) Its firmness bestows on man his characteristic erect attitude, and yet its flexibility is so great that it possesses a wide range of movement. (2) It protects the spinal cord, the seat of so many of our voluntary movements, and yet allows of its giving off all the necessary nerves of motion. (3) It furnishes a basis of support for the ribs and the various muscles of the trunk. (4) Its leading feature is *strength*, which is obtained by the close interlocking of the separate vertebræ, and by the strong ligaments or bands which keep them together, so that there is only very moderate motion between any two vertebræ. (5) It possesses a very perfect arrangement for lessening shocks and jars. In the first place, between the bodies of the vertebræ, which increase in size from above downwards, are placed thin discs of cartilage. These are soft in their centres and firm at the edges, where they are closely attached to the bones above and below them. They act as buffers between the vertebræ, and are very powerful factors in preventing any shaking or concussion of the brain and spinal cord. In the next place the spine has several very graceful curves, which are so gradual that they confer a certain amount of beauty on it without exerting any compression on the cord inside, and yet they increase the strength of the column very materially, to say nothing of the increased room they give for the organs of the trunk. One point about these curves is that they are specially characteristic of man, appearing first in youth. In babyhood they are quite absent, shewing the need of the recumbent posture at that period of life. This provision against shocks is of great importance, when we remember that the spine bears on its summit the head with its delicate-contained organ the brain, which, but for this arrangement, might be seriously damaged, even by such a simple proceeding as jumping from a chair on to the ground.

3. THE RIBS AND BREAST-BONE.—The RIBS, from the Saxon word *rib* or *ribb*, are the bones which, with their cartilages, form the top and sides of the framework of the chest or thorax. It is the largest of the three great cavities of the skeleton, and contains the heart and lungs. The other bones which complete this bony cage are the 12 dorsal vertebræ behind and the BREAST-BONE in front. The ribs number 12 on each side, and in both sexes, although the popular idea is that men have only 11 on one side, owing to a certain event which happened some few thousand years ago. The 7 upper ribs are called *true* and the five lower ones *false*, because these latter are not connected with the breast-bone (Fig. 10).

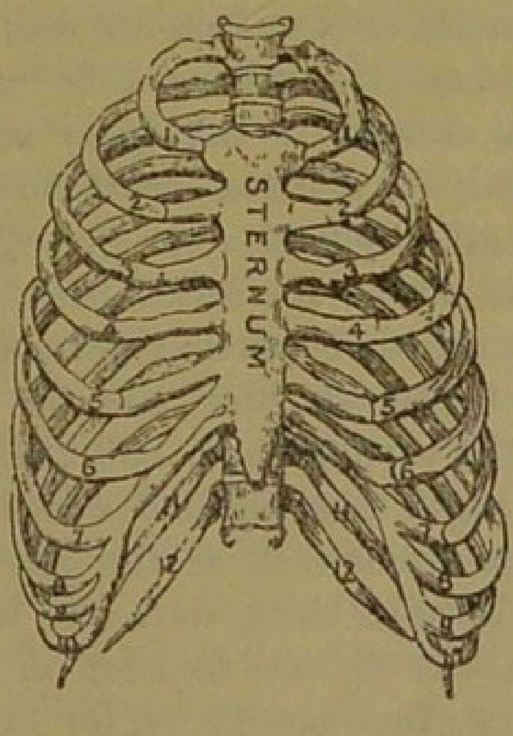


FIG. 10.—THE RIBS AND BREAST-BONE.

The plan of construction of the thorax or chest is this :—All the 12 ribs are attached behind to the dorsal vertebræ, from which they arch round like hoops towards the breast-bone. Just before they reach it they become cartilaginous, but only the upper 7 are directly attached to the breast-bone. Of the other 5 three are fixed in front to the lower border of the seventh, while the other two are quite free, and are known as the *floating* ribs. It follows from this that the chest walls are formed partly of bone and partly of gristle or cartilage, a combination of strength and elasticity which is admirably adapted for its requirements. The *breast-bone*, to which the ribs are joined, is a flattened sword-shaped bone, broader and thicker at its upper end to allow of the collar-bones joining with it, and so placed that it slants forward, thus giving more room for the lungs.

Owing to the important part the thorax takes in breathing, acting as a sort of bellows, it exhibits one or two special features. The most striking of these is the *oblique* position of the ribs, their ends which join the breast-bone being lower than the vertebral ones. Hence it follows that when they are raised in the act of breathing they push forward the breast-bone and increase their own curvature, so that the depth and breadth of the chest are made greater.

As to the individual ribs, it is usual to number them from above downwards, as seen in the figure of the chest (Fig. 10). The first one is the shortest, most curved, flattest, and broadest of them all. It is also the strongest, for it has to support the upper part of the breast-bone and collar-bones, and has to protect all the important parts at the root of the neck. (*Holden*). After the first one the ribs increase in length down to the seventh one, and then the five lower ones decrease in length from above downwards. The result of this is that the framework of the chest has a conical shape, its greater breadth being from side to side than from before backwards. It is well to keep in mind what the correct shape of the chest should be, for the mode of dress in the present day, with its tight stays and corsets, is apt to lead to compression of its lower part, interfering with its movements, and perhaps displacing, if not actually injuring, some of the important organs in the abdomen. No words can be too strong for condemning such an absurd custom, on a par with many of the practices of uncivilized people, as it is harmful to a degree, distorting the shape of the chest, and materially restricting its breathing power, so that it may lay the seeds of future illness and lung disease.

This completes our sketch of the bones of the trunk or axial skeleton, as it is termed. The only point I would notice, in conclusion, is that the variation in the height of different individuals is due chiefly to difference in the length of the lower limbs. The human spine is more uniform in length than we are inclined to suppose. This is supported by the fact that as a number of persons sit round a dinner table there is not such a marked difference in their height. It is only when they rise from the table that the great variations in stature become apparent.

THE APPENDICULAR SKELETON.

This portion of the skeleton exemplifies well the principle of the division of labour. As a rule the higher the animal is in the scale of nature the more is this idea worked out, so that we get certain parts of the body reserved for fixed and definite duties. In the appendicular skeleton of man the UPPER LIMBS are framed entirely for the purposes of prehension and to carry out the wishes of the mind, while the LOWER LIMBS are restricted to locomotion or conveying the body from one place to another. In consequence of this they are modified to suit their respective work, and yet they bear to one another a general resemblance. Thus each of them is divided into *four* secondary regions, those in the *Upper Limb* being (1) the Shoulder, (2) the Arm, (3) the Forearm, and (4) the Hand; and in the *Lower Limb* (1) the Haunch, (2) the Thigh, (3) the Leg, and (4) the Foot. It will be necessary to consider each of these very briefly, commencing with the Upper Limb.

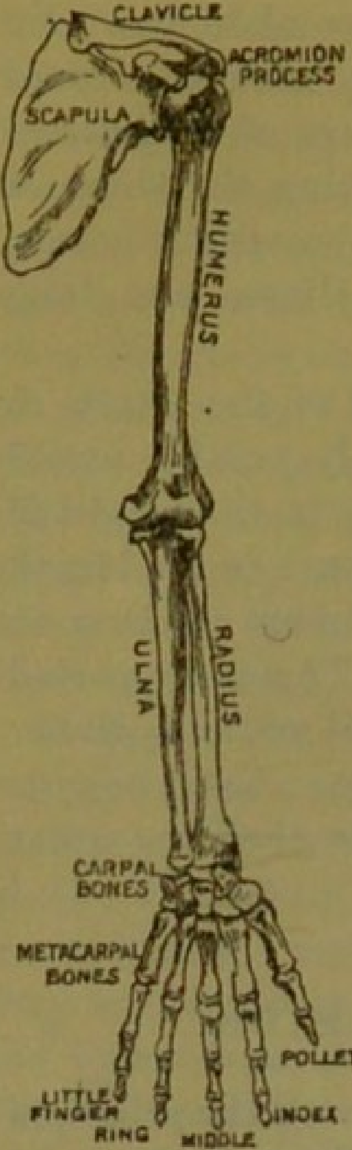


FIG. 11.–THE BONES OF THE UPPER LIMB.

UPPER LIMB.

The 32 bones of the upper limb are divided into the following regions :—

1. THE SHOULDER.—This, the first region or subdivision of the upper limb, has for its base two clearly defined bones, (*a*) the *Shoulder-blade* or *scapula* and the (*b*) *collar-bone* or *clavicle*.

The SHOULDER-BLADE is a triangular shaped flattened bone, which is placed at the back of the chest and rests over the upper ribs behind. It possesses a considerable range of movement and serves as a moveable fulcrum in all the motions of the arm. In places it is so thin as to be almost translucent, but its flattened form permits of the attachment of the large muscles which rotate the humerus or bone of the upper arm. Owing to its shape it fits closely to the chest wall and glides easily on it. One the most striking points about it is the large shallow oval cup on its outer side in which the round head of the humerus moves forming the shoulder-joint. In addition several marked processes of bone arch over it.

The COLLAR-BONE, from its fancied resemblance to an ancient key (Latin *clavis*), has received the name of *clavicle*. It is a long double-curved bone, not unlike the letter S in shape. Placed in front it extends from the Breast-bone to the Shoulder-blade in a horizontal direction. It is a very important bone in the upper limb, its work being to keep the shoulder well back and allow of free range of movement for the arm. It also gives attachment to certain large muscles and protects the axillary blood vessels and nerves. Notwithstanding the curves in the bone which give it a certain amount of elasticity and help materially to break the shocks that the arm is subject to, it is very often broken. It is on these occasions that we see how it acts as a prop for the shoulder, for no sooner is the bone broken than the shoulder droops slightly forwards, while the injured person supports the elbow in his hand and leans his head towards the broken side to relax the muscles attached to the bone.

2. THE UPPER ARM has only one bone, the *humerus*. It is the longest and strongest of all the bones of the upper limb. It has a very characteristic rounded upper end which plays in the shallow cavity of the shoulder-blade and forms with it the shoulder-joint. Its lower end joins with the bones of the fore-arm, the next subdivision of the upper limb. The junction really only takes place with one bone, the *ulna*, which has at its upper end a deep crescentic cavity, called the olecranon. This receives within it the flattened and widened out end of the humerus, and in this way is formed the elbow-joint, a most perfect example of a hinge-joint.

3. THE FOREARM.—It contains two bones, the outer of which is called the *radius*, from its resemblance to the spoke of a wheel, and the inner the *ulna*, owing to its forming the elbow, from the Greek word ὠλένη. These two bones only come together at their extremities, their central portions being quite apart. The Ulna is thicker above where it forms the elbow-joint, while the Radius is expanded below to form the wrist-joint. As a consequence of this, in falls on the hand the shock is received almost entirely by the radius, which is in consequence very often fractured just above the wrist. The movements of which the fore-arm is capable are very interesting. Not only is there the backward and forward movement at the elbow with its hinge-joint, but there is also a movement of *rotation* between the two bones, so that the hand can have its palm turned upwards or downwards. These movements are known respectively as those of *supination* and *pronation*.

When the hand is *pronated*, the palm is turned downwards, as in picking up anything from the floor; when it is *supinated*, the palm is turned upwards, as in receiving the probably well deserved "palmies" of schoolboy days. It is this power of rotation which confers such usefulness on the hand, and it would well repay one to study the mechanism by which it is carried out. Suffice it to say here that it is accomplished by having only one bone entering into the elbow-joint and one into the wrist-joint. Further, each bone works separately on the other, the radius above working in a socket of the ulna, and the ulna below in a socket of the radius. As the hand is attached to this latter bone by means of the bones of the wrist, whenever the head of the radius is turned round in the groove of the ulna the hand moves with it and is turned round.

4. THE HAND.—There are 27 bones in the skeleton of the hand, and they are arranged in three sets, viz. :—

(*a.*) Those of the wrist (*carpus*).
(*b.*) Those of the palm (*metacarpus*).
(*c.*) Those of the fingers (*phalanges*).

The eight bones of the *wrist*, or *carpus* as it is called, are placed in two rows of four each, and thus give a broad base of support for the hand. The ambulance pupil need not burden his memory with the names of the individual bones, but should note how the presence of a number of bones confers elasticity on the wrist and breaks the numerous shocks to which it is exposed. Were there only one bone in the wrist it would be very liable to be broken or displaced, whereas these eight small bones, although bound together by strong ligaments, possess a certain amount of gliding movement between them. The four upper bones of the carpus articulate with the radius, and the four lower with the bones of the palm.

The five bones of the *palm* or *metacarpus* are placed between the wrist and the fingers, and though each bone individually may be described as cylindrical, collectively they form a quadrilateral region which corresponds to the palm of the hand and supports the fingers.

The fourteen bones of the *fingers* are grouped under the general term "*phalanges*," from their resemblance to the phalanxes of a Greek army. Each finger has three, with the exception of the thumb, which has only two, though it is probable that it has three, what is termed its metacarpal bone being really a phalanx. The phalanges decrease in size from above, and are called respectively first, second, and third, but more recent anatomical works speak of them as phalanges, phalangines, and phalangettes. They form a series of jointed columns which have a great resemblance one to another and are only distinguished by their difference in size, for not only do they decrease in length from above downwards, but the dimensions of the individual phalanges are proportionate to the size of the fingers to which they respectively belong.

Such briefly is an outline of the bony skeleton of the upper limb, and a great deal might be written on the mechanical principles brought into play in the arrangement of the thirty-two bones of which it is composed, but it is sufficient to remark that as it has nothing to do with the support of the body, everything has been adapted to make it a perfect organ of prehension for lifting and carrying things. This is largely attained by the collar-bone keeping it well from the side, so as to give it a free range of movement, and by the presence at its extremity of that consummate piece of mechanism the hand, whose varied functions and delicate manipulations speak with an eloquence of their own.

LOWER LIMB.

The thirty-one bones of the lower limb are arranged into four secondary regions, just as is the case with the upper extremity.

1. THE HAUNCH OR HIP.—This sub-division contains the large and irregular hip-bone, which is known as the

innominate or unnamed bone. It really consists of the junction of three separate or distinct bones called respectively the *ilium*, the *pubis*, and the *ischium*. The haunch bone of one side firmly joins in front with that of the other side, while posteriorly there is wedged in between them that part of the vertebral column known as the *Sacrum* or sacred bone, so called from its being the part that the ancients offered in sacrifice to their gods. In this way there is formed a circle of large and firm bones, which has been named the *Pelvis*, from its resemblance to a basin (Fig. 12.)

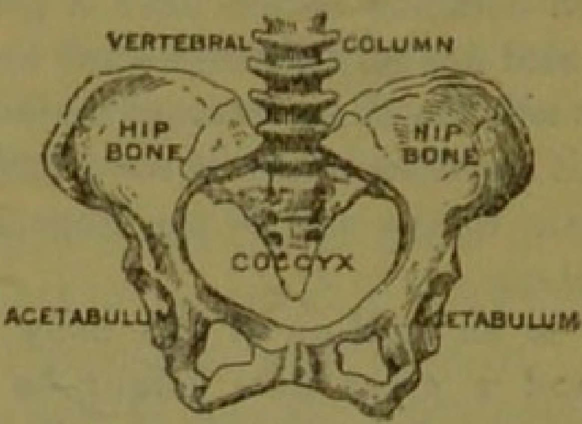


FIG. 12.—THE PELVIS.

The pelvis has its lower aperture closed in by muscle, so that it is able to hold in its interior certain organs, such as the bladder, and it has its haunch bones so widely expanded for the support of the intestines when the body is in the erect posture, that this feature of them is specially characteristic of man. Another duty which the pelvis has to discharge is to serve as a firm basis of support through which the weight of the body may be transmitted to the lower limbs. To allow of this, these latter articulate with it by means of two cup-shaped cavities, one on the outer aspect of either haunch bone, into which the globular heads of the thigh bones are received. Each of these sockets is called the *acetabulum*.

2. THE THIGH.—The *femur* is the bone of the region of the thigh, and it extends from the pelvis above to the tibia below (Fig 13). In general form it is cylindrical, and of

a curved shape. As it has to bear the whole weight of the trunk, it is only natural that it should be the longest and strongest of all the bones. Its upper end has a smooth globular head which fits into the *acetabulum*, or socket in the haunch-bone, and forms the *hip-joint*. To allow of a wider range of movement, this head is attached to the shaft at an angle, and in this way the two thigh bones form with the haunch bones an arch for the transmission of the weight of the body. The end of the femur below is enlarged, swelling out into two masses of bone, called *condyles*. These have somewhat broad and flat surfaces which unite with the tibia to form the *knee-joint*. Along with the thigh bone may be here mentioned the PATELLA, or knee-pan, which is a small, rather thick bone, of a triangular shape, with the apex pointing downwards. It is placed in the front of the knee, just as the *olecranon* is at the back of the elbow, and there seems no doubt that it is partly for the protection of the knee, and also to increase the leverage power of the muscle in whose tendon it is developed.

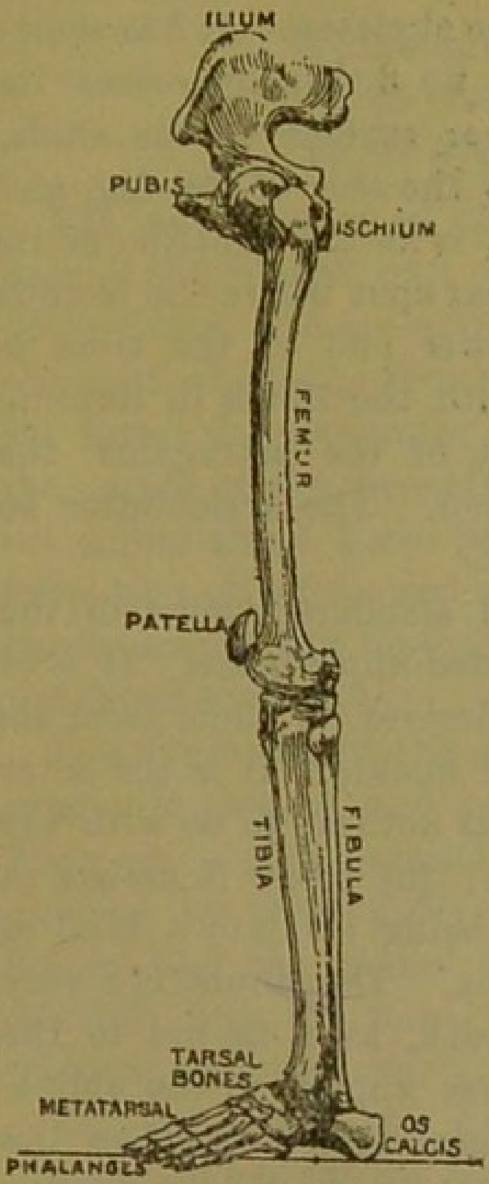


FIG. 13.—THE BONES OF THE LOWER LIMB.

3. THE LEG.—After the thigh with its *one* bone, comes the leg with its *two* parallel ones, the *tibia* and *fibula*, reaching from the knee to the ankle.

The *Tibia* or *Shin-bone* is the main bone of the leg, and lies on its inner side. An idea of its shape may be got from the fact that it is called *tibia* from its resemblance to the ancient pipe or flute. The expanded or trumpet-like end and the lower flute-like end give it the appearance of that instrument. Its broad and flat upper end supports the condyles of the femur, so that it really transmits the weight of the body to the foot. This necessitates the bone being of considerable size and strength, and we find that after the femur it is the longest bone of the skeleton. It has somewhat of a curve inwards, which, no doubt, increases its elasticity. It is the smooth inner surface of the shaft, covered only by skin, which forms the *shin* of the leg, and as the narrowest part of the shaft is at the junction of its middle and lower thirds it is at that spot where the bone is most frequently broken. The lower end of the tibia is expanded transversely to assist with the fibula in forming an articular cavity for the head of the astragalus, the uppermost of the bones of the foot. The articulation so formed is known as the *ankle-joint.*

The *Fibula* is the longest and slenderest bone in the body and has somewhat of a twisted appearance. It is of the same length as the tibia, and derives its name from its similarity to the pin of a brooch or buckle. It is the outer of the two bones of the leg and has nothing to do with the formation of the knee-joint above; but below it assists in the formation of the ankle-joint, being let into a kind of socket in the outer side of the tibia. The fibula is a very elastic bone, and serves, so to speak, as a tie-rod to the curved tibia, hence it is sometimes known as the splint-bone: its chief function is to guard and strengthen the outer side of the ankle-joint. So efficiently does it do this that the ankle-joint cannot be very well displaced without its being broken, and consequently fracture of the fibula, in connection with severe sprains of the ankle, is a very common accident, as will be further alluded to in the chapter on *Fractures.* The fibula has several muscles attached to it, and its shaft lies so completely embedded in them that only its upper and lower end can be felt. This latter is triangular in shape, and projects downwards very much, forming the marked outer prominence of the ankle-joint.

4. **The Foot.**—The 26 bones which form the last subdivision of the lower extremity are divided, like the corresponding region of the hand, into three segments. They are as follows :—

(α) Those of the ankle (*tarsus*).
(β) Those of the instep (*metatarsus*).
(γ) Those of the toes (*phalanges*).

The seven bones of the *ankle*, or tarsus, as it is called, occupy the hinder part of the foot. They are of very irregular shape, and are arranged in two rows, an inner and an outer, of which the former supports the three inner toes and the latter the two outer ones. It is not necessary to learn the names of the individual tarsal bones, the chief point to remember about them being that they are so placed as to form part of a firm and elastic arch, which is completed by the bones of the instep, or metatarsus, and supports the weight of the body.

The five bones of the *instep*, or metatarsus, are long and prismatic shaped, and complete the chief arch of the foot. They are placed parallel with one another, and are distinguished by their different sizes, the first one being the largest and the second one the longest. Their upper ends dovetail into the tarsal bones, and join with each other, while their lower ends support the toes.

The bones of the *toes* or phalanges are fourteen in number, the great toe having two, and the other toes three each. They resemble those of the fingers both in their number and arrangement, but differ from them in being shorter. This feature is most marked in the three outer rows. The great number of bones in the foot has its advantages, as in the case of the hand, for the numerous joints that of necessity are formed all confer elasticity and increased motion, and help to break the shocks and jars to which it is exposed. As a result of this, fractures or dislocations of the bones of the foot are rare. If, however, we compare the respective bones of the foot and hand we are at once struck with the difference between them. In the hand, which is for grasping, lifting, or carrying things, the fingers are long and the wrist short; while in the foot, which serves as a basis of support for the body, the toes are short, and the bones of the ankle are of considerable size, forming half of the length of the foot. Another characteristic

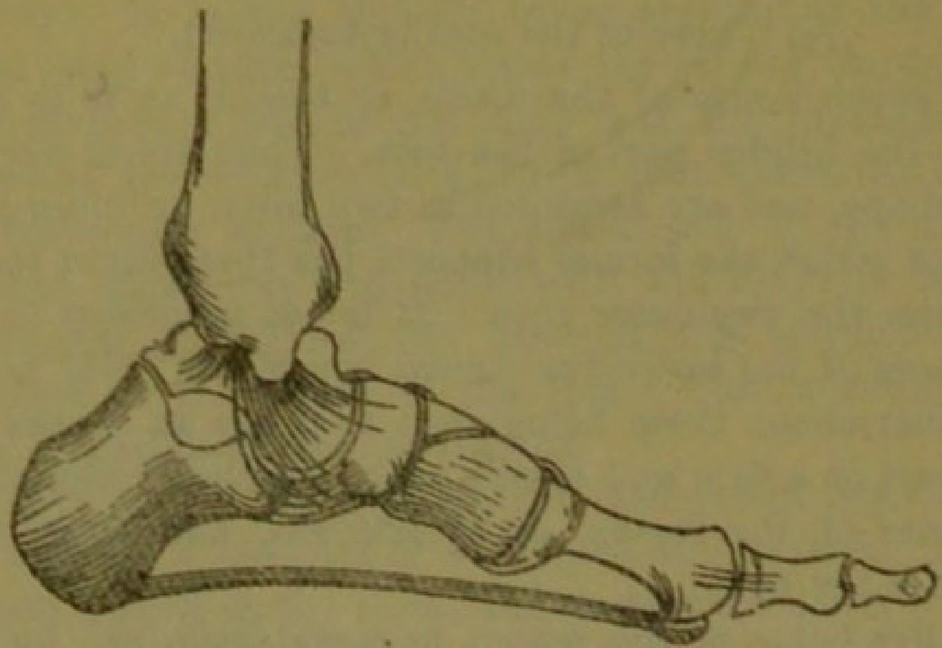


Fig. 14.—The Arch of the Foot.

feature of the skeleton of the foot is the true *arch* which it forms (see Fig. 14), thus leaving in the sole a hollow, which is more marked on the inner side of the foot than the outer, so that its external border comes in contact with the ground, while its internal border scarcely does so. This is well seen in the marks made by wet feet on the dry pavement or any other level surface, where the chief impressions observed are the outer edge of the foot, the heel, and roots of the toes, the two latter being the pillars of the arch.

There are many points of similarity between the bones of the upper and lower extremity, and their several regions correspond very closely; but the fact that one has been formed for movement, and the other for support, has led to very marked differences. Into these it is not necessary to enter at any length, as they are tolerably apparent, but the greater size and strength of the bones of the leg as compared with those of the arm, the fixity of the haunch bone compared with the mobility of the shoulder-blade, the absence of movement in the bones of the leg, compared with the supination and pronation of the radius and ulna, are instances of the modifications brought about by diversity of function.

This brings to a close the descriptive account of the skeleton, and it may be as well to briefly recapitulate here what has been gone over at some length. The *Head* includes the face and skull (*cranium*), in the cavity of which the brain is lodged. The *Trunk* is made up of the spinal column and the chest. The *spinal column* contains twenty-four segments (*vertebræ*)—seven in the neck, twelve in the back, and five in the loins—together with the *sacrum* and *coccyx* which terminate it, and form part of a basin-shaped cavity, the *pelvis.* Above the spinal column supports the head, while throughout its whole length it forms a bony canal for the protection of the spinal cord. The breast-bone (*sternum*) in front, and the twelve *vertebræ* in the back, with the twelve pair of *ribs* at the sides, are all united together and make up the chest (*thorax*). There are two upper and two lower limbs. Each *Upper Limb* is joined to the trunk at the shoulder by the movable shoulder blade (*scapula*), and collar-bone (*clavicle*), while below it consists of three parts—viz., the arm, forearm, and the hand. The arm has only one bone (*humerus*), the forearm two bones (*ulna* and *radius*) lying together, and the hand numerous bones arranged into those of the wrist (*carpus*), palm (*metacarpus*), and fingers (*phalanges*). The *Lower Limb* is connected to the trunk by the irregularly basin-shaped cavity the *pelvis.* It is divisible into three parts—viz., the thigh, the leg, and the foot. The thigh has only one bone (*femur*), the leg has two (*fibula* and *tibia*), and the foot several bones, which are grouped into those of the ankle (*tarsus*), those of the instep (*metatarsus*), and those of the toes (*phalanges*).

Seeing how the skeleton is the bony scaffolding on which the rest of the body is built, the ambulance pupil should study well this part of the human frame, until he is able mentally to fit bone to bone, and joint to joint, and construct the whole framework in his mind's eye. He should take any opportunity his lectures afford of handling the skeleton, observing how perfectly bone joins with bone, and the admirable mechanical principles displayed. If he does so the repugnance which the eyeless sockets and the fleshless form may momentarily excite will soon pass off. Should it not, let him ponder on the following poem, the first verse of which I have put as a heading to this chapter. The sentiments expressed therein should rob any skeleton of power to cause horror or dislike to approach it. The Lines were published some seventy years ago in the *London Morning Chronicle*, and excited a good deal of attention. Every effort, even to the offering of fifty guineas, was vainly made to discover the author. All that ever transpired was that the poem, in a fair clerkly hand, was found near a skeleton of remarkable beauty of form and colour, in the Museum of the Royal College of Surgeons, Lincoln's Inn, London:—

"Beneath this mouldering canopy
Once shone a bright and busy eye;
But start not at the dismal void—
If social love that eye employed,
If with no lawless fires it gleamed,
But through the dews of kindness beamed,
That eye shall be for ever bright
When sun and stars are sunk in night.

"Within this hollow cavern hung
The ready, swift, and tuneful tongue:
If falsehood's honey it disdained,
And where it could not praise was chained,
If bold in virtue's cause it spoke,
Yet gentle concord never broke,
This silent tongue shall plead for thee
When time unveils eternity.

"Say, did these fingers delve the mine,
Or with its envied rubies shine?
To hew the rock and wear the gem
Can little now avail to them.
But if the path of truth they sought,
Or comfort to the mourner brought,
These hands a richer mead shall claim
Than all that wait on Wealth or Fame.

"Avails it whether bare or shod
These feet the path of duty trod;
If from the bowers of ease they fled
To seek affliction's humble bed,
If Grandeur's guilty bribe they spurned,
And home to Virtue's cot returned,
These feet with angel's wings shall rise,
And tread the palace of the skies."

JOINTS.

The outline that has just been given of the skeleton and its individual bones would be incomplete were I not to say something about the special arrangements that are made at the points where the different bones come into contact with one another and are so joined together that they can move, if necessary, one upon the other. Those points of union are termed *joints* or *articulations*, from a Latin word *articulus*—a joint, while the study of this particular part of the human frame has received the name of Arthrology, from the Greek words ἄρθρον—a joint, and λόγος—a description. In considering the subject of *joints*, a special description of each joint in the body is not required. All that is necessary is to give a general account of their construction, showing how they are modified, and how they can be arranged in certain *classes* according to the extent of movement they possess.

A joint may be defined as *the point where any two or more bones come into contact.* As the amount of movement or play that these bones will have on one another will depend on circumstances, we find that joints differ in their nature and structure, and it is usual to divide them into three classes.

1. The Immovable Joints.—In these movement is entirely absent, and their structure is very simple. The edges of the adjoining bones are placed in close contact, and are connected usually by a series of tooth-like projections which interlock them, as it were, together. The joinings or sutures of the bones of the skull are an excellent illustration of these immovable joints, which are found almost exclusively in the bones of the head.

2. The Mixed Joints.—In these there is partial movement, but the amount of it is slight. It is usually accomplished by the aid of fixed plates of fibro-cartilage which are placed between the bones, and permit very limited motion of their surfaces upon each other. The joints between the vertebræ with their intervening fibro-cartilages are of this kind. As these joints form an intermediate link, so to speak, between the *immovable* and the next class, the *movable* joints, they have been designated "mixed."

3. The Movable Joints.—This class includes most of the joints in the body, and their distinguishing feature is mobility. To accomplish this their mode of formation is more complicated than in the other classes. The structures which enter into the formation of a movable joint are the following:—

(α) Bone.
(β) Cartilage.
(γ) Ligaments.
(δ) Synovial membrane.

It is necessary to say a few words on each of these structures.

Bone is of course the chief element in all joints, and it is generally of the spongy or cancellous variety, being, however, covered over by a thin layer of dense bone. The shape of the bones varies with each joint, but very often we find their ends expanded or enlarged. To ensure these ends being perfectly smooth, they are encrusted with a layer or plate of *Cartilage*, which is an elastic substance of a pearly white lustre. Its smoothness greatly facilitates an easy gliding movement of one bone on the other, while its elasticity materially lessens any shocks that may fall upon the bones. Further provision has been made for rendering the working of the joints as free from friction as possible, by furnishing a kind of lubricating fluid for them. This has received the name of *Synovia* from its being thick, viscid, and glairy like the white of egg, and it is secreted by the *Synovial Membrane*, which encloses the ends of the bone like a sac, and pours out this fluid into its interior. This sac or bag is often spoken of as the *capsule* of the joint, and it completely closes and lines the ligaments and other structures round the joint-cavity. It

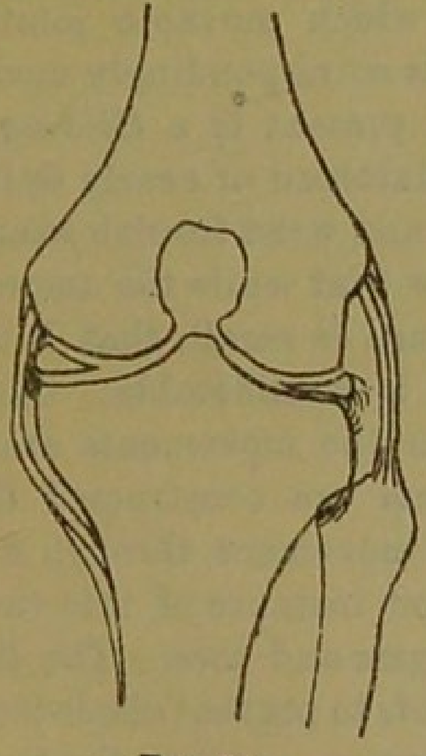


FIG. 15.

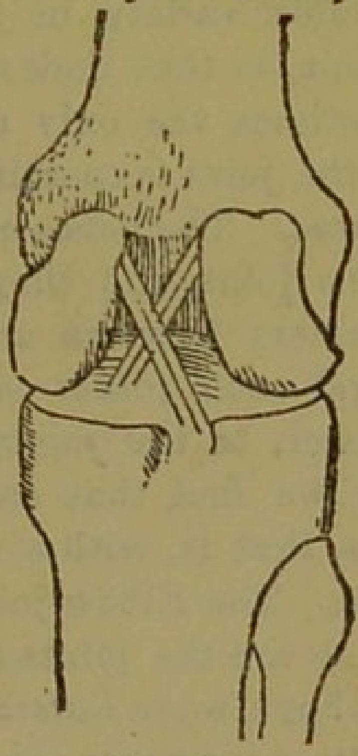


FIG. 16.

THE KNEE-JOINT AND ITS LIGAMENTS.

is necessary, however, that the joints should have some solidity, and that the ends of the bones entering into their formation should be kept from being too loose and flail-like. This is accomplished by the presence of *Ligaments*, which are bands of fibrous tissue passing from one bone to another in a joint and holding them together as seen in Figs. 15 and 16, which diagrammatically represent the knee-joint.

These Ligaments have a white and silvery appearance, and are very tough and strong, while, at the same time, they are pliant and flexible. Briefly, then, the movable joints may be said to be constructed of Bone covered with Articular Cartilage and held together by Ligaments. The bones enclose a space between them which is known as the joint cavity and is limited by a Capsule, which is a membrane secreting a peculiar fluid of an oily nature for lubricating the parts, just as we see greasy substances used for the axles of carriages. In short, its use is to prevent friction, and the more the joint is used the less there is of it, as is readily seen in the different amount of it that exists in the joints of stall-fed and grazing cattle.

Coming next to the *movements* of joints, there is a considerable variety in those of which movable joints are capable, so that their structure is correspondingly modified. Sometimes the only movement present is a *Gliding* one, and the joint is constituted by flattened or nearly flattened surfaces. The bones of the foot and wrist furnish examples of this joint, and they also shew that while the amount of movement between any two bones is small, that between several such joints collectively is considerable. Coming, however, to the joints in which the movements are very free, we find that some of them are constructed like a *hinge*, that is, with a to-and-fro movement through a wide range. The Elbow-joint is a good instance of this variety, and so are the joints of the fingers and toes. The hinge-joint has always *Lateral Ligaments* to prevent displacement, and its movements are termed *flexion*, as when the forearm is bent on the arm, and *extension* when it is carried backward and straightened. But the joint that must be regarded as the most complete of all is the *Ball-and-Socket* one, where the end of one bone is nearly spherical and the other cup-shaped. The Shoulder and Hip-joints are typical illustrations of this kind of joint, and we know how freely the leg and arm can be moved in all directions, as forward, backward, inward, outward, and round and round in a

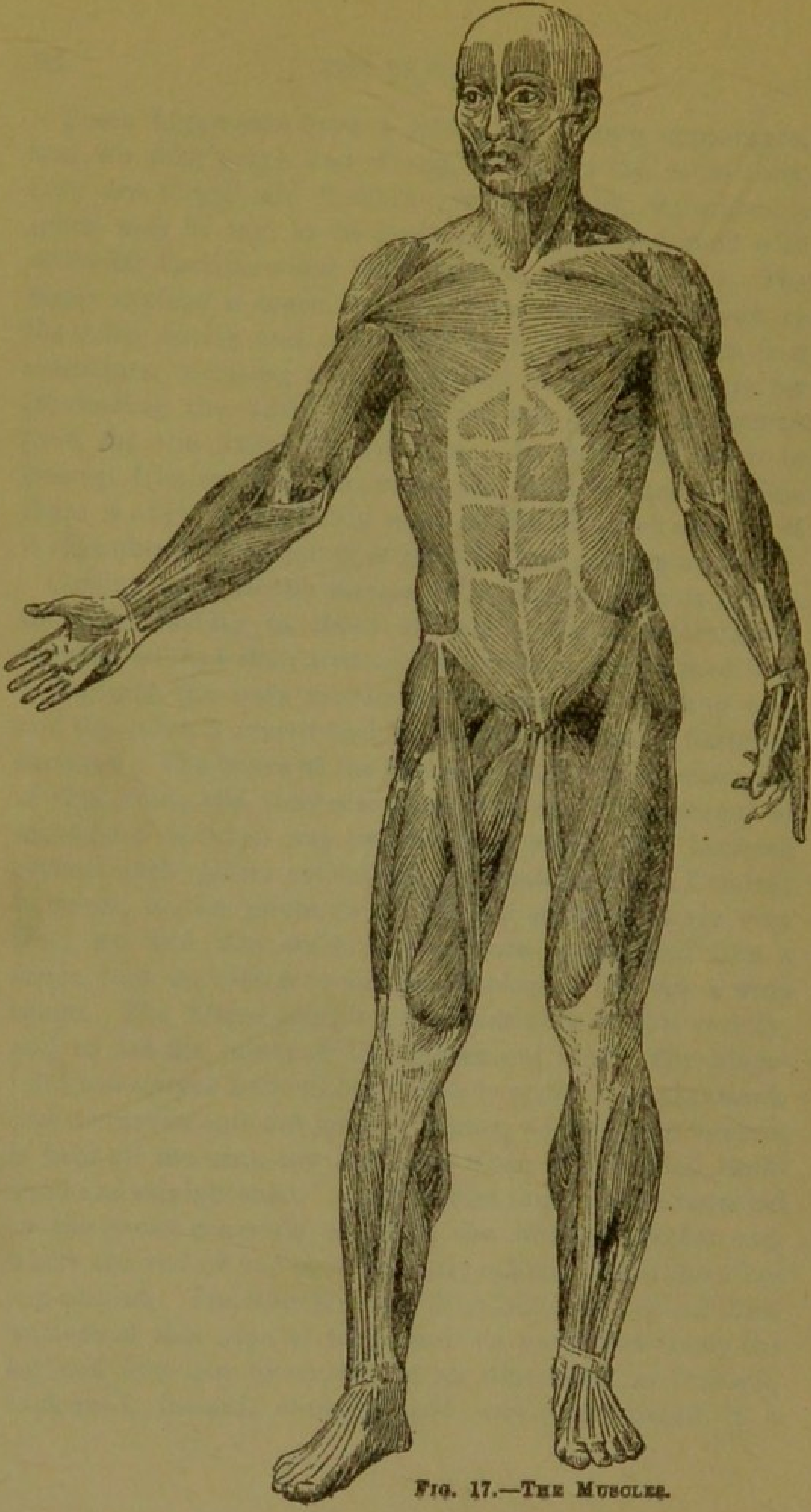


FIG. 17.—THE MUSCLES.

circular manner. In this variety of joint we observe, too, that the ordinary articular cartilage which renders the bones entering into a joint so smooth is further made use of to deepen the cavity of the cup by rimming its borders with an immovable fibro-cartilage, just as in the knee, which is so much exposed to concussions, it takes the form of a movable plate of fibro-cartilage between the cartilage-covered articular ends of the bones, and thus furnishes further protection against injury. Lastly, when I mention that the joint-surfaces are kept together by the Capsule and the Fibrous Ligaments, and that the elastic tension and contraction of the muscles around give further security, I think I have mentioned all the necessary facts about the joints which an ambulance pupil should know.

MUSCLES.

Having described the skeleton and the manner in which its individual bones are joined together, some account is necessary of the means by which they can be moved, one upon the other. This is accomplished by the *Muscles* (Fig. 17), which I have already spoken of as the flesh of the body and as possessed of a special property of contracting or shortening themselves under the influence of a stimulus. It is this power of *contractility* which is the distinguishing property of the Muscles, and to which all the varied movements of the body are due. The Muscles constitute a large percentage of the total mass of the body, representing nearly half its weight, and giving to it its chief outline and form. The more they are used the more developed they become, so that the sculptors of old loved to choose as their models the athletes or champions of the ring.

It is important to know something of the *structure* of a Muscle; and a good deal may be learned on this point by examining a little closely a bit of boiled beef. We observe that it can easily be separated into threads, which seem, as it were, arranged in bundles, and bound together by a white cottony material. From this simple examination we learn the important fact that a Muscle is made up of two distinct substances,—namely, a framework of connective tissue, in the interstices or compartments of which are lodged several bundles of fibres lying parallel to one another. It is these fibres that constitute the true Muscle structure; and every Muscle may be briefly described as a mass of contractile fibres surrounded by a covering or envelope of connective tissue, called its Aponeurosis, from which septa pass in to furnish compartments for the individual bundles of fibres. Every Muscle is supplied with arteries, veins, and nerves, and generally the fibres terminate in a white glistening cord known as a *Tendon* or *Sinew*, by which it is attached to bone. These tendons may be of various shapes, so that we find them round and flat, and sometimes divided into slips, according to the work they have to do. In the majority of cases they are cord-like, and act like ropes upon the bones to pull them up or down. They are composed of white fibrous tissue, and are of great strength.

It is unnecessary to describe at any length the microscopic structure of the fibres which make up a Muscle. It is sufficient to say that some of them are marked transversely by alternate light and dark lines, while others are without them; so that we have two large classes of Muscles—the Striped and the Unstriped. It is found that the *Striped* ones, with the notable exception of the Heart, are under our control, and so they have received the further title of Voluntary Muscles; while the *Unstriped* ones are termed Involuntary, because they are not under the will. I do not think that in every respect this is a good division, but it is necessary to refer to it here.

In what, then, does the motive power of Muscle consist? It lies in the innate vital property which muscular tissue possesses of *contracting or shortening when it is stimulated;* so that, while it diminishes in length, it increases in thickness, and thus brings together the parts to which its ends are attached. No better illustration could be given of this than that afforded by the bending of the forearm on the upper arm. Here the strong Muscle in front of the arm, known as the *Biceps*, which, in a state of repose, is fusiform and long, becomes shorter and broader as the forearm is bent on the upper arm, and forms a firm hard lump which can easily be felt through the skin, and gives the idea of power and strength. This contraction of the Muscle, by which it becomes shorter and thicker, is accompanied by a peculiar sound or note, which may be heard by the simple experiment of resting one's elbows on a table, stopping one's ears with one's fingers, and working the jaws to and fro, when the "Masseters" or "Chewing Muscles" give out a sort of blowing murmur, caused by the *contraction* passing from point to point in the Muscles. This curious note which the Muscle gives out corresponds to that musical note which we know is caused by 32 vibrations per second; and it follows from this that every time a Muscle acts the whole mass undergoes this alternate contraction and relaxation 32 times in a second. The object of this is, no doubt, to afford time, short though it be, for the whole mass to rest and recruit itself; and thus literally "in its very motion there is rest." This rest is further attained by the whole of the Muscle never contracting at the same time, but by the contraction passing in a wave-like manner from point to point.

It is then by this power of *contractility* that Muscles acquire the great strength they possess, and are the active agents in movement; and we find that, while various stimuli will cause a Muscle to contract, under ordinary circumstances the normal stimulus is some *nerve impulse* passing along a nerve. This impulse may originate in the person's Will, and is then conveyed to the *Voluntary* Muscles; or it may originate in the Sympathetic System of nerves, and then it proceeds to the *Involuntary* Muscles.

As regards the classification of Muscles, those which enclose cavities, such as the heart and the alimentary canal, are known as *Hollow* Muscles; while those which are attached to the bony levers of the body, and are its active agents in movement, are spoken of as the *Solid* Muscles. In others the muscular fibres are arranged in rings around apertures they have to close, such as the mouth and eye, and these are termed *Orbicular* Muscles. In naming Muscles, the work they have to do, their shape, and their position are taken into account. Thus, those that bend the limbs are termed the Flexors, and those which straighten them the Extensors, the one set being, as it were, antagonistic to the other; while the *Deltoid* and the *Oblique* are instances of Muscles named from their shape, and the *Thoracic* and the *Abdominal* from their position.

The Muscles of the body accomplish many motor acts, such as standing, sitting, walking, running, swimming, and jumping. Take the act of standing. It is entirely by muscular action that the erect position of the body is maintained; and if we analyze the act, we will find that it is by the combined influence of a large number of Muscles acting at the same time. Speaking generally, it may be said that it is the Muscles of the calf, of the back of the thigh, and of the spinal column which tend to keep the body from falling forward; while those of the front of the leg, of the front of the thigh, of the front of the abdomen, and of the front of the neck are the ones which tend to keep it from falling backward. Further, if any one cared to examine into the various movements of the body he would find that all the different orders of levers are illustrated by such acts as the rocking of the head from side to side, the lifting one leg off the ground, and the raising of the forearm.

When we look at the soft and yielding substance that Muscle is, we can scarcely realize that it contains the power it does. No doubt its vital energy has something to do with this as well as its physical condition, for living Muscle will sustain a weight that dead Muscle will not. Instances of the surprising strength of Muscles are familiar to us in the case of Milo of Crotona, who, it was said, could rend an oak, and of Thomas Topham of London, who could, with his fingers, roll up a very thick and large pewter dish. Investigation shews that civilization is favourable to muscular strength, and that this last has some relation to the different races of mankind. There is no doubt that, for the proper development of the Muscles and motor power, gymnastic exercise is most important, and should be followed by both sexes at an early age. The strengthening of weak Muscles by systematic exercises, such as those followed under Ling's system, is a most powerful help in removing that weakness which often leads to deformities; while the kneading, pressing, and rubbing of the more recent fashionable *Massage* is in many cases, of great service.

CHAPTER V.

FRACTURES.

December 27.—Killed a young goat and lamed another, so that I caught it and led it home in a string: when I brought it home *I bound and splintered up his leg*, which was broke.—*Robinson Crusoe.*

NOTWITHSTANDING the excellence of the mechanical principles displayed in the structure of the locomotory apparatus of the body, we find that it is liable to certain accidents which throw it out of gear and seriously impair its functions. Thus the Bones, though possessing the strength of the oak, may be broken as if they were as brittle as glass, while the Joints may be dislocated or sprained, and the Muscles bruised or ruptured. Of these injuries Broken Bones are, by far, the most common, and as they are a class of cases in which the Ambulance pupil may often render most important assistance, we will consider them first. To make the subject clear, it will be necessary to do so a little in detail, saying something as to their varieties, causes, symptoms, and dangers.

DEFINITION.—The word *fracture* is from a Latin word *frangere*, to break, and it may be briefly defined as "the surgical expression for a broken bone." The term always implies that the injury has been caused by some sudden and unexpected violence.

VARIETIES.—When we speak of the causes of Fractures we shall see that, while they are always the result of force, the modes of violence are various and differ in their amount. As a consequence, the injuries caused vary in severity. We may have the bone broken without any wound or tear of the skin and soft parts around it; or the force may have been so great that these have been torn through, making a wound which communicates with the broken ends of the bones, and allows the air to have access to them. This important difference has led to Fractures being classified under two great heads or varieties:—viz.,

I. *Simple Fractures*, where there is a broken bone, but the skin is entire.

II. *Compound Fractures*, where there is a broken bone, and, in addition, there is a wound of the skin and soft parts, through which air gains admission to the broken ends of the bone

The Ambulance pupil must clearly grasp this great distinctive feature, for the two varieties of Fracture differ enormously in their seriousness. The Simple ones, as a rule, do well, and do not endanger life; while the Compound ones are dangerous injuries, involving risk at the time of the accident from bleeding, and afterwards during the period of repair. We will see subsequently that the usefulness of the aid furnished by the Ambulance pupil will consist sometimes, no doubt, in stopping bleeding, but oftener in *preventing* the Simple Fracture becoming Compound by rough handling and injudicious treatment.

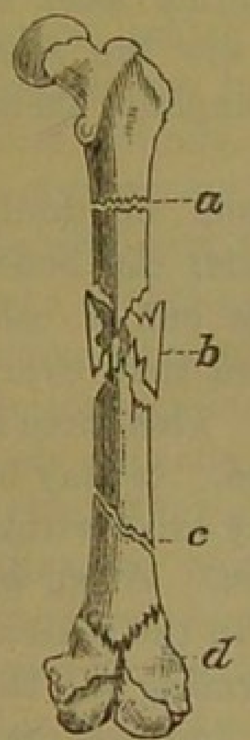


Fig. 18.
Varieties of Fractures.

Besides the above division of Fractures there are other terms used as a means of classifying them that should be mentioned, as they are quite intelligible even to non-professional people, and a knowledge of them is of service in understanding that temporary treatment of Fractures which comes under Ambulance work. One very common plan of classification is that of the direction in which the line of Fracture runs. Thus, a *Transverse Fracture* is where the bone is broken straight across at right angles to its long axis, as shewn at *a*, in Fig. 18. These Fractures are not common, save, perhaps, in children, and the ends of the bones suffer very little displacement. Then we have the *Oblique Fracture*, as at *c*, in Fig. 18, where each fragment has a sharp-pointed end. This is a numerous and important class, for it is in these cases that so often, owing to rough handling, the sharp end of the bone is driven through the skin and soft parts, converting the Simple into the more dangerous Compound Fracture. Another variety is the *Longitudinal Fracture*, as seen at *d*. This is not of such frequent occurrence, and when it does happen it is usually in the vicinity of joints like the elbow and knee, and sometimes it assumes the T shape, as shewn in the Figure. Apart from any system of classification, and whether Simple or Compound, Fractures are also spoken of as *Comminuted*, when the bone is broken into several fragments, as at *b*, Fig. 18; *Multiple*, when the same bone is broken at more places than one; *Complicated*, when some other injury is present, as the rupture of the main artery of a limb, or some organ hurt, as the lung in fractured ribs; *Complete*, when the bone is broken right across; and *Incomplete*, willow, or greenstick, when the bone is partially broken and partially bent, as so often happens in the case of children, whose bones are cartilaginous and elastic. There are other terms used in connection with Fractures, but the above are the most frequently met with. They more or less explain themselves, and are easy of comprehension.

CAUSES.—Certain conditions of the system no doubt predispose to fracture, inasmuch as they render the bones more brittle and fragile; but, leaving these out of consideration, it may be laid down as an axiom that every fracture is due to force of some kind or other. This force is the *immediate* or *exciting* cause of the fracture. It may be in the form of some *external violence*, or it may arise within the body itself in the shape of *muscular action*. When we think of all the complicated conditions of life in the present day, we realize the impossibility of enumerating all the shapes that external violence may assume, but we may arrange them to some extent under one or two heads. Thus the violence may be *direct*, that is to say the bone may be fractured at the spot where the injury is received. A blow from a stick or stone, a kick, the passage of a wheel over a limb, the fall of a heavy mass, like an iron plate, on any part of the body, all these are illustrations of direct violence, and it is this class of injuries that cause *Compound fractures.* When, however, the bone is broken at some distance from the place where the injury was received, we say that the fracture was caused by *indirect* violence. A familiar example of this is where the collar-bone breaks from falls on the hand, or the thigh-bone is fractured in alighting on the feet when falling or jumping from a height. These two illustrations shew that fractures from indirect violence are most common in the extremities. *Muscular contraction* has been mentioned as an immediate cause of fracture, and it may be so, as in the case of the knee-cap. On the whole muscular action is an uncommon cause of fractures, although it is probable that it comes in as an aid in many of the cases caused by indirect violence. When we speak of the comparative liability to fracture of the different bones of the skeleton, we shall see that there are local predisposing causes, such as the situation and shape of the bones, which influence the matter, but that the *exciting causes* may be briefly summed up as falls, blows, and gun-shot wounds.

SYMPTOMS.—In describing the bony skeleton, it was pointed out that one of the chief functions of the bones was to act as levers for the attachment of muscles. The importance of this point comes into play in connection with fractures: for when a bone is broken it ceases to serve in this capacity, and the muscles acting on the fragments to which they are attached pull them into new positions, and thus we have one of the leading symptoms of Fracture produced—namely, Deformity. The symptoms of Fracture may be divided into two divisions, the (α) *Subjective*, which the injured person complains of, and the (β) *Objective*, which one can recognise for oneself. Of the Subjective ones the chief are *Pain* and the *Loss of Voluntary Motion*, though sometimes, as in the case of falls, the patient will, in addition, announce that he heard a snap or crack. Of the *Objective* signs, the most characteristic one is an alteration in the shape of the part giving rise to *Deformity*, which, in the case of the extremities, very often leads to shortening. Accompanying this is *Swelling* and *Unnatural mobility* in an unusual and wrong direction, and at a point where it should not exist, while manipulation of the injured part will often elicit a peculiar grating sensation which is called by the special name of *Crepitus*, and is caused by the rubbing together of the rough ends of the broken bone. This is the symptom that is most confirmatory of the existence of fracture, and in fact, when clearly heard and felt, it is proof positive of it. After it in importance should be placed *Unnatural mobility.*—All of the following then may be given as the ordinary local symptoms of simple fracture: —viz., (1) Pain; (2) Loss of power; (3) Sensation of a Snap; (4) Deformity; (5) Shortening; (6) Swelling; (7) Unnatural Mobility; and (8) Crepitus. In addition to these, should the injury causing the Fracture be severe, there may be a certain amount of *Constitutional* symptoms, in the form of faintness and sickness, requiring the usual restorative and precautionary measures for these conditions. It is only right to say here that it is not always easy to say when a bone is broken. In the case of the shaft of long bones as the thigh-bone, the arm-bone, and the bones of the leg and forearm, all or most of the above symptoms can be readily recognised and there is no doubt about the nature of the case, but in fractures of the ribs, of the haunch bones, of all small and short bones, and of the ends of long bones near joints, it is generally difficult to determine the exact nature of the injury, save by such a forcible and prolonged examination as it is highly inadvisable an Ambulance pupil should make. His duty is to err on the side of safety, and to treat the case as though it were a Fracture, leaving any further examination to the Surgeon. From what has been said of the general symptoms of fractures, it may be laid down that when, with the history of a severe injury, Pain, Loss of power, and Swelling are present, there are reasonable grounds for suspecting a Fracture, but that when Deformity, Unnatural Mobility, and Crepitus also exist, these are conclusive on the point.

THE DANGERS OF FRACTURES.—Under this heading it is not proposed to discuss the grave and serious consequences that may supervene during the healing or repair of Fractures; these are medical matters, and out of place in an Ambulance book. What is aimed at is to direct attention to the dangers that any one runs during the time immediately following such an accident. In the first place, some Fractures are dangerous because of the contained organs, as those of the ribs and skull; and, in the next place, should the Fracture be a *Compound* one, there is the risk of bleeding. This the Ambulance pupil will be taught how to deal with. Then the injury may be so severe as to cause great shock to the system, with syncope or faintness. This will require suitable management so as to avert more serious consequences. But the chief danger that a sufferer from broken bones runs arises from the fact that most of these accidents occur in the open air, which necessitates the removal of the person to his own home or the hospital. If this is done without suitable temporary treatment being applied to the Fracture, an amount of further injury may be inflicted. As, for example, the sharp end of the broken bone may penetrate the blood-vessels; or a simple Fracture

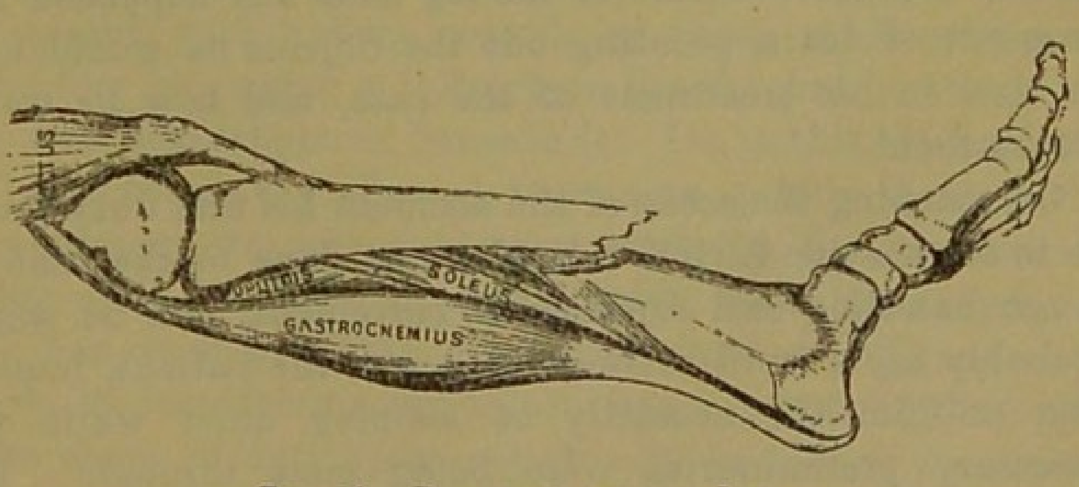


FIG. 19.—FRACTURE OF THE LEG.

may easily be converted into the more dangerous compound one. This often happens in the case of the leg, where, as Fig. 19 shows, the sharp end of the upper fragment may easily be driven through the skin if the unfortunate sufferer makes an effort to walk, as he very frequently does at the earnest solicitation of his friends, or the by-standers, who assure him there is nothing wrong, and who will not be easy in their minds until they see him on his feet in the upright position. It is in such cases that Ambulance training comes in so usefully. It should never be forgotten that no harm will come to a Fracture if it and the person who has sustained it are left quite quiet and undisturbed until medical aid comes. Hence, in simple Fractures occurring in the house, and with a doctor within easy reach, it is often the best thing to merely place the limb in a comfortable position on a pillow, and do nothing further with it than apply a warm fomentation. It is, of course, different when the patient has to be moved. Then further measures are called for *on the spot*, and the removal of the patient must be conducted in a proper manner.

With these introductory remarks on Fractures, we may now consider that temporary treatment of them that is embraced under the "first aid" of the Ambulance pupil. To make this better understood and more intelligible, it may not be out of place to sketch briefly the plan of procedure a surgeon would adopt if summoned say to a case of Simple Fracture of the leg that has happened to a man out of doors, pointing out the objects he would keep in view in his treatment of the case, and how he would attain them.

On reaching the scene of the accident his first duty would be to see that no further mischief was done to the limb by rough handling and injudicious movement, and he would probably say a word of re-assurance to the patient, impressing on him the necessity of keeping quiet while the necessary preliminaries were being gone through. His next duty would be to adequately secure the limb on the spot before moving the patient. He might, or might not, deem it advisable to remove the clothing on the limb. If he decided to do so, it would be seen that he would do so very cautiously, and that he would avoid all pulling by cutting open the boots, slitting up the stockings, and ripping up the seams of the trousers. He would also commence the removal of the clothing on the side opposite to the injury. The application of some extempore support would next be proceeded with, and this support would require to be something at hand, and would, of course, vary with the locality where the accident has happened. This done, if the patient's strength permitted, steps would then be taken to remove him to his home. In the case of fracture of the lower extremity this would have to be done on a stretcher, hurdle, door, or shutter, covered with spare clothes or with straw. The lifting of the patient on to this improvised stretcher would require to be conducted in a special manner, and the surgeon himself would certainly take charge of the injured limb. Unless a properly constructed Ambulance Waggon could be obtained, he would direct the stretcher or hurdle to be carried by hand, as infinitely more easy for the patient than the jolting which is inseparable from any carriage or cart. Having by this means got the patient home, the surgeon, on arriving at the house, would direct attention to the passages and stairways, so as to determine how best to have the patient brought in, and having fixed on a room, he would have him laid on a suitable bed of proper width and height, with a firm smooth mattress, rendered more unyielding by having a "Fracture-Board" (made of a few light deal boards) placed beneath it. On to this the patient would be lifted, and allowed to remain quietly there until the necessary arrangements were made for the permanent setting of the limb. Up to this point, then, the surgeon's work has consisted (1) in preventing further suffering and injury, by furnishing some improvised support for the limb in the shape of extempore splints; (2) in taking measures to have the patient properly carried to his own house;

(3) on arrival there, in seeing that he was placed on a bed suitable for him to occupy during the period of repair of the Fracture; and (4) in having him carefully undressed.

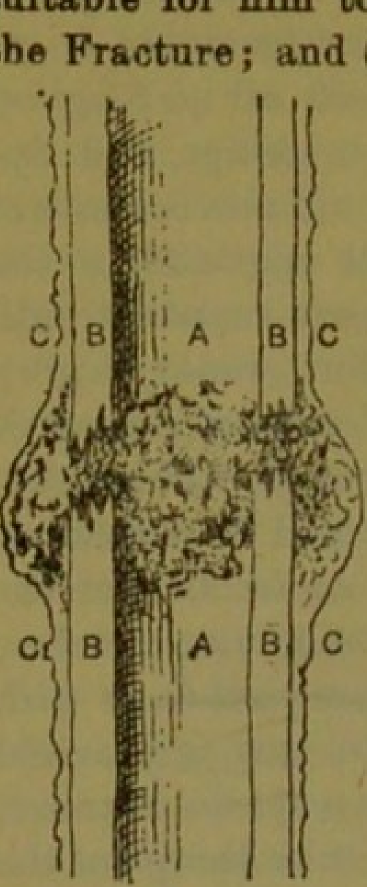


Fig. 20.

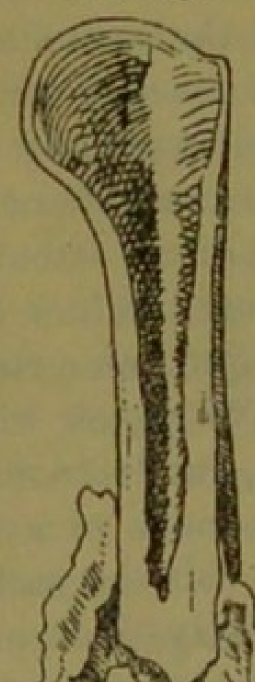


Fig. 21.—Union of Broken Bones.

This brings us to consider briefly how a Fracture is mended, and what the surgeon has to do to assist the process. The broken ends of a bone unite very much as a wound in the soft parts, between the edges of which an exudation takes place. This is seen in Fig. 20. The Medullary Canal A, the space between the broken ends of the bones BB, and the torn periostrum CC, are filled at the seat of Fracture with a soft mass of new material which has received the special name of Callus. This serves to unite the broken ends of the bone. These latter are also somewhat softened by the healing process, so as to allow of the whole being welded together, just as we soften the ends of two bits of sealing wax which we want to join together. With time this new material becomes fibrous tissue, and eventually by the deposit of the salts of lime it is converted into true bone. At first this new bone can be felt as a thickened mass at the seat of Fracture, as is seen in Fig. 21; but gradually it is absorbed, and the bone in some months shows no evidence of the Fracture, having resumed its original thickness and the Medullary Cavity being re-established.

From this description it is clear that a Fracture is really repaired by Nature and her working. And this is so, but to allow of its going on properly, it is essential that the ends of the bones should lie opposite to one another. Now this is what they seldom do. They are nearly always displaced. This is

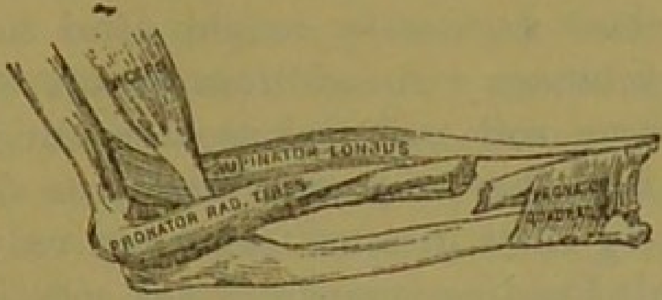


FIG. 22.—DISPLACEMENT IN A FRACTURE.

well shown in Fig 22, where there is considerable space between the fragments. This *displacement* in Fractures is due to one of several causes, or sometimes to all of them combined. These causes are—(1) Muscular action; (2) The direction of the injury causing the Fracture; (3) The weight of the limb in the case of the extremities; and (4) The direction of the Fracture, whether oblique or transverse. Were the fragments allowed to remain displaced, the bone would unite deformed, or even might not unite firmly. One of the duties the surgeon has to do is to overcome this displacement, and to reduce and replace the fragments end to end. This is popularly known as "setting the Fracture." Every Fracture has its own difficulties, and it is only by special anatomical knowledge that they can be overcome, and sometimes even chloroform is required. The essential part of the process consists in making what is termed "extension" and "counter-extension" below and above the Fracture, and in the case of adults with large and powerful muscles two assistants are required, so as to leave the surgeon's hands free to mould and shape the fragments. When this "setting" is accomplished, the next thing to be done is to retain the broken ends of the bones in position, and this the surgeon does by using what are known surgically as *Splints*. These may be defined as *pieces of wood or other firm substance used to confine the broken ends* *of a bone when set.* As regards the derivation of the word, it seems to be a nasalized form of the word "split," and our word "splinter" has probably some connection with it. The materials of which surgical Splints are made are endless, and it is unnecessary to enumerate them here, but I may say that the chief desiderata sought after in them are lightness and firmness. In addition to the Splints, the surgeon uses some soft material as a Padding for them, because, being firm, they may press unduly on the skin and soft parts, and by their pressure cause not only pain but ulceration. This Padding is made of any soft substance as tow, cotton-wool, layers of old flannel or blanket, &c., and the chief point about it is that it should overlap the edges of the Splints on all sides. Lastly, to keep the Splints with their padding in place, and prevent them slipping, the surgeon employs bandages, and usually the *roller* ones, as they are more suited to the permanent treatment of Fractures. The "fracture-apparatus" then employed by the surgeon, consists of (1) Splints; (2) Pads; and (3) Bandages, each of which is used with a special object in view. When the Fracture has been "put up," the surgeon sees that it is placed in a comfortable and suitable position, and in the case of the lower limb he employs a "cradle" to keep the bed-clothes off the part and free it from all sources of irritation. The surgeon continues in attendance on the case subsequently to carry the patient through a period that has its dangers and complications, and re-applies the retentive apparatus from time to time, until such a period has elapsed that he considers union complete. All apparatus is then abandoned, and steps are next taken to overcome the stiffness and weakness of circulation that are such troublesome attendants on broken bones, and the surgeon does not consider the patient out of his care until the injured part is as sound and useful as before the accident. In these remarks it has been pre-supposed that a *Simple* Fracture has been dealt with, but should it be a *Compound* one that has to be treated, a somewhat different mode of procedure has to be followed, the main difference, however, being that, previous to the application of any "fracture-apparatus," all bleeding from the wound has to be stopped, any loose fragments of bone removed, and a suitable dressing applied to the wound.

Such is a brief outline of the proceedings that would take place in the case of a Fracture placed under a surgeon's care, and if he has grasped this outline of how a surgeon would act in a case of Fracture, the Ambulance pupil will see that there is a good deal he can do to give very valuable "first aid" to a sufferer from such an injury, without encroaching on the doctor's work. Summoned or brought into contact with a case where he recognises by the symptoms that a Fracture has taken place, or where from the history he thinks it probable that this is so, he will first of all direct his attention to seeing that no further damage is done. What, then, are the sources of danger from which the patient has to be protected? First of all, strange to say, from himself. He is often his worst enemy, inasmuch as he at once makes an effort to stand up, and see if he can walk. If it is the leg that is broken, and that obliquely, he generally succeeds in pushing the sharp end of the bone through the skin, and thus adds a severe complication to his injury. The patient, then, should be encouraged to lie quiet, and on no account to stand up. If he seems faint, send for a drink of water for him, but keep him lying. Next, he must be protected from the too active interference of the by-standers, or, it may be, his own friends, all of whom are only too anxious to see him on his feet again, and encourage him to stand up. It is probable that some of the proverbial immunity from severe accidents that drunkards enjoy is due chiefly to the fact that they make no effort to save themselves and that they lie where they fall, as they are in no condition to make the attempt to rise and walk, and they have not usually a large circle of friends around them. These points attended to, the further duty of the Ambulance pupil is to see that if the injured person is to be removed *the attempt is not made until the Fracture has been secured by some extempore Splints, to act as a support.* The preparation of these will call for some ingenuity and reflection, and the material available for them—as Esmarch has pointed out—will depend on the locality where the accident has happened. *In the town, or near inhabited houses,* thin boards can be procured, such as firewood, lids of boxes, laths, broom-sticks, yard measures, folded newspapers (Tory or Liberal), covers of books (sometimes the best part of them), felt (old hats), foot mats, fire-irons, &c., while the by-standers in the streets can furnish walking-sticks, umbrellas, parasols, &c. *In the country* one can get branches, twigs, bark, reeds, bits of fencing and paling, padding being made out of stockings, coat sleeves or shirt sleeves stuffed with grass, hay, and straw, while in the case of hunting accidents, the stirrup leathers can often be usefully employed. *In the workshop or factory* many of the tools and appliances used there are serviceable as Splints. *On the battle-field,* rifles, bayonets, swords or their scabbards, telegraph wires, &c., may all be utilized. Whatever Splints are devised, they require to be secured in place; and in the absence of bandages, this can be done by pocket-handkerchiefs, neckties, cravats, stockings, garters, &c., on the principles laid down in describing the triangular bandage. The question will arise as to whether the extempore supports should be applied outside the patient's clothing or not? In the absence of bleeding or other complications it is better to do so; and the presence of the clothing obviates to some extent the necessity for any special padding of the Splints. Should it be decided to remove any clothing, or should the Ambulance pupil be called upon to assist in the general undressing of a patient when put to bed immediately after an accident, the process should be conducted on the principle of not pulling or tearing off the clothing, everything being cut off or slit up the seams, so as to destroy the garments as little as possible.

Following the application of the temporary supports, and the non-arrival of any medical man, comes the question of the removal of the injured person. How to carry out this will be considered in a special chapter on the transport of the injured, so that I will not enter into the matter here further than to say, that the by-standers should never be allowed to put a person with a fractured leg into a cab. He should either be placed on a hurdle, door, or shutter, and carried by hand, the bearers not keeping step, or else he should be conveyed in a specially constructed Ambulance waggon. On the other hand, a person with a broken arm, whether below or above the elbow, if his residence is not at a great distance, or if there is a doctor's house anywhere near, would probably walk with much less pain and shaking than if driven in a vehicle of any kind. As soon as the patient has reached his home or the hospital, and has been comfortably placed in bed, "Ambulance aid" may be said to be at an end, and the arrival of the medical man must be awaited. Should the sending for the doctor fall to the lot of the Ambulance pupil, he will remember to let the message be in writing, stating any important facts about the case that may help the surgeon to a knowledge of what to bring in the way of appliances.

SPECIAL FRACTURES AND THEIR TREATMENT.

While any of the bones of the skeleton may be broken, there are some more frequently so than others, owing either to their peculiar shape or their more exposed situation. Age, however, is a very important element in the matter. Thus, in children the Collar-bone is probably the most frequently broken bone, just as the Neck of the thigh-bone and the lower end of the Radius are the most common fractures amongst the aged. In young people and middle-aged persons the bones of the leg, the bones of the fore-arm, and the thigh bone are the ones that usually suffer. If age is not taken into consideration, it will be found that the most frequent fracture is that of the Radius, and next to it that of the Collar-bone.

As the general principles on which all fractures are treated have been pointed out, it may be advantageous now to say a few words on the leading features of the different special fractures, taking first those of the Axial, and then those of the Appendicular skeleton.

FRACTURES OF THE AXIAL SKELETON.

It will be remembered that the Axial Skeleton includes the three separate parts of the Head, the Vertebral Column, and the Thorax with its ribs and breast-bone; so that it will be as well to consider the fractures of these different parts in the above order.

I.—FRACTURES OF THE HEAD.

These fractures divide themselves naturally into two groups:—

(*a*) Those of the Skull or Cranium.
(*b*) Those of the Face.

(*a*) FRACTURES OF THE SKULL.—These are *caused* generally by direct violence, as blows or falls on the head. If the injury has been inflicted by any sharp-edged body, there may be an external wound of the scalp; so that we may have the usual *varieties* of either simple or compound fracture. As regards the *symptoms* of fractures of the skull, it will be readily understood that these injuries are chiefly important from the danger they involve to the brain, and the condition of the patient will vary with the extent of the damage to that organ. Of the outward signs the most important is bleeding from the mouth, nose, or ears. Accompanying this may be indications of concussion of the brain, which, however, may be so transient as to scarcely attract much notice. As a rule, however, the patient is insensible, with deep, heavy breathing, and a slow bounding pulse, although, in some cases, the breathing may be very quiet, and the pulse quick and fluttering. It is almost impossible for a non-professional person to say exactly what is wrong in any case of head injury. The important point to remember is the seriousness of any of the symptoms mentioned above, and to be careful not to mistake the condition for one of drunkenness. More will be said on this point afterwards, and the possibility of making such an error is only mentioned here. The line of *treatment* to be followed by the ambulance pupil in these cases is to send for medical aid, and, if the accident has happened in the public thoroughfare, to summon the ambulance van, should there be one in the district. In the meantime the injured person should *be placed or kept in the lying down position*, the head being in a line with the neck and shoulders, or only slightly raised, so that the breathing may be as free as possible. Any mud, blood, or froth that may be around the mouth and nostrils should be wiped away, and all tight clothing about the neck or body should be undone and loosened. If there is a scalp wound, any bleeding should be arrested, and a temporary dressing, if possible, applied. When the accident has happened in the street, see that the spectators do not crowd closely round and prevent the access of air to the injured person. As soon as a medical man arrives, hand over the case to his care, and act under his instructions. Should one, however, not come within a reasonable time, then it will devolve on the ambulance pupil to take the further management of the case. He will have to arrange for the conveyance of the patient either to the hospital or to his own home, if that is known; and as, in this class of fracture, no temporary mechanical support can be applied, all lifting and moving should be done with the greatest care and steadiness. The removal must be accomplished by some form of stretcher, and in the absence of an ambulance van it must be carried by hand. On arrival at the hospital "first aid" ends, as medical assistance will then be at once available; but if the sufferer has been taken to his own home, and no doctor is at once obtainable, the ambulance pupil may be of still further assistance. He should get the patient comfortably placed in bed, and he should use his influence with the household not to employ very active measures until medical advice is got. He should point out to them the direction in which to work. He should have the patient kept absolutely quiet in a darkened room free from noise, and from the talking of excited friends. He should advise the application of cold to the head in the form of a sponge or folded handkerchief steeped in cold water, and of warmth to the feet if they are chilly by means of hot bottles, taking care, if there is insensibility, not to burn the patient. He should caution the relatives against the use of stimulants by the mouth, though smelling salts to the nostrils may be of use when there is great weakness and pallor. In short, he should impress on those around that the indications for immediate treatment in these cases of head injury are to prevent all further damage by careful handling of the patient, to favour reaction by warmth to the limbs, and to lessen the chances of inflammation of the Brain and its coverings by quietness, cold to the head, and the avoidance of stimulants.

(*b*) FRACTURES OF THE BONES OF THE FACE.—These injuries are always the result of direct violence, such as blows or kicks. Of the numerous bones of the face *those of the nose* are often broken, and one of the most characteristic symptoms of the accident is free bleeding from the nostrils. Swelling and deformity soon come on and great disfigurement of the face results. Surgical skill is required for replacing the displaced bones, and the "first aid" consists in arresting the bleeding from the nostrils, and in dressing any wound that may have been inflicted. Cold water dressings usually afford most comfort. Sometimes the force of the blow causing the fracture has been so great that the patient may be stunned, and this condition must be met by the recumbent posture until the effects pass off, which they usually do in a few minutes.

The other bone of the face frequently broken, and from similar causes, is the *Lower Jaw.* The nature of the injury is usually quite apparent, as the contraction of the numerous muscles attached to the bone displace the fragments considerably. Hence the *symptoms* of this fracture are (1) *deformity*, arising from the inequality in the line of the jaw; (2) *inability to close the mouth;* (3) *dribbling of the saliva;* (4) unevenness in the line of teeth; (5) bleeding from the mouth; and (6) *crepitus* or grating on moving the fragments. As the mucous membrane of the mouth is usually torn in these cases, the fracture is really always a *compound* one. The "*first aid*" *treatment* in these cases is to relieve the pain and bleeding which generally accompany them. The suffering of the patient is often very quickly removed by securing the broken bone to the upper jaw, which serves as an excellent splint. This is done by folding the triangular bandage *broad*, passing it under the injured jaw, and tying it firmly on the top of the head. This gives good support to the fragments. In addition, another bandage may be folded broad, placed over the centre of the chin, and the ends tied behind the neck. The single handkerchief answers very well by itself, and the other is not a necessity. In patients with beards it is not easy to apply the bandage satisfactorily, and a good deal of firmness is required. When the jaw has been secured, see that the patient does not talk; and should the bleeding from the mouth be troublesome, cold water to rinse it out with, or bits of ice to suck, usually suffice to check it. Medical aid should be got as soon as possible, as these fractures of the lower jaw are often difficult to treat owing to the deformity.

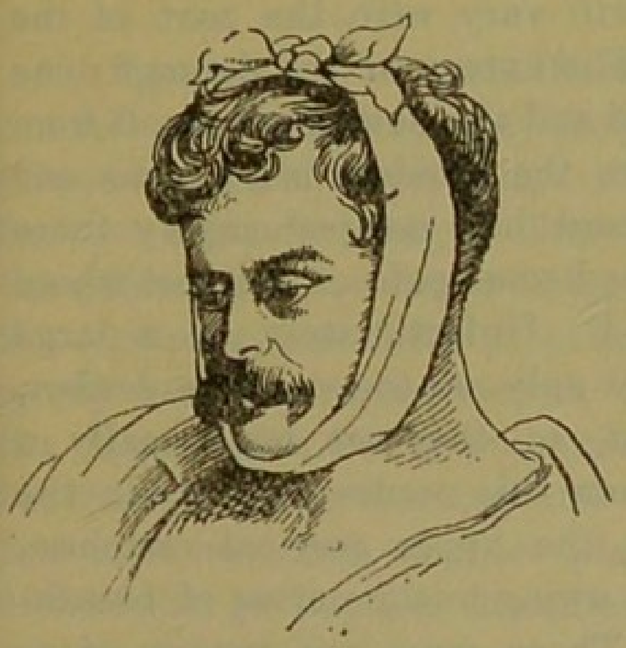


Fig. 23.—Temporary Treatment of Fracture of Lower Jaw.

II.—FRACTURES OF THE TRUNK.

Fractures of the Vertebral Column.—These distressing accidents are better known under the terms of "broken back" or "broken spine." They are *caused* usually by great violence. Thus, they have followed falls from a height across a beam or rail, blows from the handle of a crane, the passage of a waggon over the body, and from the crushing force of the sudden fall of a mass of coal or dirt on the back. Here the force has been applied *directly* to the spine. In some cases the violence has been more *indirect*, as from falls from a height upon the head, striking the bottom with the head in diving, and from catching the head whilst passing under too low a door-way or tunnel. The *symptoms*, of course, will vary with the part of the vertebral column injured. The extent of the damage done to the contained *spinal cord* and the nerves given off from it really decides as to whether the accident is a serious one or not. When the spinal cord has escaped injury there may be almost no signs beyond some pain at the spot where the blow has been received. Unfortunately, in a large proportion of these cases not only are the vertebræ *broken*, but they are also *displaced*, so that we have really a "*fracture-dislocation.*" When this occurs high up in the vertebral column, as among the upper cervical vertebræ, death may be instantaneous, owing to the nerves of breathing being interfered with. These cases are spoken of as "death from a broken neck," as occurs in some cases of "judicial hanging." Below the lower cervical region fracture of the spine, with crushing of the cord, shews itself by loss of power and sensation in all the parts below the seat of injury. It may not be easy for the Ambulance pupil to say exactly what damage has been done to the spine; but it will be safer for him, with a history of a severe accident, as of a cart-wheel having gone over the back, to consider the case as one of the worst form of injury, and to deal with it accordingly. Here the only "*first aid*" that can be given is to revive the patient, should he be at all collapsed, and to see that no further damage is done to the cord. If a medical man can be got quickly do not consent to the patient being moved before his arrival; but if a doctor cannot be obtained, then remove the patient with the greatest gentleness and care, slipping a blanket or rug beneath him, and lifting him by it sufficiently to allow of a stretcher of some kind being placed under him. When this has been done convey him to the hospital or to his own home, and then see that medical advice is got.

III.—FRACTURES OF THE RIBS AND BREAST-BONE.

(*a*) Fractures of the Ribs.—Broken ribs are a very common accident, and they may be fractured on only one side of the chest, or on both. All the different *varieties* of fracture are met with, as *Simple*, *Compound*, *Multiple*, or *Complicated*, these latter being accompanied by injury to the organs in the chest or abdomen. The ribs most commonly broken are the fourth, fifth, sixth, and seventh,—the upper ones being protected by the clavicle, and the lower ones being floating and free. While a rib may be broken in one, two, or more places, the most frequent site of fracture, perhaps, is the middle portion, where the curve is the most marked.

The *causes* of fractured ribs are varied. Very common ones are blows, kicks, as from a horse, and falls upon any sharp edge, as of a table. These are instances of *direct* violence, and in them the force being applied over a small surface the sharp ends of the broken bone are apt to be driven inwards, and internal organs, such as the lungs, injured. Another not infrequent cause of fractured ribs is great compression of the chest, as in the squeezing experienced in a dense crowd. Here the ribs bend outwards and give at the point of greatest curvature. In these cases it is not unusual to have several ribs broken. *Muscular action* has been known to cause fracture of the ribs, as in severe spasms of coughing, or where there has been any great straining. When speaking of the changes that age works in the bones we saw that one was the loss of elasticity; and so we find that fractured ribs are more common in middle-aged and old persons than in the young, where they are more yielding.

The *Symptoms* of such an accident are well marked. The most noticeable is *pain*, increased, owing to the part the ribs take in respiration, by breathing, which is, consequently, carried on with difficulty. Then, on placing the hand flat over the injured part and asking the patient to inspire deeply, the *crepitus* or grating of the broken ends of the bones can be felt, and is, indeed, sometimes perceptible to the patient. When, then, we have the history of an injury to the chest, such as any of those mentioned above, and when this is followed by tenderness, pain in the side, difficulty of breathing, and, perhaps, a short hacking cough, it is a fair conclusion to come to that the chest-walls have been severely bruised, and probably one or more ribs broken; but if crepitus can be elicited, the nature of the accident is quite clear.

In these *uncomplicated* cases a great deal may be done by "*first-aid*" *treatment* to relieve the patient. Should he be faint or suffering from shock, this should be attended to, and then steps should be taken to lessen the pain and prevent any further possible damage to internal organs. To some extent the ribs above and below the fractured one keep it quiet and serve as splints; and it is the general movements of the chest-walls in breathing that cause pain and inflict, perhaps, further damage. Consequently, the aim of treatment should be to control the mobility of the chest-walls *as much as possible*, for, of course, they cannot be entirely arrested. This is best done by applying a broad bandage or cravat round the chest, from close up to the arm-pits down to the floating ribs, with sufficient firmness to make the patient feel comfortable. The injured person will often be able to tell you what degree of tightness should be used, and this will be the guide. The bandage should be put on during expiration, and no excess of force should be employed, as this might force inwards the broken ends of the ribs, and do further mischief to the structures within. If the accident has happened outside, the patient will have to be carefully removed home and medical aid got. A certain number of cases of fractured ribs are *complicated* by the lungs being wounded by the original injury, and then there may be *spitting of blood*, which is usually of a crimson colour. The treatment of this will be given more at length in another chapter; but what should be done is *to keep the patient quiet and cool, and to give bits of ice to suck.* If this cannot be got, sips of cold water should be given, or water with vinegar or alum dissolved in it. As a rule, in these cases the spitting of blood is never excessive. It is somewhat of a disputed point whether a bandage should be used in these cases, for fear of further pressing in the fractured ends of the bone. The best rule to follow is to watch the effect of the gentle pressure of the hand on the chest-wall. If that affords relief, then the application of the broad roller bandage will probably do good. Should it cause pain, or increase the difficulty of breathing, it should be at once removed. In cases where the ribs are broken on both sides of the chest it would probably be better not to use any bandage.

(*b*) Fractures of the Breast-bone.—These are not common, for though the bone is very much exposed, the cartilages of the ribs support it like so many elastic springs, and it yields accordingly. When fracture occurs it is usually due to some great *direct* violence, as a cart-wheel going over the chest; but it is sometimes *indirectly* broken, as when the spine is bent violently backwards or forwards. The *symptoms* are very much those of fractured ribs,—namely, pain, difficulty of breathing, and crepitus. In addition, there is, generally, deformity, and sometimes complications, as internal injuries. The "*first-aid*" *treatment* is that of fractured ribs; but a bandage should be applied with great care, and its effect watched.

These are the chief fractures of the Axial Skeleton; and it will be observed that, as they implicate in all cases cavities containing vital organs, they are often serious, and frequently dangerous injuries. At the same time the Ambulance pupil may often be of great service in preventing further damage by judicious removal, and by preventing too active measures being carried out. In none of them does temporary "first aid" involve the use of splints.

FRACTURES OF THE APPENDICULAR SKELETON.

I.—Fractures of the Upper Limb.

(*a*) *Fractures of the Scapula.*—The shoulder-blade is a flat bone, with a thick padding of muscles protecting it on each side. Owing to this fact, together with its mobility and the thickness of its processes, it is seldom broken. When it is so, it is always by great crushing force, and the accident is accordingly accompanied by great bruising, pain, and impaired movement of the arm. The indications for "*first-aid*" *treatment* in these injuries about the shoulder are to put the arm in a large sling and fix it to the side, the elbow being well raised and the fore-arm bent.

(*b*) *Fractures of the Clavicle or Collar-bone.*—Fracture of the collar-bone is a common accident in the hunting field and at football; but, as was mentioned before, it is most frequent in infancy and childhood (as when children are learning to walk), and statistics shew that one-half of the total number of fractures of this bone occur under five years of age. It may be *caused* by direct blows, but it is more commonly the result of *indirect* violence,—as of falls on the hand, elbow, or point of the shoulder. It has also been known to follow muscular action, as in cracking a whip.

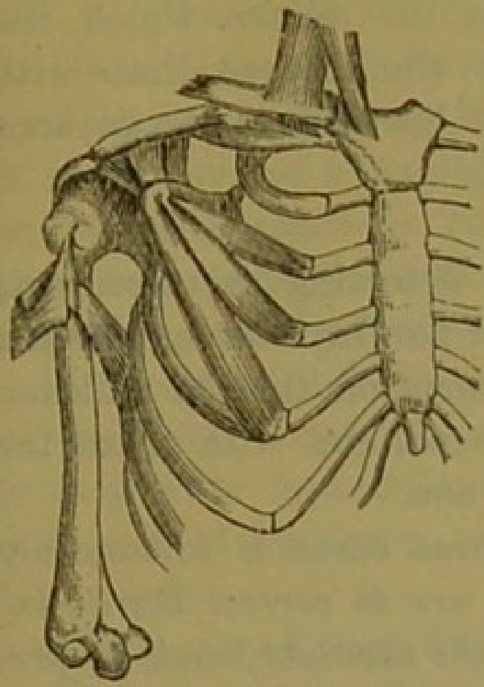


Fig. 24.
Fracture of the Clavicle.

The *situation* of the fracture varies, and the bone may give way at either its inner, middle, or outer third. The middle is the most frequent seat of fracture, as shewn in Fig. 24. It will be noticed that there is considerable displacement of the fragments,—the outer one being at a lower level than the inner one, and being, as it were, underneath it, while the inner fragment has the appearance of being tilted a good deal upwards.

The *symptoms* of this fracture vary with its situation; but as the break is usually at the middle of the bone, at the junction of its two curves, it will be best to state them as seen in such a case. To understand them it must be remembered that the collar-bone is a very important part of the upper limb, and that its work is to act as a prop for the shoulder, and to keep it well back. Accordingly, when it is broken at its middle, the shoulder falls forwards, downwards, and inwards, partly from the weight of the arm, and partly from the action of the muscles around, so that we have the displacement of the fragments seen in Fig. 24, where the deformity arises mainly from the altered position of the outer fragment, the inner one being only very slightly raised. The symptoms, then, of this accident are:—

(1) Deformity, especially noticeable in thin persons, and easily detected by running the finger along the bone.

(2) Loss of power in the limb, the patient being unable to raise the hand to the head.

(3) Grating, got by raising and rotating the arm, with

the elbow pressed to the side, and placing the fingers over the broken part.

(4) Drooping of the shoulder, to relieve which the patient usually supports the injured limb with his other hand, and leans his head to the injured side to relax the muscles.

(5) Great pain on movement.

As a rule there is no difficulty in detecting this accident, especially after a history of any of the injuries mentioned above. It is right, however, to mention that in children the symptoms are not so pronounced, and with them the fracture is sometimes a *green-stick* one.

The "*first-aid*" *treatment* of these cases is fortunately easy and simple. The indications are *to correct the downward and inward displacement of the shoulder, and, by preventing all motion of the arm, to lessen pain and do away with the danger of the fracture becoming compound.* These objects are attained:—(1) By placing a good sized pad in the hollow of the arm-pit; (2) By raising the elbow by a well applied broad sling; and (3) By binding the arm to the side by a bandage above the elbow. Fig. 25 illustrates this *temporary treatment,* which meets all the requirements of the case, and will allow of the patient walking comfortably to his home, or to the hospital.

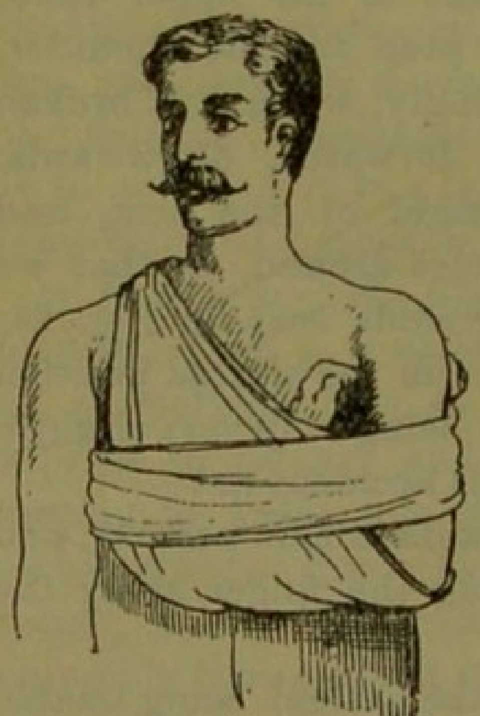


FIG. 25.
FRACTURE OF THE CLAVICLE.
TEMPORARY TREATMENT.

The pad in the arm-pit serves as a fulcrum for the upper end of the humerus and presses the shoulder outwards when the elbow is brought to the side. The sling, if properly applied, raises the elbow and counteracts the downward displacement of the arm, while the fixation of the arm to the side prevents all motion.

Nothing could be simpler than the above apparatus. Some ingenuity, of course, may be demanded in furnishing a pad and handkerchiefs large enough for the purpose when the accident happens in the open, as in the hunting field, but by a little management these difficulties may be overcome. A newspaper or a waistcoat folded squarely, or a stocking stuffed with grass or hay all make good pads; while a sling may be improvised by turning up the tail of the coat or jacket over the fore-arm and pinning it to the coat.

(c) *Fractures of the Arm.*—The upper arm, it will be remembered, contains only one bone—the humerus. It is very often broken, and the fracture may be situated in any part of the bone, as its upper end, its middle, or its lower end.

The *causes* of these fractures are *direct* violence, as blows and falls; *indirect* violence, as falls on the hand or elbow; and sometimes *muscular action*, as in throwing a stone.

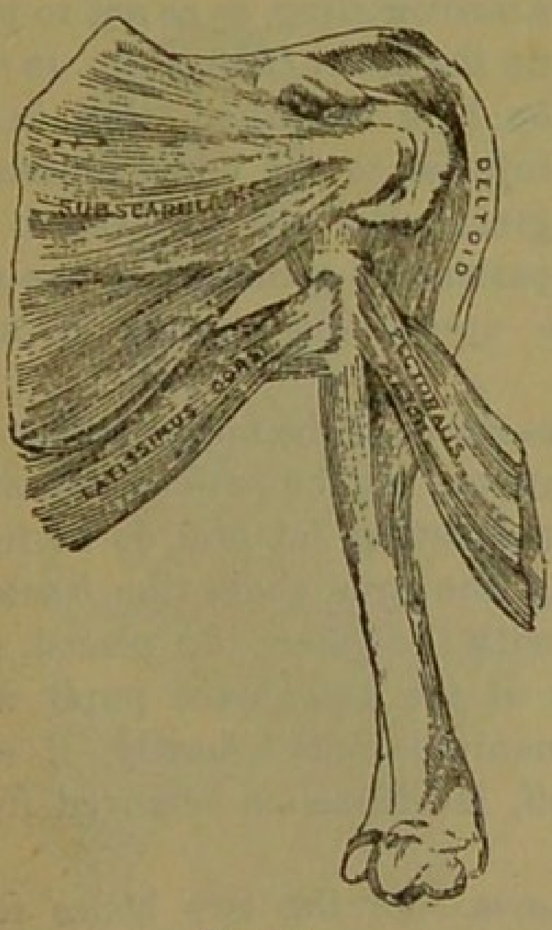


Fig. 26.
Fracture of the Arm.

The *symptoms* of fracture are usually well marked, and there is no great difficulty in deciding on the nature of the injury. As a rule, the limb hangs helpless, and there is great pain on movement; while deformity, increased mobility, and crepitus are generally present. The deformity is very apparent, especially if the fracture is oblique, and it is largely due to muscular action. This is well seen in Fig. 26, where the bone has given way near its upper end, and the lower fragment is drawn inwards by the strong muscles attached to it.

The "*first-aid*" *treatment* of these cases is to keep the fractured ends of the bone at rest by the use of two or three well padded splints, and then to support the injured arm, which is apt to lie dangling helpless by the side. In the majority of cases, two splints of fairly good breadth, placed one on the inner and the other on the outer aspect of the arm, will suffice (Fig. 27). These splints should be well padded, and, if necessary, they could be fitted on the sound arm before being placed on the injured limb. After being secured in position by two triangular bandages folded *broad*, the arm should be supported by bending the fore-arm at right angles to the upper-arm, and placing it in a *narrow* sling, so as not to push up the lower fragment. It may be here remarked, that in all injuries to the upper extremity great relief will be given to the patient by bending the fore-arm at a right angle with the upper and placing it in a sling.

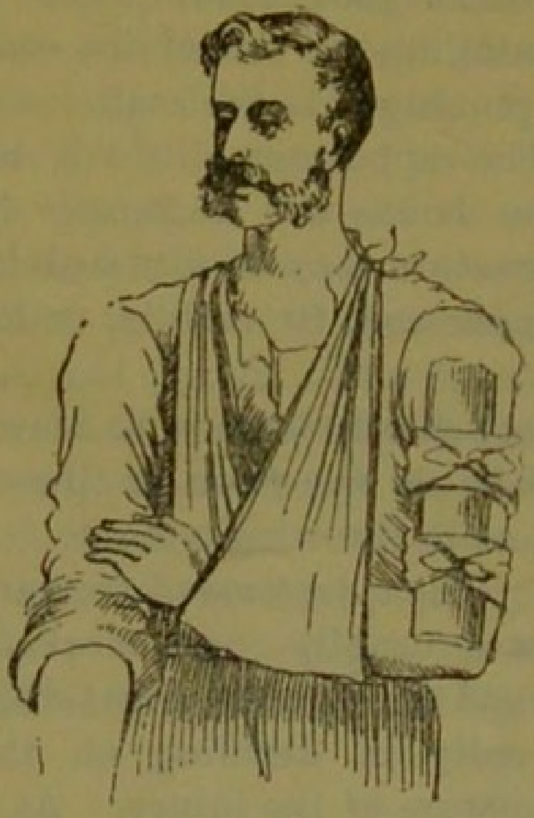


FIG. 27.
FRACTURE OF THE UPPER ARM.
TEMPORARY TREATMENT.

Further, in dealing with fractures of the upper extremity, if any apparatus has to be put on, let the patient be seated on a chair, and, if any one is assisting, let him do so from behind the patient, grasping the arm above the fracture with one hand and below it with the other. So placed, the assistant is out of the way of the ambulance pupil who is making the necessary manipulations. Lastly, if any clothes have to be taken off, let these be removed from the sound arm first.

(*d*) *Fractures of the Fore-arm.*—Of the two bones that enter into the fore-arm, both may be broken at once, or only one of them. There is some difference of opinion as to whether fractures of both bones are more common than those of only one bone; but all are agreed that the radius is more frequently fractured than the ulna, owing to the latter bone being more protected on the inner side of the arm, to its shaft being stronger, and to its having no connection with the wrist-joint.

The *causes* of fractured fore-arm are the passage of any heavy body over it, blows, and falls on the hand.

When both bones are broken, there is generally not so much difficulty in making out the accident, as all the usual *symptoms* of pain, loss of power, deformity, increased mobility and crepitation are present; but where only one bone is fractured, the other serves as a splint, and the nature of the injury is not so apparent. Under these circumstances, no lengthy or minute examination should be made by the ambulance pupil, but he should treat the case as one of fracture.

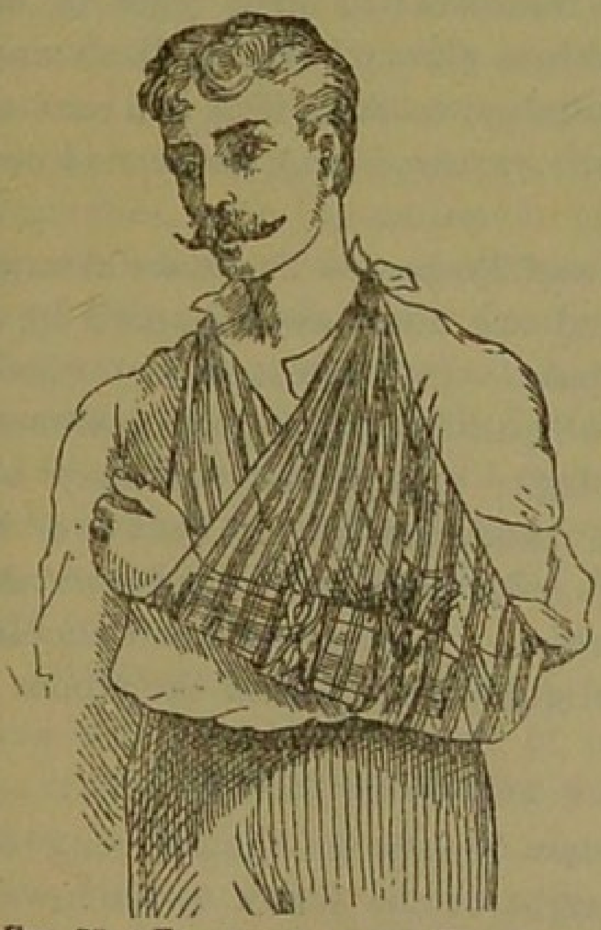


FIG. 28.—FRACTURE OF THE FORE-ARM. TEMPORARY TREATMENT.

The "*first-aid*" *treatment* is the same whether one or both bones are broken, and consists in the application of two well padded straight splints, one in front and one on the outside of the fore-arm. The inner splint should reach from the bend of the elbow to the roots of the fingers, and the outside one from the elbow to the wrist, as in Fig. 28. In applying these splints the assistant should stand behind the patient, and holding the fore-arm with the thumb upwards he should make slight extension and counter-extension by pulling on the hand and elbow. The splints should then be applied, and secured on with two triangular bandages, the fore-arm being afterwards placed in a *broad* sling, which should take in the elbow,—the hand being slightly higher than the elbow.

In connection with fractures of the fore-arm, the Ambulance pupil should bear in mind that there is one very common *fracture of the radius*, just above the wrist, which is caused in elderly people by falls on the palm of the hand and to the unprofessional eye looks like a bad sprain of that joint. If it is not properly attended to, great deformity and loss of movement results. Let it be the rule, that in all injuries near the wrist-joint medical advice should invariably be sought. So, again, falls on the elbow are apt to cause fracture of that part of the ulna called the *olecranon*, which forms the tip of the elbow. Such an injury may very readily be overlooked and regarded as a bruise of the joint, and, if untreated, it may lead to great loss of usefulness of the hand. The *"first-aid" treatment* of such cases is, no doubt, to put the arm at rest in a sling; but a medical man should be consulted without delay, so that, if it is a case of fracture, the special treatment required may be carried out at once.

(*e*) *Fractures of the Hand and Fingers.*—These are always the result of great force, and are often accompanied by a good deal of swelling and pain. In these cases the whole hand should be laid on a well-padded splint, and fastened to it by a triangular bandage; or a round pad may be placed in the hollow of the hand, the fingers bent over it and secured there by a triangular bandage, folded *narrow*, and applied boxing-glove fashion. Lastly, the hand should be put in a sling, and kept slightly higher than the elbow.

II.—Fractures of the Lower Limb.

(*a*) *Fractures of the Pelvis.*—The basin-shaped ring of bone which transmits the weight of the trunk to the lower limbs, and gives origin to the muscles which move them, is sometimes broken. When it is so, it is usually the result of tremendous violence,—such as a fall of rock or coal in a mine, the passage of a wheel over the lower part of the body, a crush between a cart and a wall, or a squeeze between the buffers of railway carriages.

The fracture may extend through different parts of the bone, but the great danger accompanying it is lest the injury should involve any of the contents of the pelvis,—such as the bladder or intestines. It is unnecessary to dwell at any length upon the *symptoms* of such an accident. The patient would have severe pain in the region of the pelvis, he would, probably, be quite unable to get up, and he would be suffering from more or less shock. The Ambulance pupil's duty, when dealing with such a case of injury, is not to make any lengthy examination, but, when he suspects a fracture of the pelvis, to proceed as if it were clearly made out.

As regards the "*first-aid*" *treatment* of these cases, there is not very much can or need be done. It will be remembered that their gravity is due more to the *complications* attending them than the injury to the bone. Should any shock or collapse be present, it should be met by the usual remedies, with the patient in the recumbent posture; while the comfort of the patient may be greatly promoted by applying a broad binder firmly round the part, to keep the fragments at rest. Special care and gentleness will also be necessary in the removal of such a case to his own home or the hospital; and it might even be necessary to make use of what is known as the "long splint" to ensure perfect rest to the body. No time should be lost in obtaining medical aid in these cases.

(*b*) *Fractures of the Thigh.*—Although it is the longest and strongest of the bones of the body, the femur is apt to be fractured, and, as its shape would lead us to suppose, it may be broken at one or more points. The most usual situations are near the hip, in its middle, and above the knee. Fracture of the thigh is always a serious accident, and is of common occurrence, especially in children and old persons. It may be *caused* in various ways, as by falls on the feet, knees, or hips; and in elderly people the femur is very often broken high up, near the head of the bone, by some slight force indirectly applied, as by tripping the toe in the carpet. Any of the different *varieties* of fracture may be present, but as a rule there is no great difficulty in making out the injury, unless, perhaps, when the bone is broken very high up. When the fracture is in the shaft of the bone we have the usual *symptoms* of deformity and loss of motion, with great pain on movement. A mere glance at the limb shews, by its unnatural appearance, what is wrong, for as a rule the injured person lies on his back, with the leg slightly bent, and resting on its outer side, the foot also being everted or turned outwards. This gives it a peculiarly helpless look, which is very characteristic of the injury. The deformity is caused partly by the weight of the limb, and partly by the action of the large and powerful muscles which surround the femur on every side. This is well shewn in Fig. 29, which represents a fracture high up in the shaft. Should it be thought necessary, it would not be difficult to make out "crepitus" or grating in a case of this kind; but it is not advisable to have any undue handling of the limb, for it would be easy to complicate matters very much by injuring the artery of the limb with the sharp edge of such a jagged fragment as is shewn in the adjoining figure (Fig. 30), or such a fragment might be driven through the skin, and the simple fracture be converted into the more serious one of a compound fracture of the femur.

FIG. 29.
FRACTURE OF THE THIGH.

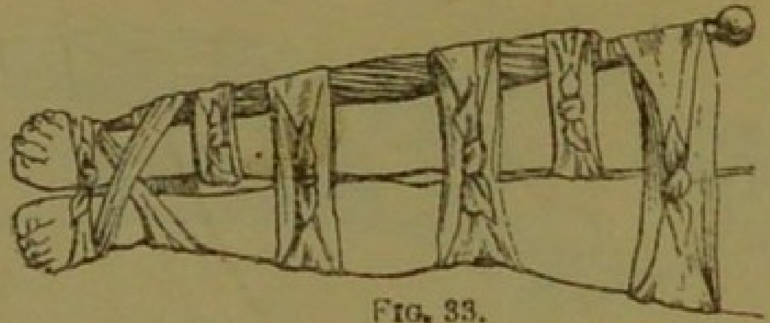


Fig. 33.

Umbrella used as Splint

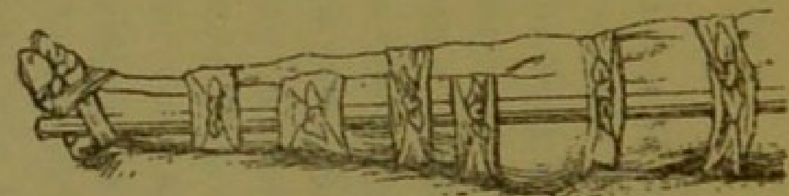


Fig. 31.

Broom-handle used as Splint.

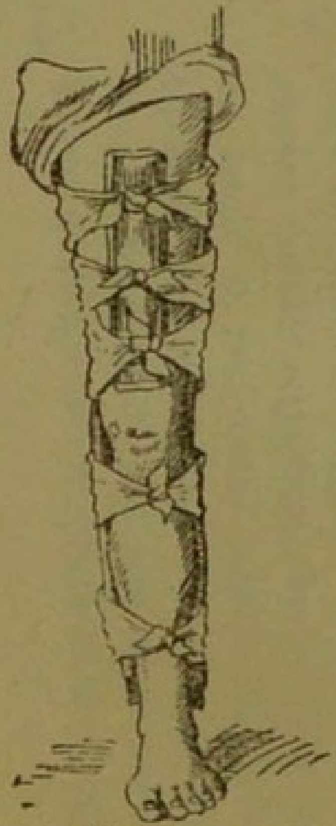


Fig. 34. Posterior and Short Splints.

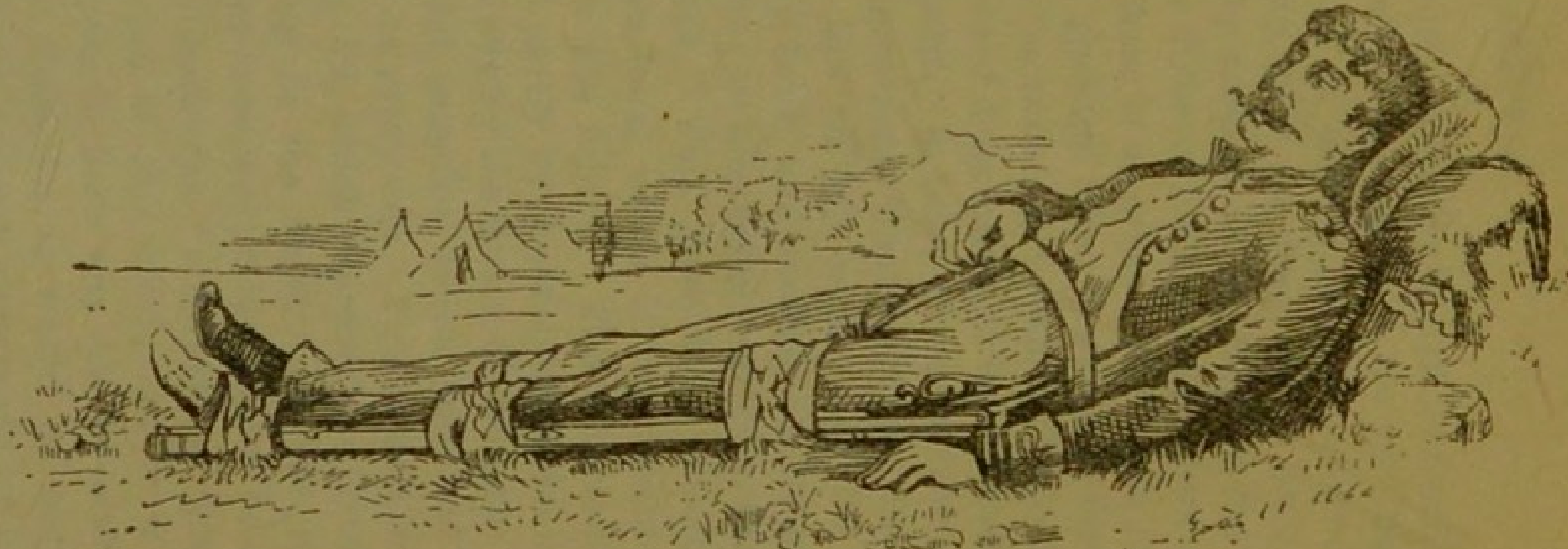


Fig. 32. Rifle used as Splint.

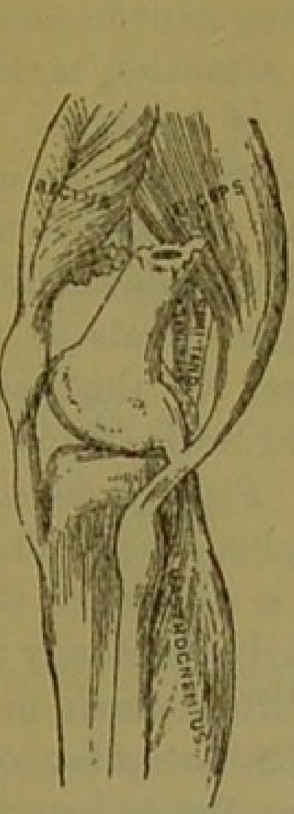


Fig. 30.
Fracture of the Thigh.

These dangers should be sufficient to impress on every one the importance of carrying out proper "*first-aid*" *treatment*, which consists in grasping the foot firmly at once, and making some extension on the limb by pulling it downwards. This will immediately prevent all movement, and will be probably some relief to the patient. Extension must be made on the limb until it is the same length as the other one. If the Ambulance pupil is alone, he must not let go the limb until he has secured it to the other by means of a handkerchief tied firmly round both legs above the ankles. If there is assistance at hand, he can either hand over the care of the fractured limb to some one else while he improvises a splint, or he can keep his hold of the foot, and give the necessary directions for the preparation of a splint. The kind of splint available will depend on the locality where the accident has happened and the materials at hand, but whatever is chosen should have both length and firmness. It should be long enough to reach from the arm-pit to the foot, so as to keep the whole body rigid. A good broom handle, as shewn in Fig. 31, is very serviceable and can be got in every house; while the rifle of the soldier or volunteer makes an excellent splint, as seen in Fig. 32. In the hunting field, the bar of a gate or hurdle, and at football a portion of one of the goal-posts would meet all requirements; while, in an emergency, an umbrella, as in Fig. 33, or a posterior splint, with a short one in front, as in Fig. 34, might be utilized. In the case of adults an umbrella has scarcely sufficient length, but for children it does admirably. Having improvised a suitable splint, the next thing to be done is to apply it. It is best placed on the outer side of the limb, and it can be very well fastened on by handkerchiefs. While this is being done, the injured limb should be fully extended, the foot being kept in an upright position. Another point requiring attention is, that no handkerchief should pass over the seat of fracture. To facilitate the passing of the handkerchiefs, the natural hollows that exist above the heels, behind the knees, and just below the hips should be utilized. The handkerchiefs may be passed through at these points without raising the limb, which is a very important matter. If the splint reaches to the arm-pit, it should be secured to the trunk by a broad cravat or shawl, suitably folded. Finally, as soon as the splint has been satisfactorily applied, both limbs should be firmly tied together. This is a procedure that should never be omitted, as it materially helps to steady the parts, and allows of the patient being lifted much more easily. In fact, in fracture of the thigh, if no splint were available, the mere fastening of both legs firmly together would lessen considerably the dangers of the accident, and the patient might be moved without causing him a great deal of suffering. It must, however, be understood that a splint should always be employed; and sometimes it is not a bad plan to supplement it by placing one or two short ones close round the thigh itself. This still further helps to keep the ends of the bone quiet, and limits movement. The whole aim, then, of the "*first-aid*" *treatment* in fractures of the thigh, is to render the body quite rigid from head to heels, so that the patient may be comfortably lifted on to a stretcher and conveyed home, with the precautions that will be afterwards mentioned.

(c) *Fractures of the Patella or Knee-cap.*—This small bone situated in front of the knee is sometimes broken by falls or blows, but most frequently by muscular action, as when a person in danger of falling forwards attempts to save himself by throwing his body backwards. The effect of this violent muscular effort is to snap the bone in two over the lower end of the femur, just as a stick is broken by bending it across the knee. More or less separation of the fragments takes place, as is seen in Fig. 35, and there is a sudden loss of power in the limb. In fact the leg is perfectly useless, and the patient, as he lies in the recumbent position, cannot raise the limb from the ground. If the knee is examined, the separated fragments of bone can be felt. The only "*first-aid*" *treatment* that the Ambulance pupil can give here is to put a splint at the back of the knee, and secure it on by handkerchiefs. Both limbs should be tied together, and the patient conveyed home on a stretcher, when medical aid should be got without delay.

FIG. 35.—FRACTURE OF THE KNEE-CAP.

(*d*) *Fractures of the Leg.*—The leg, with its two parallel bones the *tibia* and *fibula*, is often the seat of fracture. Both bones are usually broken, but each bone may be fractured separately, and it appears that the fibula is oftener fractured alone than the tibia. This accident usually occurs in adults, fractures of the leg in children being not so common as fractures of the thigh. The *causes* of it are any of the external forms of *direct* violence, as kicks, blows, and the passage of a wheel over the limbs, as in carriage upsets. It sometimes follows *indirect* violence, as in jumping or falling from a height, or in sudden wrenches of the leg when the foot is fixed. When *both bones* of the leg are broken, there is usually not a great deal of difficulty in making out what is wrong, for the usual *symptoms* of fracture, in the shape of deformity, pain, loss of power, and crepitus are present. When either bone remains intact, serving as a splint for the other, the exact nature of the injury is not so apparent, although gentle and careful examination will very often reveal what is wrong. The rule, however, for the Ambulance pupil to follow is not to waste time upon deciding a point that does not come within his province, but to treat the case as if it were a fracture, until it is seen by a medical man. And it is in these cases of "broken leg" that *Ambulance aid* is so valuable; for very often in the case of the tibia the line of fracture is oblique, as in Fig. 36, and the

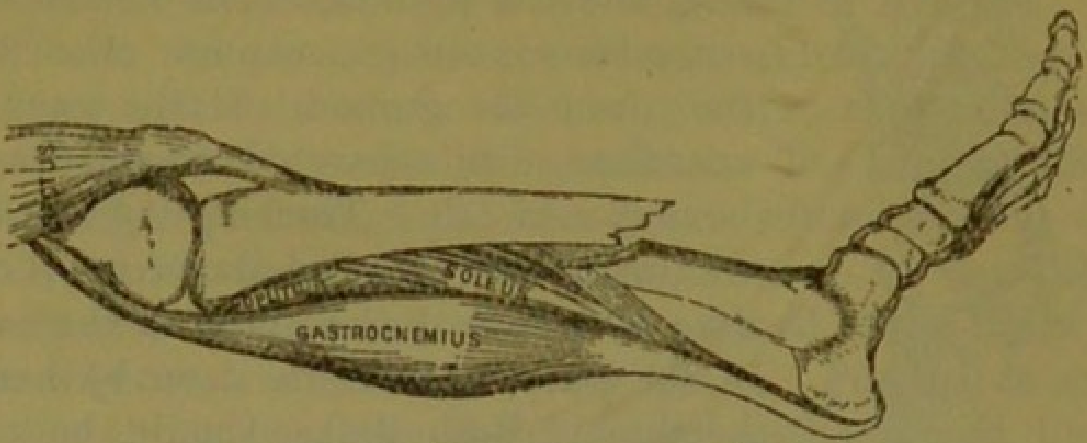


FIG. 36.—FRACTURE OF THE LEG.

sharp end of the upper fragment is very easily pushed through the skin, with the result that a *compound* fracture is produced. The great thing is to impress upon the patient the necessity of keeping quiet and of making no effort to get up; and then, without delay, to have the ends of the bones secured against further movement by placing suitable splints on the outer and inner side of the leg, and securing them on in the usual way with handkerchiefs. (See Fig. 37.)

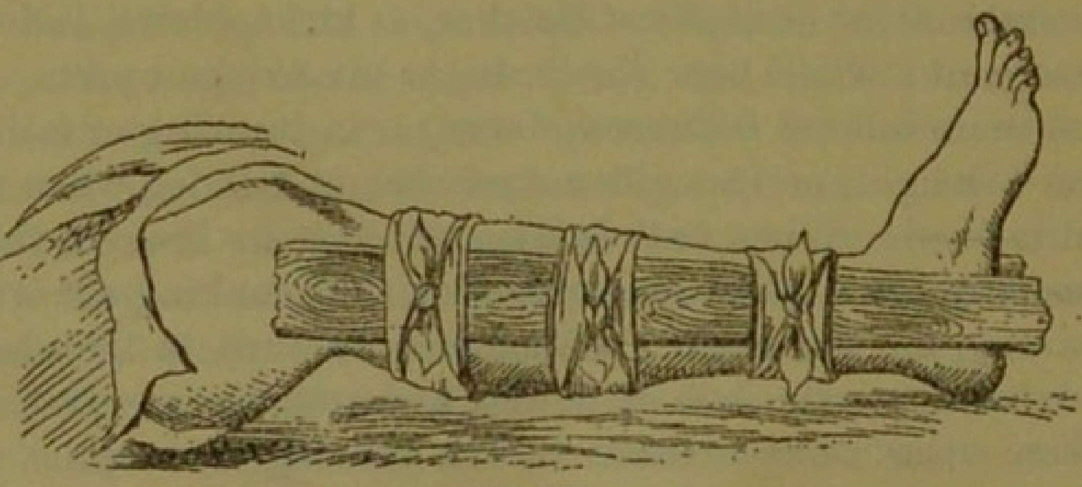
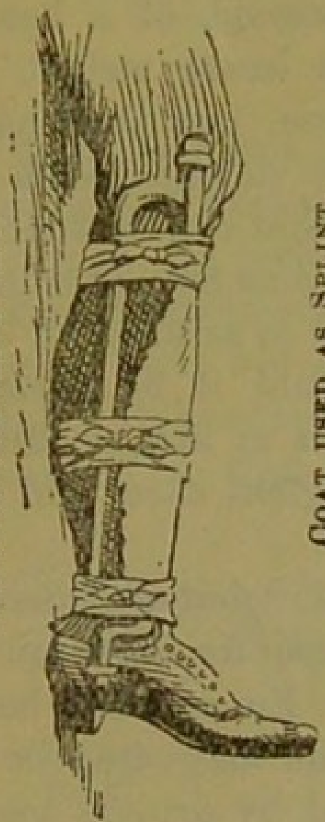


FIG. 37.
FRACTURE OF THE LEG.—TEMPORARY TREATMENT.

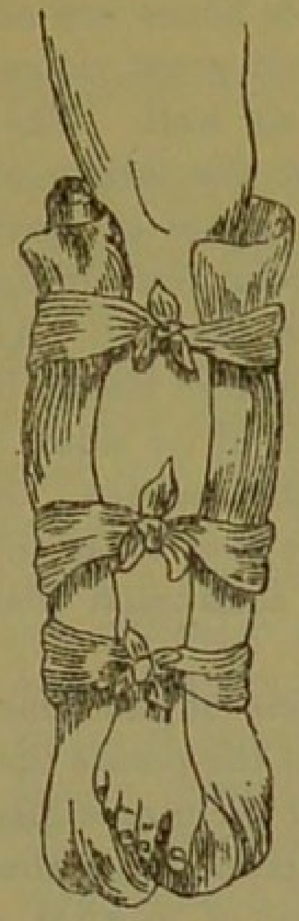
As soon as this is done, both legs should be tied together, as in the case of the broken thigh. It is a further support and safeguard, and allows of the patient being more easily lifted.

In Fig. 37 the splints are represented as being applied next to the skin, and in such cases they must be carefully padded; but the splints may be put on outside the trousers, which serve as padding. Figs. 38, 39, 40, shew how



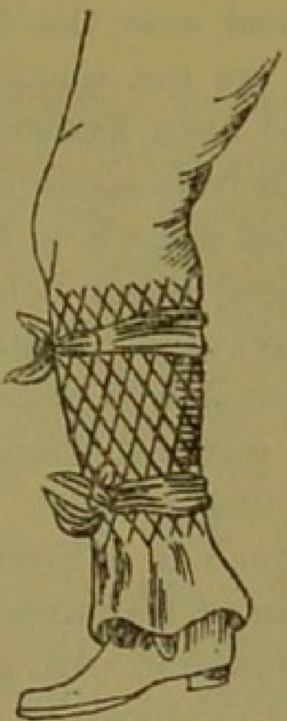
BAYONET USED AS SPLINT.

FIG. 38.



COAT USED AS SPLINT.

FIG. 39.



TRELLIS FLOWER POT USED AS SPLINT.

FIG. 40.

bayonets, a coat, and a trellis flower pot may serve as temporary and very efficient splints. The removal of a person with a broken leg will, of course, be carried out with all the precautions to be mentioned in the chapter on that subject.

When speaking of fractures of the fore-arm, I alluded to one of the radius that was very often regarded by non-professional persons as a severe sprain of the wrist. A similar note of warning must be given about a fracture of the fibula low down. It is frequently mistaken for a sprain of the ankle and treated so, with the result that great impairment of movement takes place, and the limb is very much crippled. The Ambulance pupil will be careful never to take upon himself the serious responsibility of deciding such an important question as the existence or non-existence of a fracture, but will advise the calling in of medical aid.

(e) *Fractures of the Bones of the Foot.*—Although the foot is often injured, its bones are seldom broken. When they are, it is from such great violence that the soft parts are usually involved as well. The passage of a heavy wheel over the foot, or the falling of a heavy weight on it, are not uncommon causes of fractures, but they have also been known to occur from indirect violence, such as falls from a height upon the feet. All that can be done in these cases is to keep the foot steady by some form of splint, placed either below it or at its sides, and to arrange for the conveyance home of the patient. Should it be deemed advisable to remove the boot so as to get at any bleeding, its removal should be conducted with great care, and all pulling avoided.

Such is a brief outline of the general "*first-aid*" *treatment* of fractures and of the points that require attention in connection with each of them specially. Enough has been said to shew the Ambulance pupil that he may often be of great service in this class of injuries, and by *prompt treatment on the spot* lessen pain and avert not only the dangers that inevitably follow on a fracture becoming *compound*, but the more prolonged illness that must ensue, and which, to a working man, is a serious thing financially. It will be observed that the directions for "*first-aid*" *treatment* have all been given on the assumption that the fractures treated are *simple* ones. In the chapter dealing with *Bleeding* directions will be given for the treatment of *compound fractures*, so that nothing more need be said about them here beyond that what is needed additional in these cases is to stop any bleeding and to apply a simple dressing before securing the fracture with splints.

CHAPTER VI.

DISLOCATIONS AND SPRAINS.

"Thou has drawn my shoulder out of joint."—*Henry IV., Part II.*

DISLOCATIONS.

WHEN we speak of anything being *dislocated*, we mean that it has become "displaced," and one of the accidents to which the locomotory apparatus of the body is subject is the displacement from one another of the articular surfaces of bone which enter into the formation of the various joints. Whenever this happens it is spoken of as a "dislocation," so that by custom the term always implies *that one articular surface of a joint has been displaced from the other with which it is usually in contact, and no longer occupies its natural position.* The accompanying figure 41 shews a very common dislocation, namely, that of the shoulder, where the head of the humerus has slipped out of its socket and lies below it.

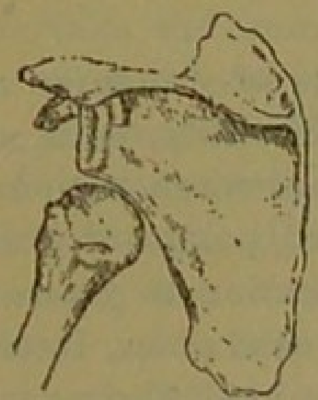


FIG. 41.
A DISLOCATION.

Just as in the case of fractures, dislocations are usually *caused* by violence, which may be *directly* applied to the injured joint, or *indirectly* transmitted from a distance, as where the shoulder is dislocated by a fall on the elbow. Sometimes, however, a dislocation may be produced by *muscular action*, as happens with the lower jaw when it is overstretched in yawning or laughing. There are certain circumstances which favour the occurrence of dislocations. Of these the chief are the nature of the joint, age, and sex. Thus we find that the shoulder, with its ball and socket joint and its consequent great range of movement, is the most frequently dislocated joint in the body; and it has been noticed that not only are very young children and very old people much less liable to dislocations than those of middle age, but that women also are less so than men.

When the bones forming the joint are entirely separated, then the dislocation is called *complete*, but when they are only partially separated, *incomplete.* If there is no wound, the dislocation is a *simple* one; but if there is a wound, it is *compound.* These are the chief *varieties* of dislocation. In nearly all dislocations the effects on the joint involved are partial or complete rupture of the ligaments, tearing of muscular fibres, and general damage of the soft parts around the joint.

The following *symptoms* are common to all dislocations :—

(1) The shape of the joint is altered.

(2) There is loss of power in the joint, which is often fixed in an unusual position.

(3) There is pain in the joint.

In some respects, then, the symptoms of *fractures* and *dislocations* resemble one another, for deformity, pain, and loss of movement are common to both, but when compared closely it is easily seen they have marked points of difference. Thus the seat of mischief in dislocation is *generally in a limb and always at a joint.* In the next place, instead of the increased mobility of fracture, we have the reverse, namely, *fixation.* As one writer puts it tersely, "In fracture there is movement where there should not be, and in dislocation there is none where there should be." Lastly, on moving the limb there is an entire absence of *crepitus*, which is so distinctive of fractures.

As a rule there is no great difficulty in making out that there is not a fracture, though it may not be so easy to say that there is not a dislocation. The duty of the Ambulance pupil in the case is, however, clear. He has not to settle whether it is a fracture or a dislocation. That is the doctor's work. The "*first-aid*" *treatment* is to prevent any further mischief, and to lessen or remove pain. Accordingly, if the injury is to the upper limb, the arm should be placed in a sling, and secured to the body firmly but gently by a cravat or handkerchief. If there is any faintness, the patient should be kept lying down until that has passed off, and if the accident has happened out of doors, he should be taken home in a conveyance, or allowed to walk, according to circumstances. In the case of the lower extremity being apparently dislocated, some temporary support should be applied, the two limbs tied together, and the sufferer carried carefully to his home or the hospital, and put to bed in the manner mentioned under fractures. Should the doctor be long in arriving, and the pain very severe, the clothes might be removed from the part, and warm fomentations applied to it.

The *surgical treatment* of dislocation is, of course, to get the displaced bone into its proper place as soon as possible, but that does not imply that the Ambulance pupil should undertake the immediate reduction. In fact there is not any urgent necessity for that. The end of the displaced bone is covered with smooth cartilage, and it is more or less fixed in its new position, so that it cannot do the same damage to the tissues that the sharp and rough ends of a fractured bone would, and the patient might even be moved without materially harming him, though, of course, his pain and suffering would be very much increased. To reduce a dislocation effectually, there must be some knowledge of the obstacles to reduction that have to be overcome, especially as the bone has to travel back into its place by the same route as it escaped. This knowledge the Ambulance pupil cannot possess, and it would not be advisable to attempt to teach it to him; so that it is a very proper decision of the St. Andrew's Ambulance Association to regard this form of injury as one that does not call for any "*first-aid*" *treatment* beyond what has been given above. Very unfortunate results have been known to follow the efforts of non-professional persons to reduce dislocations by pulling at them. Extensive extravasations of blood, the rupture of veins and arteries, the tearing across of nerves, and even fractures of bone, have followed prolonged and forcible pulling at dislocated shoulder-joints. Let it then be taken as a general rule that no attempt should be made by the Ambulance pupil to reduce dislocations, as they require a surgeon's skill and knowledge to replace the bone or bones. The "*first-aid*" *treatment* should consist merely in putting the part at rest in the easiest position, supported by splint, sling, or pillows, as the case may be, and in obtaining medical aid without delay. If the pain is severe, and a doctor cannot be got at once, then the clothes may be carefully removed as in dealing with a broken limb, and warm fomentations applied. It is here supposed that the accident has happened not far from home; but if it should have taken place, say, in the hunting field, some miles away from home, then the question will come up as to whether the patient should travel so far with an unreduced dislocation. If a doctor is available, it would be preferable to have it put in at once, as the sooner it is done the better; but if the patient prefers to see his own medical man, no harm will come by his travelling, if the limb has been secured, and, in these days of chloroform, the lapse of a few hours does not add much to the difficulties of reduction.

A few words should perhaps be said on *dislocation of the lower jaw*, as it is an occurrence that sometimes gives rise to a good deal of alarm, because when it happens the power of speaking is so much interfered with as to be almost unintelligible, and the fear of a paralytic shock having taken place at once presents itself. Opening the mouth too wide is the primary cause of this dislocation, and so we find that it occurs during yawning or immoderate laughter. When it has taken place the mouth is fixed quite open, the power of speech is consequently lost, and the chin is thrown so far forward as to completely change the whole expression of the face. No harm will follow waiting for the arrival of a doctor to reduce the dislocation, but if one cannot be obtained an effort at reduction may be made without involving any risk. This is best done by pushing the jaw downwards and backwards into its place with the thumb protected by a napkin, the operator standing above the patient, who should be seated in a chair. Another very good plan is to place a bit of strong but thin walking stick across the mouth, just like a horse's bit. Having pushed it far back, pressure should be made downwards and backwards until the jaw is felt to slip into its place.

SPRAINS.

When speaking of joints it was mentioned that the *ligaments* were fibrous bands which kept the bones in their proper position, and prevented them being displaced. A *Sprain* is a violent stretching and straining of these ligaments. It is a very painful and, sometimes, very serious injury, as it is the beginning of many cases of joint disease. In a sprain the bones entering into the formation of the joint have been more or less forcibly separated, but they have not been permanently displaced, as occurs in dislocation. At the same time, it will be observed that the two injuries have much in common, and that the sprain may be regarded as the first stage of the other more complete injury. Hence a sprain is sometimes described "as a dislocation begun and not completed." Another popular name for it is "a twist or rick of a joint."

The joints most frequently *sprained* are the knee, ankle, elbow, and wrist, while those most commonly *dislocated* are the shoulder and hip. Hence it has been laid down as a rule that the joints most liable to dislocation are least liable to be sprained. Like dislocations, sprains are the result of falls, or of any sudden and unnatural movement communicated to a joint. Thus the common *causes* of a sprained ankle are putting the foot into a hole in the ground, slipping on a smooth floor, on orange peel, or off the edge of the curb-stone, and treading on an irregular-shaped stone. In the case of the ankle, there is no doubt that its liability to be sprained is largely increased by the habit of wearing high-heeled boots and shoes.

As regards *symptoms*, a severe sprain makes itself felt by a dull, aching, sickening pain in the part, which is sometimes so severe as to cause fainting. Along with this there is marked swelling of the joint, and almost complete inability to move or use it. Speaking generally, there is no great difficulty in recognising a sprain on the part of the sufferer. The mode in which it has happened, the peculiar sickening pain, the rapid swelling of the part, and the uselessness of the limb, all indicate pretty clearly what has occurred.

To grasp the proper *treatment* of a sprain, it is necessary to bear in mind what takes place in the joint so injured. At first the wrench or twist separates the bones, and severely stretches or, it may be, tears the ligaments. In consequence of this violent movement, a number of the small vessels under the skin are ruptured, and, of course, bleed. The blood thus poured out is sucked into the space between the ends of the bones and effuses itself into and around the joint, so that we have swelling making its appearance with great rapidity. It is this sudden swelling which is such a marked feature of severe sprains, and the quickness with which it appears shews that it must be blood, a view which is further confirmed in a few days by the discoloration that shews itself, the joint and the parts in its neighbourhood becoming "black and blue." The pain is caused largely by pressure of the blood poured out, which distends the joint and forces its way into the tissues around; and it is a matter of common observation that the more swollen and tense a sprained joint is the more painful it is.

The "*first-aid*" *treatment*, then, of a sprain of any severity is to stop the bleeding which is going on into the joint and the tissues beneath the skin, seeing that it is mainly the cause of the swelling, tension, and pain. When we come to speak of the arrest of bleeding it will be shewn that (1) *Cold*, (2) *Pressure*, and (3) *Position* are powerful means of stopping it. These can all be utilized in the case of sprains. *Cold* may be applied in various ways, as in the form of cloths soaked in cold water and wrapped firmly round the joint; or ice, when it is available, may be used, being placed in a sponge bag, or in one made of oil silk. To increase the evaporating power of the water, and, consequently, its coldness, some prefer to mix it in equal parts with spirit, Eau de Cologne, or vinegar, while others pin their faith to diluted arnica and water, although this latter is more useful, probably, at a later stage, and owes most of its efficacy to the spirit it contains. The effect of the steady application of cold for a time is to stop the bleeding going on under the skin from the small vessels that have given way, and the real point of importance to attend to is to see that the cold is kept up more or less continuously, any cloths around the joint being freshly wetted from time to time. If this is not done the cloths lose their coolness, become dry, and cease to be of service.

Besides cold, however, we have a very efficient aid to treatment in *pressure*. This may be employed by strips of cloth soaked in cold water, and then wound round the joint, or the triangular bandage may be folded narrow and applied wet.

Lastly, any further effusion of blood may be prevented by attending to the *position* of the injured part. Never let a sprained joint hang down. If it is the upper extremity support the limb in a sling, with the hand rather higher than the elbow; while if the lower extremity, let the patient lie with the limb raised. By thus keeping the part quiet, and not permitting it to be used, the joint is most favourably situated for recovery, and the effects of the accident are very considerably minimised. Should very complete rest be desired, a splint might be used as well. Should the ankle be the joint sprained, and the person some distance from home, the question will arise whether the boot and stocking should be taken off, to allow of the cold applications mentioned above being made. This will depend on circumstances, for it must be remembered that in the case of a bad sprain, with rapid swelling, it may not be possible to get the boot on again. If this should happen, and at any great distance from home, the person would have to limp along, without the support of the boot, and matters might be rendered in this way very much worse. Probably the better plan would be to tie a handkerchief or strap tightly round the ankle, outside the boot, and not to take off this latter until the patient has been removed home.

The application of cold has been advocated, because it is the one most readily available, as a rule. It is, however, right to say that it would be a perfectly proper course to immerse a sprained joint in *hot* water, if the accident took place at a time or in a place where that could be readily obtained. The reason for that is that *hot* water arrests bleeding as efficiently as cold. This may seem strange to non-professional minds, but it is the case, and it will be more fully explained in the chapter on the Arrest of Bleeding. At present the statement must be accepted that there is nothing contradictory in using, according to circumstances, hot or cold water for a sprained joint, as each acts beneficially in the same way—namely, by stopping the bleeding which goes on under the skin and is the cause not only of the chief immediate symptoms, but also of the later stiffness that is so troublesome and tedious.

As to the proper *after-treatment* of sprains, nothing need be said here, save to utter a note of warning, that there is no accident for which so many popular remedies are in vogue, and that any one foolish enough to try all those recommended will probably find herself or himself in the position of a certain woman who suffered much from many physicians, and was nothing bettered, but rather grew worse. This caution is not altogether uncalled for, as some of the plans of treatment very generally recommended are really dangerous and harmful. Thus, much mischief has followed the carrying out of the popular idea that one should "walk off a sprain." Such a proceeding, however applicable it may be later on, is both cruel and risky in the early stage, as it is apt to set up inflammation and suppuration. Again, the routine practice of applying leeches is both useless and dangerous; for leeches will not take up the blood effused in a bruise, and their bites may admit air, with its possible impurities; these latter setting up inflammation and leading to the formation of matter.

If the ambulance pupil is wise, he will never undertake the after-treatment of a sprain. Always bear in mind that "a bad sprain is worse than a broken bone;" and that the danger with every severe sprain is, that the bones entering into the formation of the joint or in its neighbourhood may be broken or displaced. Should this be the case, and proper treatment not be adopted, the accident may be the cause of crippling the limb, so that its future usefulness may be very much impaired. Another point to remember, too, is that sprains are very often the starting-point of joint disease; and that, consequently, the management of a sprain involves responsibilities that an ambulance pupil should not undertake. He should confine himself to the "first-aid" treatment mentioned above, leaving all curative measures to the medical man called in. Should there be any great delay in the arrival of the doctor, the cold applications should not be kept up too assiduously, in case of lowering the vitality of the part; and they might be advantageously changed to warm fomentations, especially if there is much pain complained of. The application of heat, some hours after the injury, frequently relieves swelling and tension, and proves very grateful to the patient.

STRAINS.—Just as the bones and joints are subject to fractures, dislocations, and sprains, so the muscles which form the other portion of the locomotory apparatus are liable to be stretched or *strained* by any severe, sudden, or unnatural exertion. We see this in some occupations where particular muscles are called into play, *e. g.*, stone-mason's thumb, and in certain forms of exercise, as in riding, where long continuance in the saddle, especially in the early days of the hunting season, unduly stretches the large adductor muscle on the inner side of the thigh and gives rise to what is popularly termed "rider's strain." When a muscle or muscles are over-stretched or strained there is great pain on movement, with some swelling and tenderness of the part. Accordingly the indications for treatment are to keep the muscles at rest, and if there is any pain, to apply warmth in the form of fomentations. In the case of the upper limb the rest is best obtained by the use of a sling, and in the lower extremity by the recumbent posture with elevation, and in certain cases flexion of the leg at the knee.

Sometimes the stretching to which the muscle has been subjected is so severe as to cause actual rupture of its fibres or tendon. This occurs most commonly in the case of the large sinew at the back of the heel connected with the powerful muscles of the calf of the leg and known as the Tendo Achillis. A false step while walking or in coming down stairs, any sudden effort as in hurrying up a steep hill, very energetic movements in dancing, as in a Scotch reel, have all been known to cause this accident, the symptoms of which are very pronounced. Owing to the tendon rupturing quite suddenly, the person falls to the ground as if shot, having experienced a sensation as if some one had struck him on the leg with a stick or stone. On rising he finds that he cannot use the injured limb, as it is quite unable to bear his weight when he tries to walk, and he is forced to remain quiet. This is the proper thing to do, and the "*first-aid*" *treatment* consists in helping the patient home, if the accident has happened out of doors, and placing him on a sofa or bed, where he may rest with the limb raised and the knee bent until medical aid arrives.

In the present day, when lawn-tennis is such a popular game, we have what are known as "lawn-tennis arm" and "lawn-tennis leg," the former consisting in the slipping out of its place of one of the muscles of the fore-arm in the sudden attempt to take the back-handed stroke, while the latter arises from the rupture of a small tendon in the calf of the leg. In this last accident the person falls suddenly to the ground, just as with a ruptured Tendo Achillis, and feels as if he had been struck on the leg. The "*first-aid*" *treatment* is that mentioned above, and medical advice should be obtained at once, as the earlier proper surgical treatment is put in force the more successful will be the result.

Bruises and Contusions.—Although not specially connected with the locomotory apparatus of the body, it may not be out of place to say a few words in this chapter on these very common, troublesome, and painful accidents. They are *caused* by some external violence, such as a heavy weight falling on the part, or by the person striking some part of the body against a hard and unyielding substance. No matter how it happens, a bruise or contusion implies that the weapon or object inflicting it is not edged or pointed, so that the skin is unbroken and there is no wound. The *symptoms* or appearance of a bruise are quite familiar to every one. The part struck swells up and is painful, it subsequently blackens, and eventually passes through all shades of colour (blue, green, and yellow) before the skin resumes its natural colour.

To understand properly the "*first-aid*" *treatment* of a bruise it is necessary to remember that all the appearances, the swelling, pain, and subsequent discoloration, are due to the effusion of blood poured out by the vessels which have been ruptured under the skin by the blow. The indication then is to arrest as quickly as possible this bleeding. How can this be done? By (1) *Cold*, (2) *Pressure*, and (3) *Position*, as in the case of sprains; and the remarks made on the treatment of those injuries apply equally here. The application of cold and pressure, the elevation of the part, and the placing it at rest, by sling, splint, or the recumbent posture, if necessary, are all carried out in the same way. So, too, when the first effects have passed off and the part is painful from the tension of the effused blood, then warmth, in the form of fomentations or poultices, should be used to soften and relax the tissues and favour their yielding. If the bruise has not been severe enough to call in medical advice, then the after-treatment should be directed to favour the absorption of the effused blood by gentle friction with some stimulating lotion or liniment rubbed into the part. It must always be remembered that the blood effused in a bruise may break down into matter and a gathering or "abscess" result, so that in the course of the after-treatment of such an injury should the part get hot, painful, and red, with a throbbing feeling in it, no time should be lost in getting medical advice.

While the above is a general outline of the treatment of bruises, there are one or two particular forms of this class of injuries that require a special word of advice.

Bruises of Joints should never be neglected. They are often the commencement of joint disease in weakly children, and they should have complete rest, with splint if required, and the part should not be used until a medical man has given permission.

In *Bruises of the Scalp* parents are often alarmed at the suddenness and great size of the swelling that makes its appearance on the head. It consists entirely of blood and need cause no alarm. In these cases *pressure* applied early is often more effectual than cold, and perhaps the most suitable way of doing so is by means of a coin wrapped in lint or linen and then bound firmly over the seat of injury. When this is done at once, it often completely stops the further effusion of blood and thus prevents swelling.

The *Bruise of the Eyelids* popularly known as a "black eye," is one that causes its possessor a good deal of mental as well as bodily annoyance, owing to the disfigurement it causes and the uncharitable suspicions so often associated with it. A host of remedies have been suggested for the prevention of the discoloration, which is really the objectionable feature in the accident, and is often so very slow in passing away. From what has been said it will be understood that any application that will prevent discoloration must be one that will prevent the effusion of blood, for once that has taken place the discoloration must follow. Now, the laxness of the tissues of the eyelids favours the rapid pouring out of the blood, and swelling follows the receipt of the blow very quickly, so that in all probability cold bathing, or the pressure of a folded cloth soaked in cold water over the eye, is the best immediate application for diminishing the effusion of blood and so limiting the subsequent discoloration. When this last has taken place there are various remedies that seem to hasten its departure very materially, such as bathing with hot water or with weak lotions of Arnica or Calendula. It is only right to mention here, that for the prevention of discoloration after a blow or fall, many rely on the use of a little dry starch or arrowroot merely moistened with cold water and laid on the injured part. It should of course be applied at once to be really effectual; but even some hours afterwards it may be used with advantage. It certainly prevents the action of the air on the skin, and should there be any scratches, as from a fall on gravel, it cleanses them and facilitates their healing. It is, too, less repugnant, especially to children, than raw meat, which is very much extolled, and apparently possesses some power to reduce swelling. This is most marked when it is tied firmly on, the *pressure* undoubtedly aiding in the good result.

The last special form of bruise that needs mentioning is the very painful one of *shutting a door, drawer, or window on a finger*. This is usually a most severe form of bruise, and the pain is often excruciating for a time. It is the end of the finger that gets jammed and the brunt of the pressure falls on the nail, which very quickly gets black from the blood effused under it. Sometimes the soft parts of the finger are torn as well. The best application at first is *cold combined with pressure*, and this is best carried out by wrapping a cold water bandage or cloth round the injured part and keeping it raised. This lessens the effusion of blood, and then subsequently the finger should be placed for some time in water as hot as can be borne. This softens the nail and it yields to the blood poured out under it, a good deal of the suffering experienced being due to the unyielding character of the nail. Later on, pressure may be still further relieved by scraping away the nail and thus thinning it. As a consequence of such an injury the nail nearly always comes off, and in a few cases severe inflammation of the finger has also followed, so that medical advice should always be sought after such an accident.

CHAPTER VII.

THE CIRCULATION OF THE BLOOD.

' Then the Heart, I take it out,
  Handling it with no compunction;
Once it wildly pulsed, no doubt,
  Well performed each wondrous function;
Sped the life-blood in its race
  In miraculous gyration,
Felt, responsive to *one* face,
    Palpitation."
  --*From "With the Scalpel."*

BEFORE taking up the treatment of Wounds and the Bleeding which invariably accompanies them, the Ambulance pupil should have some knowledge, in the first place, of the nature and structure of the vital fluid which we call Blood; and, secondly, he should thoroughly understand the mechanical arrangements by which it is circulated through the body. The present chapter will treat briefly of these two subjects.

I.—THE BLOOD.

1. *General Characteristics.*—The general appearance of this fluid is so familiar to all that any lengthy description of its physical properties is unnecessary. As it exists in the living body, and would flow from any wound of the skin, Blood is an alkaline, somewhat sticky fluid, thicker than water, and of a bright scarlet colour, although, under certain conditions, it may be of a purple tint. Owing to certain salts dissolved in it, it has a saltish taste, and it emits, when fresh, a faint peculiar odour. Its temperature at the surface is about 98° Fahr., but it is probably more in the interior of the body.

2. *Amount of Blood in the Body.*—It is a difficult matter to estimate this exactly, and so we find there are differences

of opinion on this point. In an individual of ordinary muscular development it would probably be a fair average to place the amount at 12 lbs.

3. *The Microscopic Appearances of Blood.*—It is only by placing a drop of blood under the microscope that we can obtain a proper knowledge of its structure. This instrument shews that it really consists of a clear transparent fluid, in which float a great number of small circular bodies. The former is known as the Plasma of the Blood, and the latter as the Blood Corpuscles.

4. *The Plasma of the Blood.*—This is a very important constituent of the Blood, for its function may be said to be, in the main, *nutritive.* Leaving out of consideration any waste matters that it may contain, the Plasma has a very complex composition, for it is really a liquid store from which all the tissues draw the substances necessary for their repair. Hence we find in it saline, saccharine, and fatty constituents; and if we were to burn some dried blood we would have no difficulty in demonstrating in the ash that remains the presence of sulphur, phosphorous, chlorine, potassium, and other elements. Speaking generally, however, the Plasma may be said to consist of *Water* holding in solution (1) *albumen*, (2) *fibrin*, and (3) *certain gases.*

The *Albumen* is in the form of serum-albumen, and it is, in all probability, *the* nutritious principle of the blood. It is it which is absorbed by all the different tissues to repair their waste. The *Fibrin* is very closely allied to the albumen, though differing from it in composition, and also in the fact that it has the power of *spontaneously becoming solid as soon as it leaves the body.* It is not exactly known what this substance is, but it is quite clear that it is a very important element in the circulating fluid, and that it has largely to do with the coagulation or "clotting" power of blood. The *Gases* present are Oxygen, Carbonic Acid, and Nitrogen—the quantities of each being variable; but on an average there are in every 100 parts of blood 17 parts of Oxygen, 29 of Carbonic Acid, and 1 part of Nitrogen.

This power of absorbing gases which Plasma has, like other fluids, is of great importance, as will be apparent when the process of Respiration is considered.

5. *The Blood Corpuscles.*—These are the minute bodies seen by the microscope floating in the Plasma, and in every 100 parts of blood about 12 parts are composed of these Corpuscles. By the presence or absence of colour they are divided into two definite or distinct groups—the *Red* and the *White*, the former being the more numerous, in the proportion of about 400 to 1 of the latter. As they differ in many respects, they each require a few words of description.

(*a*) *The Red Corpuscles.*—Since the discovery of their existence in the blood by Lenwenhock, in 1673, these bodies have been very carefully studied, and we now know that they are not the round spherical bodies they were thought to be, and which led to their being called "globules," but that, while circular in shape, they have a saucer-like depression in the centre, so that, when seen sideways, they have a bi-concave or dumb-bell shape (see Fig. 42, 1 and 2).

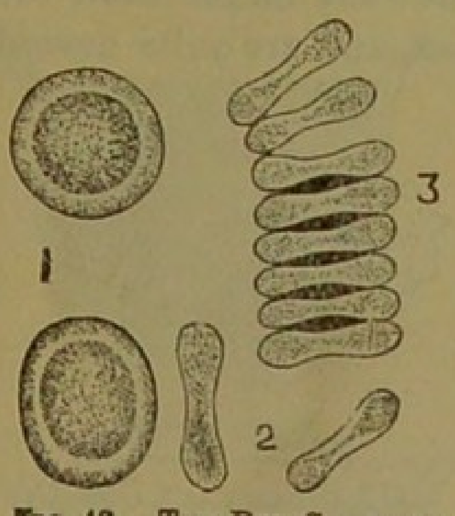


FIG. 42.—THE RED CORPUSCLES OF THE BLOOD.

An idea of their size is got by remembering that it would take 3,200 of them, placed side by side, to measure an inch. Viewed singly by itself each Corpuscle has a yellowish tint, but a number of them together present a dark red colour, just in the same way that a thin slice of currant jelly has a yellowish appearance, while the whole shape itself looks red. In fact it is the Red Corpuscles that give the blood its colour. Another point about these Corpuscles that the microscope reveals is their tendency to adhere to one another, so that they lie in rows like rolls of coin (see Fig. 42, 3), and the different rolls eventually cohering, they form an interlacing network, in the interstices of which some White Corpuscles become here and there entangled.

It is important to bear in mind the exact nature and structure of these Corpuscles. There is nothing dense or firm about them. On the contrary, they are soft and change their shape under the slightest pressure, for they are composed of an elastic and flexible stroma, in the meshes of which is embedded a substance called *Hæmoglobin*. It gives them their colour; but more important than this in connection with it is *its great affinity for Oxygen gas*, so that by its presence the Red Corpuscles become *Oxygen-carriers*, and convey this gas all through the body to the different tissues. This power of absorbing Oxygen and carrying it through the body is the *most important function* that the Red Corpuscles have, although it is probable that they also take up into their substance some of the liquid and albuminous Plasma in which they float, and after completely changing its composition adapt it for the nutrition of the highly organized muscular and nervous tissues of the body.

(*b.*) *The White Corpuscles.*—Somewhat larger than the red ones, they are much less numerous, and are quite devoid

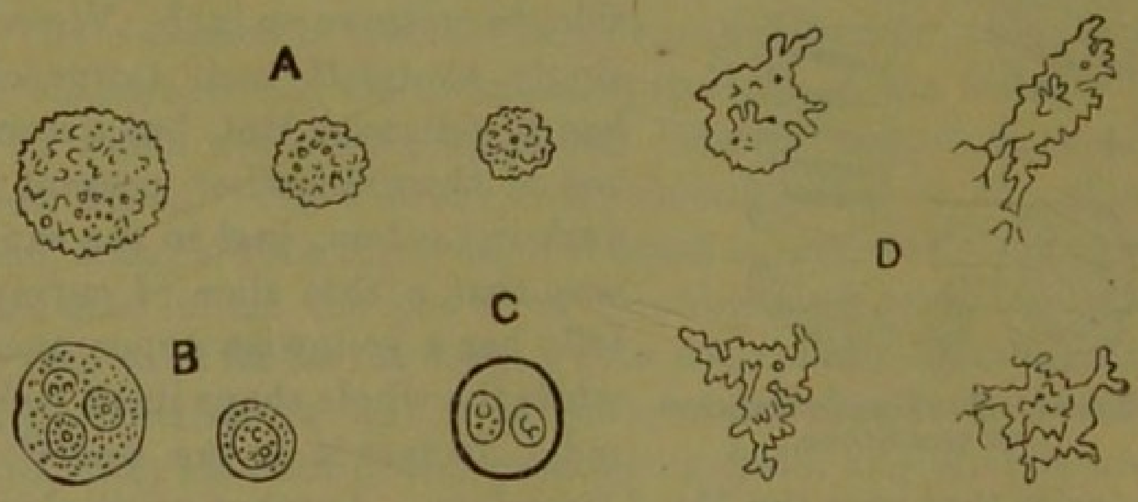


Fig. 43. Fig. 44.

The White Corpuscles of the Blood.

of colour. They are globular in shape, and contain one or two nuclei (see Fig. 43, B and C). They are made of a soft granular substance (protoplasm), which has not only the power of spontaneous movement, but also of throwing out processes from it, so that, under the microscope, the white corpuscles are seen to be constantly changing their position, shape, and appearance (see Fig. 44 D). Very little is known as to the function of these bodies, but it is generally believed that they are the parents of the red ones, and that they act the part, as it were, of policemen, getting rid of many extraneous and harmful substances that have found their way into the blood.

6. *The Coagulating Power of the Blood.*—As long as the blood remains within a living body it is fluid, and presents the characteristics mentioned above, but if withdrawn from the body into a vessel, and allowed to remain quiet, in a few moments it gets quite viscid, and in the course of a quarter of an hour it becomes converted into a *jelly-like yet solid lump*, which can be turned out of the vessel and handled. This process of solidification is known as the *Coagulation* or *Clotting of the Blood.* Were this now solid blood permitted to remain in the vessel undisturbed, at the end of 24 hours it would be noticed that a further process had taken place, and that the clot of blood had contracted and diminished in size, and was surrounded by a clear straw-coloured serous fluid, as seen in Fig. 45, where the dark-shaded portion represents the *clot*, and the lighter part the *serum.* So distinct are these two, that the former floats, as it were, in the latter, and can be lifted out of it.

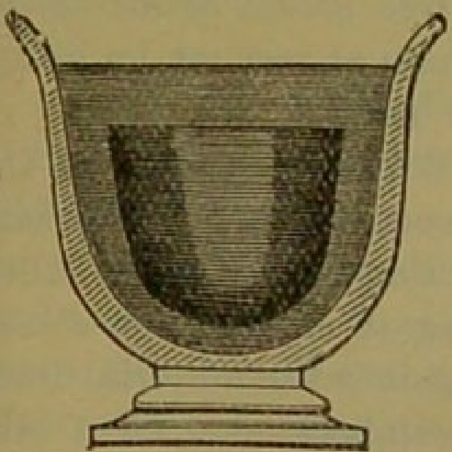


FIG. 45.—THE COAGULATION OF THE BLOOD.

It is unnecessary to go into the different views as to the exact nature of coagulation. It is quite clear that it is due to the appearance in the blood of *fibrin*, which, pre-existing in the blood only in a fluid form, develops, at the moment the blood is withdrawn from the body, a coagu-

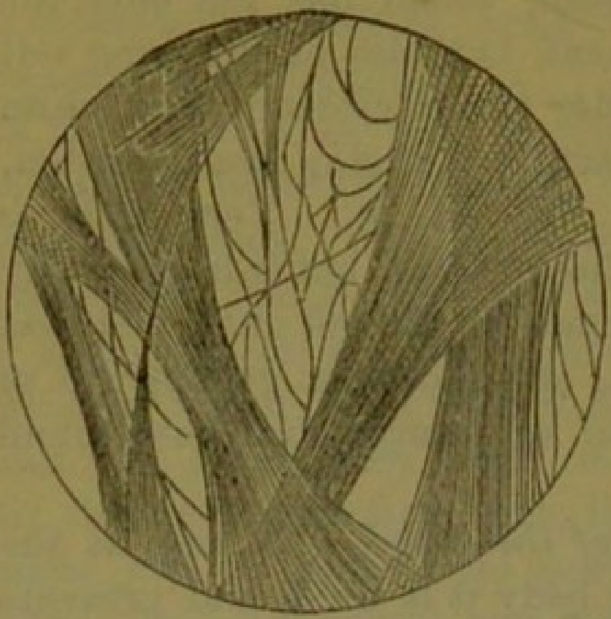


Fig. 46.
The Fibrin of the Blood.

lating power, and forms itself into the number of fine delicate threads which compose the clot (see Fig. 46). These threads entangle in their meshes the blood corpuscles, and also possess some contractile power, so that, if sufficient time is given them, they squeeze out the contained serum, as mentioned above. Curious as is this property of blood, it is one of great importance, for without it the least wound or cut would bleed until all the blood in the body was drained away; and when we come to speak of the arrest of bleeding we shall see that this power of clotting possessed by the blood is a most salutary provision on the part of nature, and a powerful factor in the arrest of hæmorrhage. Fortunately, too, we have it in our power to influence the process, and it is found that it can be *hastened* by free access of air to the blood, by allowing the blood to remain at rest, or by bringing it into contact with any foreign body.

7. *The Functions of the Blood.*—When we remember the various uses and functions of the blood, we are not surprised that it is a complex fluid, and that it has been called the "river of life." Not only does it serve as a storehouse of nutriment for the body, but it is the material from which all the various secretions are elaborated. Then into it are poured the waste products of the body, so that not only is it the vehicle by which they are carried to the different organs and got rid of, but alongside of them are borne the oxygen, heat, and moisture that are required for the repair and upkeep of the whole human fabric. Nowhere is this better expressed than in the following quotation from Professor M. Foster :—" Blood, then, is a very wonderful

fluid: wonderful for being made up of coloured corpuscles and colourless fluid; wonderful for its fibrin, and power of clotting; wonderful for the many substances, for the proteids, for the ashes or minerals, for the rest of the things which are locked up in the corpuscles and in the serum.

"But you will not wonder at it when you come to see that the blood is the great circulating market of the body, in which all the things that are wanted by all parts, by the muscles, by the brain, by the skin, by the lungs, liver, and kidney, are bought and sold. What the muscle wants it, as we have seen, buys from the blood; what it has done with it sells back to the blood; and so with every organ and part. As long as life lasts this buying and selling is for ever going on, and this is why the blood is for ever on the move, sweeping restlessly from place to place, bringing to each part the thing it wants, and carrying away those with which it has done. When the blood ceases to move, the market is blocked, the buying and selling cease, and all the organs die, starved for the lack of the things which they want, choked by the abundance of things for which they have no longer need."

II.—The Circulatory Apparatus of the Body.

Having briefly sketched the nature of the blood, the next points to consider are the mechanical arrangements that exist for circulating that fluid through every part of the body, seeing that it supplies all the tissues with nourishment, furnishes the material from which the different organs elaborate their secretions, and serves as the vehicle for carrying off the waste products of the body. The means taken for accomplishing these ends are known under the general term of *The Circulatory Apparatus*, and the principle underlying it is that adapted by engineers in the water-supply of a town, namely, a system of pipes laid down in connection with a reservoir, at which point a force-pump, or energy of some kind is brought into play to drive the water through the pipes. The Circulatory Apparatus of the human body follows exactly the same plan, so that we find it consists of a central reservoir, the *Heart*, which serves as a pump, to force the blood through a set of tubes distributed all over the body, and known as the *Blood vessels*. It is necessary to make a few explanatory remarks on each of these portions of the system separately.

(*a*) *The Heart.*—To understand how this organ gets its propulsive force by which it sets the blood in motion and drives it through the body, we must recall what was said when speaking of the Locomotory Apparatus. It was then explained that all the different movements of which the body is capable are effected by the muscles, owing to their possessing the special and peculiar property of *contractility*, under which they shorten and diminish in length. It is easy to see that structures endowed with such a power can be made available for carrying on any special work, and that it is only a matter of arranging the muscular fibres in a particular way. Thus, if one or more muscles were wound round a soft bag containing water or any other fluid, and these muscles were compelled to contract, they would diminish the capacity of the bag, and would squeeze the contents out of it, provided there was an aperture in it. This principle has been acted on in the formation of the Heart, which is really a hollow bag surrounded by muscular fibres, the contractions of which force the blood contained in it into the blood vessels connected with certain apertures in it.

A Heart such as this is the simplest form in which it could exist, and we find it in some of the lower animals, as, for instance the Crab, the Crayfish, and others (See Fig. 47). In them the contractions of this pulsating sac, which fills and empties itself at regular intervals, put the blood in motion and circulate it through the body. Now the term *circulate* implies a *going round*, and it means that the blood passes round and round the body and returns to the spot, that is the Heart, from which it started. This is accomplished by a suitable arrangement of the pipes or blood vessels of the

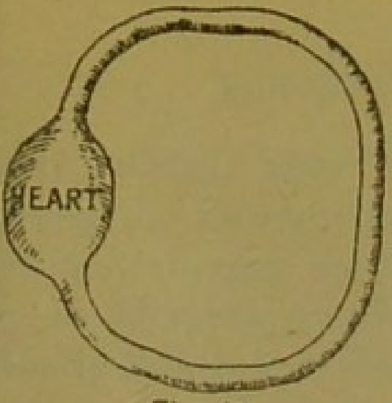


Fig. 47.

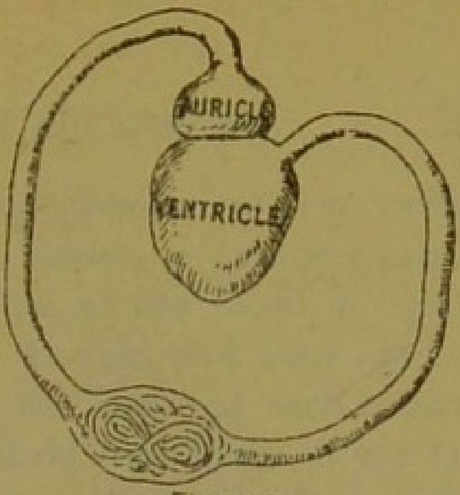


Fig. 48.

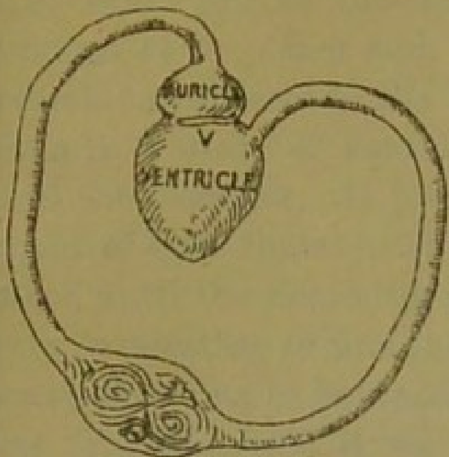


Fig. 49.

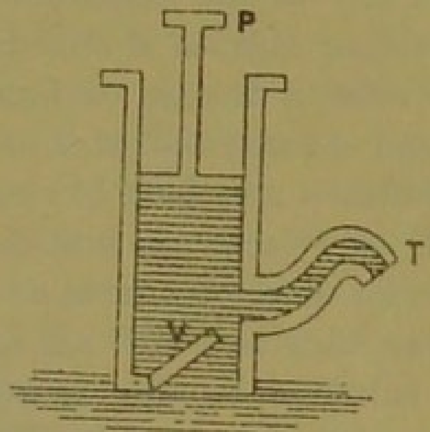


Fig. 50.

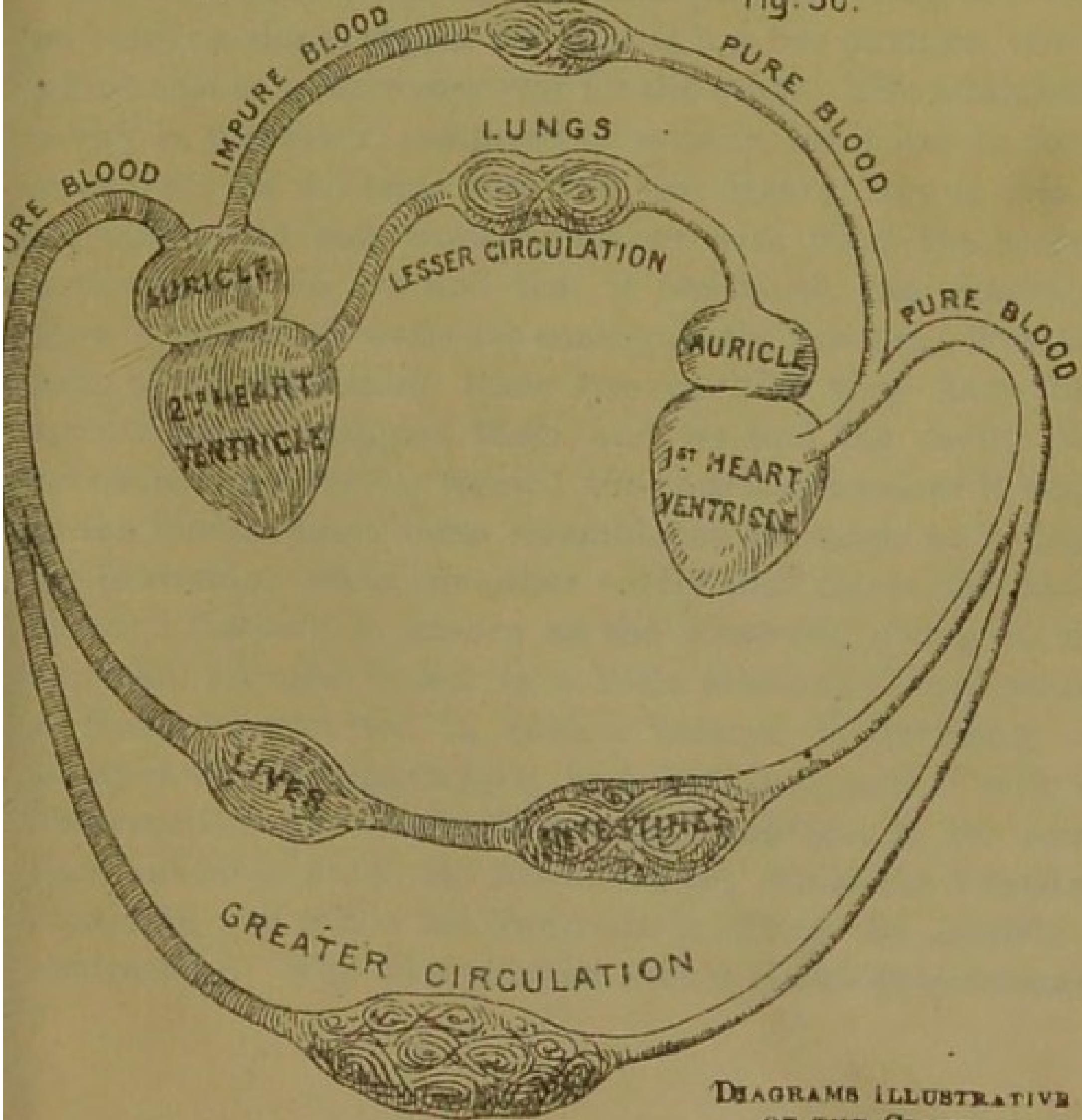


Fig. 51.

DIAGRAMS ILLUSTRATIVE OF THE CIRCULATION OF THE BLOOD.

body, which, after distributing themselves everywhere among the different organs and tissues, converge again to the central organ the Heart. Now, as the blood is bottled up, so to speak, in these blood vessels, and they are constantly full, it is evident that if the heart at each contraction drives a fresh amount of blood into them at one end, they must relieve themselves by getting rid of a similar amount at the other end. But this other end of the blood vessels terminates in the Heart, which is at this particular time in a state of contraction, and so cannot receive very well the overflow. It follows from this that there is needed a sort of ante-chamber or receptacle to hold this overflow of blood until the heart relaxes again and can receive it. It is very interesting to find that such an arrangement as common sense shews us to be necessary, is the very one that nature has provided, and if we take the trouble to examine the heart of a *fish*, we will have no difficulty in seeing that it is no longer a single organ, but that it has *two* cavities, one of which acts as a mere reservoir for the other. This additional cavity is, moreover, composed of muscle, for it has to force or squeeze its contents into the real Heart; but as this is very light and easy work compared with what the second cavity has to do, we find that it has much less muscular fibre in it, and its walls are consequently thinner. For the sake of distinguishing these two cavities they have had special names assigned them, and we find the cavity that serves as the reservoir termed the *Auricle*, because it bears in the human heart some resemblance in shape to a dog's ear (*auricula*), while the other cavity that forces the blood through the body is known as the *Ventricle*, owing to the supposed likeness it has to a little stomach (*Ventriculus*). A Heart constructed in such a manner is decidedly an advance on the simple form first described, and it will be observed that the two cavities do not contract at the same time but alternately, the Auricle filling while the Ventricle contracts, and while the Ventricle is filling the Auricle is contracting. Fig. 48 represents such a Heart diagrammatically, and Fig. 49 the same in section. This latter brings out a point that requires notice. On examining the diagram it will be seen that the communication between the two cavities is not a simple hole or aperture (Fig. 49 V). If it were so, when the Ventricle contracted it might as easily drive the blood back into the Auricle as into the blood vessels of the body. To prevent this occurring, and *to ensure the blood going in a fixed direction*, recourse has been had to the employment of what is known in mechanics as a *valve* (Fig. 49 V), a contrivance of great simplicity and usefulness. The accompanying sketch, Fig. 50, illustrates its working. The drawing up of the piston P creates a vacuum, into which any fluid that is below the valve V rushes, the valve offering no obstacle to its entrance. When the piston P is pushed down, the liquid above V is pressed upon, and exercises such pressure on the valve as to keep it forcibly down over the aperture. The fluid consequently cannot pass out by the way it entered, and as it can find no other place of exit than the pipe T, it makes its way out of this with considerable force. This same mechanical arrangement of *valves* is introduced into the structure of the Heart, only the valve found there is not of the same kind as in a pump, though it acts in the same way. It is made of a thin membrane, and is composed of two or more flaps, which are attached by their bases to the aperture, while their points hang down into the cavity of the Ventricle, and offer no obstacle to the flow of blood into it from the Auricle. As soon, however, as the Ventricle begins to fill, the blood gets behind the flaps and floats them upwards towards the aperture where their bases are attached. Eventually they close it, and their points are kept from being driven into the Auricle when the Ventricle contracts by an arrangement of delicate fibrous threads (*cordæ tendineæ*) which are fastened to muscular masses (*columnæ carneæ*) in the walls of the Ventricle, and are just sufficiently long to allow of the flaps reaching the middle of the opening and nothing more. When the course of the circulation is described, it will be seen that the fact of the blood always passing in *one direction only* depends on the presence of such valves in the Heart.

A Heart consisting of Auricle and Ventricle, such as has been described, is sufficient for those grades of animals where the organization is not of a high type and great purity of blood is not required; but in all *warm-blooded* creatures, including birds, quadrupeds, the whale-kind and man, a very pure blood and one highly charged with Oxygen is called for. This necessitates a further modification in the Circulatory Apparatus and it becomes more complex. To understand the necessity for this it must be borne in mind that one of the functions of the blood is *to receive the waste products that result from the chemical changes going on in the body, and thus to become a vehicle for carrying off useless and harmful matters.* As a consequence of this, the blood when it arrives back at the Heart would be so impure that it would be useless for the nutrition of the body of such a highly organized being as man unless some steps were first taken to purify it. This is what is done, and in man it is accomplished by bringing the blood into special contact with the air, so that it may absorb fresh Oxygen and get rid of its impurities. When the process of Respiration is described, the details of how this purification is carried out will be described. What now concerns us is that the necessity for it has led to further modification in the Circulatory Apparatus to the extent of introducing another Heart with an Auricle and Ventricle. One Heart drives the blood through the body where it becomes of course impure, but instead of returning back to the Auricle of the organ from which it started it is conveyed to another Heart, which drives it in its impure condition through the Lungs. In these organs it is freed from its harmful properties and returns pure to the first Heart from which it started. Such an arrangement really includes a *Double Circulation*, for while one Ventricle is pumping pure blood through the body the other one is sending impure blood through the Lungs, and as the distance traversed in the one is much shorter than in the other the first is spoken of as the Greater and the second as the Lesser Circulation. Fig. 51 illustrates in a diagrammatic form the two circulations, the impure blood in the one Heart being indicated by the shading.

To many the above description of the Circulatory Apparatus of the human body may seem strange and startling, the general belief being that we only possess one Heart. And so in reality we do, for the two are joined into one, and have become a central single organ. A glance at Fig. 52 shews how easily this could be accomplished—the mere approximation of the two, side by side, accomplishing it. At the same time, there seems no absolute necessity why they should be merged into one; and there is one of the whale tribe, the Dugong, in which they are quite separate. In the human Heart, even, instances have occurred where the cleft extremity of the organ indicates clearly its double nature. Although, then, by custom, we have come to regard it as a single organ, and speak of it having a right side and a left side, we will have a better grasp of the work it does and of the course the blood takes, to say nothing of the clearer understanding we will have as to why it contains four cavities—namely, two Auricles and two Ventricles—if we keep in mind its double origin. To impress this fact more forcibly upon the mind, it has been proposed by some to call the right side *The Heart of the Lungs*, and the left side *The Heart of the Body;* but these terms have not met with general acceptance.

In the perfect state in which it occurs in the human body, the Heart has certain characteristics which are of importance and call for a short description of it. The Heart lies in the chest or thorax, between the lungs, and is placed nearly in its middle and lower part, though it is much more inclined to the left than the right side. It rests on the diaphragm, and is further held in position by the large vessels which spring from it. Its size is roughly estimated by the closed fist of the person possessing it;

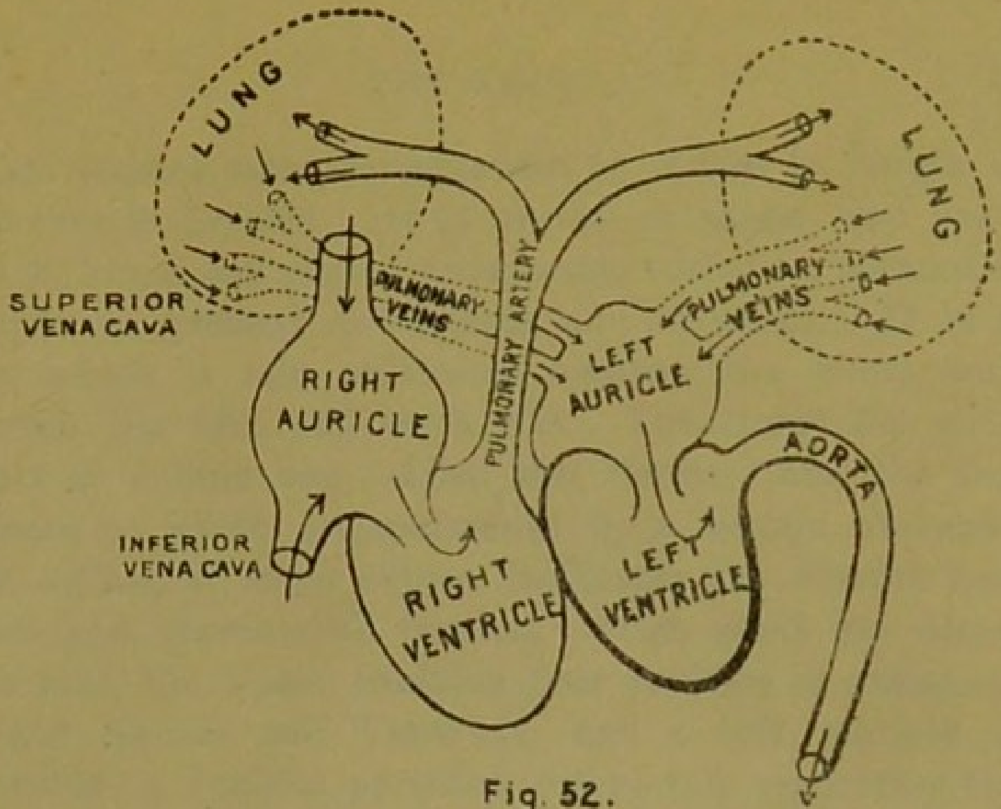


Fig. 52.

Diagram Illustrative of the Circulation of the Blood

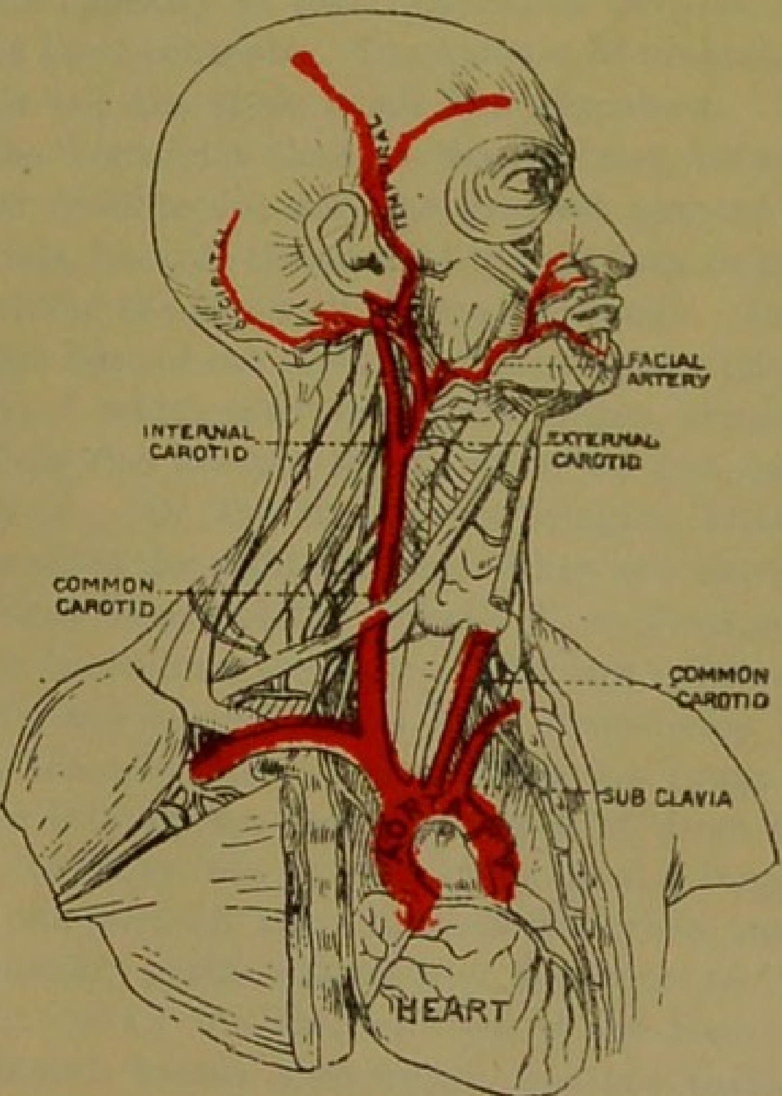


Fig. 53.

The Aorta and Arteries of the Head and Neck.

but its correct measurements are 5½ inches in length and 3½ inches in breadth. It is conical in shape, and has its base or broad end placed uppermost, whilst its pointed end or apex is directed downwards and forwards. It is the apex which is felt pulsating against the chest walls, between the fifth and sixth ribs. The Heart lies within a sort of double bag, called the Pericardium, the inner surfaces of which are moistened by a certain amount of fluid. This, to some extent, facilitates the Heart's movements and prevents all friction. From what has already been said, the Heart contains *four* cavities or chambers—a right Auricle and Ventricle, and a left Auricle and Ventricle—a vertical partition completely separating them from one another. Round each of these muscular fibres are wound in a spiral manner, so that when they contract they diminish the capacity of their respective cavities, and thus squeeze out their contents. The amount of muscular tissue, however, is not the same in all four chambers. There is more in the Ventricles than in the Auricles, because they have harder work to do; and the greatest amount is in the left Ventricle, because it has the heaviest task to perform—namely, driving the blood all through the body. In connection with the base of the Heart there are *eight* pipes or blood vessels—*six* of which converge to the organ, bringing fluid into it; while *two* are projected out of it, and carry fluid away from it. Of the six vessels bringing blood to the Heart, *two* enter the right Auricle. They are known as the *Superior Vena Cava* and the *Inferior Vena Cava*, and carry the impure blood from the body. The other *four* enter the left Auricle, and are called the *Four Pulmonary Veins*, as they bring the now purified blood from the lungs. Of the *two* vessels leaving the heart, *one* goes off from the right Ventricle, to carry the impure blood to the lungs; while the *other* one goes off from the left Ventricle, and distributes the freshly purified blood from the lungs to the body. The interior of all the four cavities of the Heart is lined with a smooth serous membrane; but the inside of the

Auricles differs somewhat from that of the Ventricles, these latter being more irregular, owing to the musculo-fibrous threads which pass to the valves guarding the apertures between the Auricles and the Ventricles.

(*b*) *The Blood Vessels.*—These represent the water pipes of a city, and they are laid down on very much the same plan. In the case of the water-pipes this is usually as follows:—Issuing from the reservoir there is a *main pipe*, which soon breaks up into branches for the several districts of the town. In each of these districts the leading branch gives offshoots to the principal streets, and these in their turn to the cross streets near. From these branches, running along the different streets, pipes pass to each individual house, in the interior of which there is a further division of the pipe for the supply of the separate rooms. In this way every street, every house in a street, and every person in every house has brought within reach that health-giving fluid which is such a necessity of our daily lives. The plan on which the blood supply of the body is arranged is very much the same. From a central reservoir, the Heart, there passes a large *main blood vessel*, which sends off branches to supply the head, neck, trunk, and extremities. These branches in their turn so subdivide or send off other branches that the blood courses through all parts of the body, rebuilding and repairing every spot no matter how remote. The name given to these tubes which issue *from* the Heart is that of *Arteries*.

Let us now note the *situation* of the chief arteries of the body, for with the position and direction of these the ambulance pupil should be acquainted, just as the engineer of the water-supply of a city is obliged to know where the main water pipes lie, as he may be called upon at any moment to deal with a burst or leak.

Commencing at the Heart (situated, it will be remembered, in the Chest), the Left Ventricle of that organ drives the pure blood which that chamber contains into a large *main blood vessel* called the *Aorta.* As soon as it leaves the heart the Aorta passes upwards for a short distance, then transversely across the chest, and lastly, downwards again, so that its first portion exactly resembles in shape the crook of a shepherd's staff, and is known as the *Arch of the Aorta* (see Fig. 53). From this large and capacious vessel steps are at once taken to supply with blood no less than *four* districts of the body, two on its right side and two on its left. These are:—

1. The Right side of the Head and Neck.
2. The Right Arm.
3. The Left side of the Head and Neck.
4. The Left Arm.

The blood supply of the first two districts is at its commencement a common one, as it is for a short distance accomplished by a large branch which goes off from the right side of the Arch of the Aorta. This vessel measures a couple of inches in length, and as it has received no special name it is known as the *Innominate* or nameless blood vessel. Just behind the articulation of the collar-bone with the breast-bone on the right side the Innominate divides into two branches of considerable size. One of these runs upwards in the neck in the direction of the ear for the supply of the right side of the head and neck and is known as the *Right Common Carotid*, while the other one curves outwards and downwards at the root of the neck for the supply of the right arm and is called the *Right Subclavian.* It will make the description clearer if the Right Common Carotid is taken first.

Blood Supply of Right Side of Head and Neck. The word "Carotid" is derived according to some from a Greek word "*karoo*" which means *to induce sleep*, because a popular idea exists that pressure on the Common Carotid Artery for a prolonged period induces sleep. This explanation is not accepted by all, and it seems more probable that it is from two Greek words "*kara*" – the head and "*ous-otis*" – the ear, thus indicating that the vessel supplies the head with blood and that it runs in the direction of the ear. I have mentioned these derivations of the word, as it will remove the idea held by some non-professional persons that the blood vessel has something to do with "garrotting," and it will serve to fix its situation in the memory. A line drawn from the articulation of the collar-bone and breast-bone to the ear represents fairly well the position of the Right Common Carotid. It is the chief artery of the neck, and is the one that sometimes suffers in suicidal wounds of the throat. At a level with the larynx it divides in its turn into two branches of smaller calibre, known as the External and Internal Carotids. This last runs upwards and pierces the base of the skull near the ear and thus disappears, breaking up inside the skull into a number of smaller branches for the supply of the right side of the *Brain.* The External Carotid also passes directly upwards parallel to the other branch, the Internal Carotid, but it is distributed entirely to the parts outside, so that its branches pass to the larynx, the jaws, the face, and the scalp. Of these branches some run deeply and are not of so much importance from an ambulance point of view, but others are more superficial and are accordingly more open to have the *first aid treatment* for bleeding applied to them. Of these latter, the ones whose position the ambulance pupil should note in the diagram are the *Facial* for the face, the *Superficial Temporal* for the front part of the scalp, and the *Occipital* for the back part of the head.

Blood Supply for the Right Arm.—The right arm is supplied with blood by that other branch which leaves the Innominate behind the articulation of the collar-bone and breast-bone, and curving outwards and downwards, is known as the *Subclavian.* It is so called because it passes over the first rib and under the clavicle (*sub*—under, and *clavus*—clavicle). Its course is as follows:—It enters the arm-pit or *axilla* (Fig. 54), where it is known as the *Axillary* Artery, and on leaving the hollow under the shoulder, it runs along *the inner side of the upper arm, close to the humerus.*

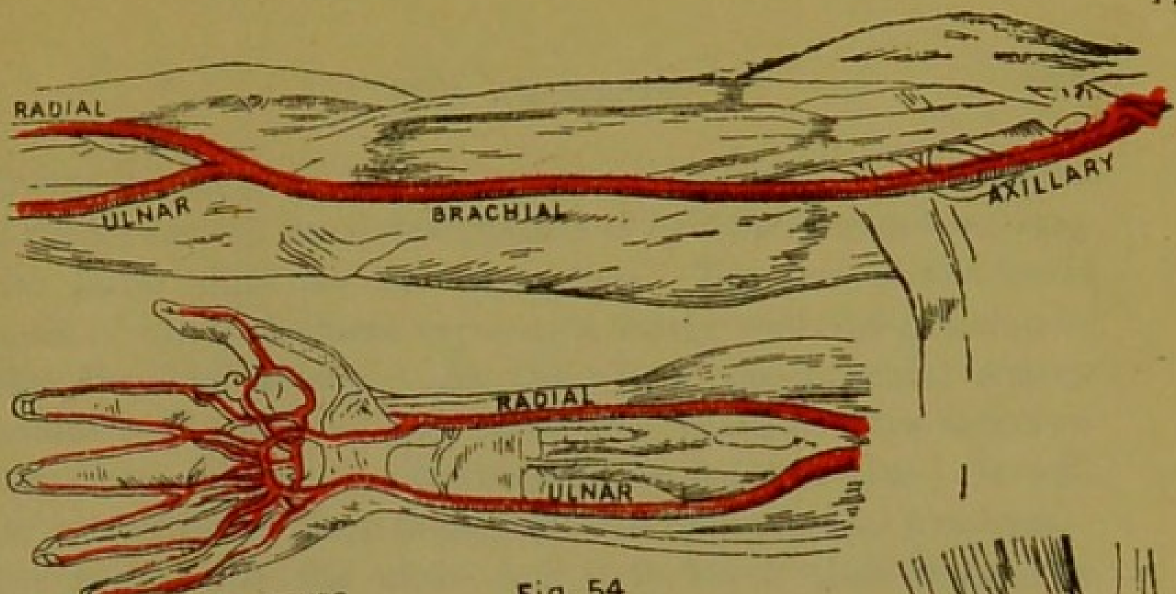


Fig. 54

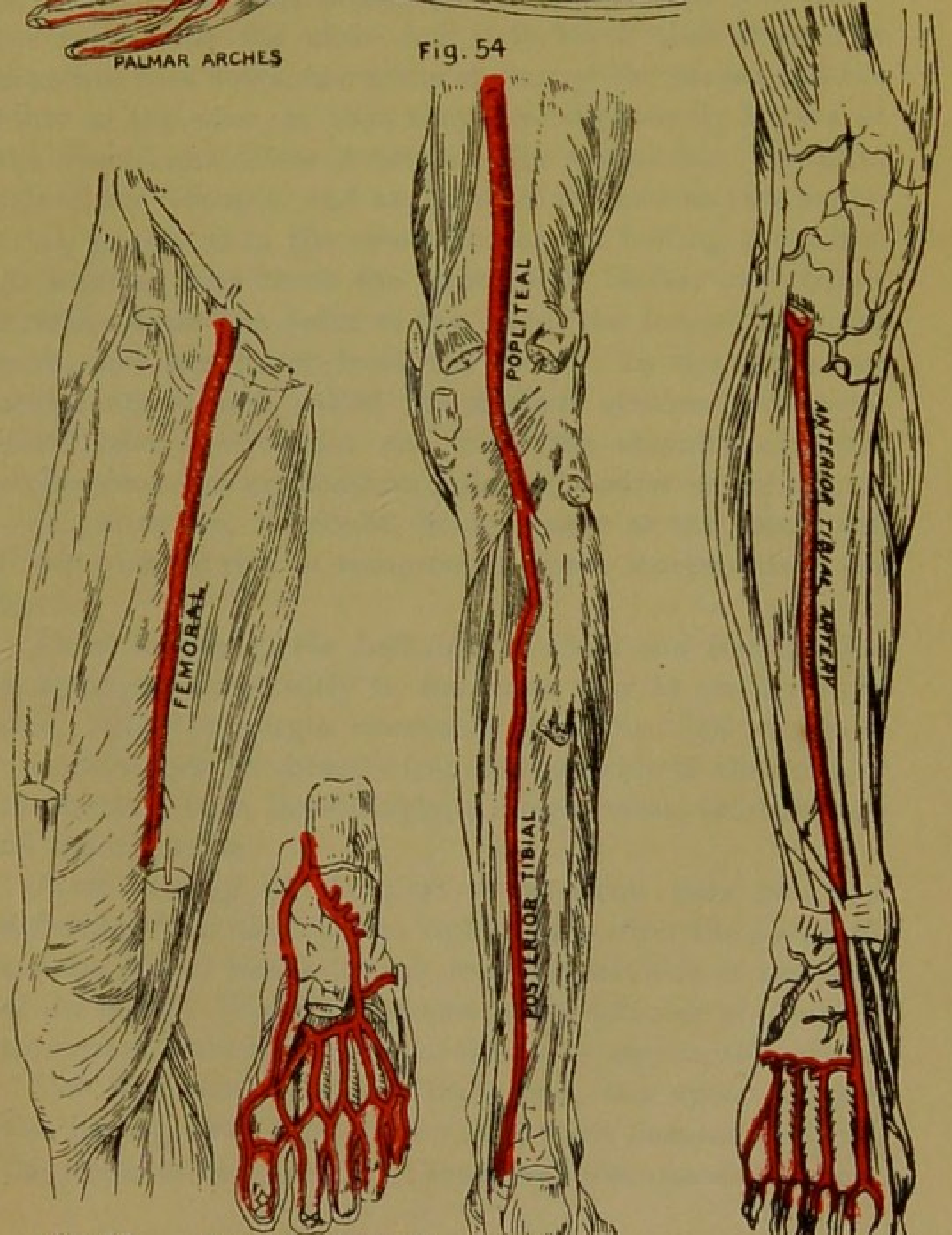


Fig. 55. Fig. 58. Fig. 56. Fig 57.

Owing to this, it has been named by some the *Humeral* Artery; but its usual designation is *Brachial*, from *brachium*, the Latin word for the upper arm. The line of the inner seam of the coat sleeve represents fairly well the position of the *Brachial* artery. At the elbow the Brachial Artery passes to the front of the joint, and there divides into two branches, which run downwards in the fore-arm. It will be remembered that there are two bones in the fore-arm—the *radius* and the *ulna*—and it is found that these two branches pass down, one under shelter of the *radius* and the other of the *ulna*, so that they are respectively known as the *Radial* and *Ulnar* Arteries. The *radial* is on the outer side of the fore-arm, and at the wrist it becomes very superficial, so that it is the vessel chosen for feeling the *pulse*. As soon as they reach the wrist, both *Radial and Ulnar* Arteries enter the palm of the hand, the former from the back, and the latter from the front. In the palm two *arches* are formed, called the *Palmar Arches*, with their convexities downwards; and from the summits of these arches branches are continued along the *sides* of the fingers—this situation, no doubt, being chosen as the safest and freest from all risk of compression in the movements of the hand.

Blood Supply of the Left Side of Head and Neck.—This is arranged for exactly in the same way as on the right side, with the single exception that the *Left Common Carotid* comes off directly from the left side of the Arch of the Aorta. It is, accordingly, a longer vessel than the one on the right side.

Blood Supply of the Left Arm.—The only point of difference from that of the right arm is, that the *Left Subclavian* Artery issues directly from the left side of the Arch of the Aorta. These differences on the left side of the body arise from there being no Innominate Artery on the left.

The blood supply of the head, neck, and upper extremities having been provided for, the most natural thing for the Aorta to do would be to continue its course downwards, so as to meet the requirements of the trunk and the lower extremities. This is exactly what it does; and we find it running down *on the front of the vertebral column*, so as to be safe from injury.

Blood Supply of the Trunk.—That portion of the Aorta within the chest or thorax is called the *Thoracic Aorta*, and the only branches it sends off are those for the muscles between the ribs, and known as the *Intercostals*—from *inter* = between, and *costa* = a rib. On leaving the chest, the Aorta passes through the diaphragm, and entering the abdomen, becomes the *Abdominal Aorta.* This part furnishes blood to the organs contained in this cavity, so that we have branches for those at the upper part, namely, the stomach, liver, and spleen; and then for the intestines, kidneys, and other viscera. The wants of the abdomen and its contents having been satisfied, steps are next taken for the blood supply of the parts below; and as there are two Lower Extremities, it is quite clear that one central vessel will no longer suffice, and that it must divide into two. This it does at the level of the fourth lumbar vertebra—the two divisions being known as the *Right and Left Common Iliac Arteries* respectively. The term "*iliac*" is from the word "*ilium*," which is the Latin for the flank or loin; and it is interesting to note that the division of the Aorta into two distinct trunks takes place high up in the loins, so as to make the alteration in the direction of the vessels gradual, and thus do away with any sudden or sharp turn, which would only serve to interrupt the current of the blood and develop friction. Each *Iliac* Artery now proceeds in an outward direction towards the limb it has to supply; but before it leaves the abdomen, it further subdivides into two branches, which are called the *External and Internal Iliac Arteries.* This *Internal* vessel dips down on each side, to carry blood to the organs in the pelvis and to the mass of muscles which clothe that bony basin outside. But for this arrangement these important parts would be without blood. Meanwhile, the *External*

Iliac on each side continues its course, and enters each Lower Extremity at the exact centre of the top of the thigh, popularly known as the fold of the groin.

Blood supply of the Lower Extremity.—As soon as the *External Iliac* artery reaches the top of the thigh it becomes the *Femoral* artery, because of its nearness to the *Femur* or bone of the thigh (Fig. 55). At its entrance into the lower extremity the vessel is quite superficial, and it can be felt beating. It does not long keep the central line, but *winds towards the inner side of the limb*, and ultimately turns half way round the thigh bone, so as to get at the *back* of the knee-joint, just as the Brachial artery wound round to get at the *front* of the Elbow-joint. The space behind the knee is lozenge-shaped, and contains no bulky muscles. It is known as the *Popliteal space*, from the Latin word *poples-itis*—the ham, and so at this spot the vessel is often designated the *Popliteal artery*. It follows from what has been said that a line from the centre of the groin to the inner side of the knee represents fairly well the course of the Femoral artery. On leaving the Popliteal space the *Popliteal* artery divides into two branches for the leg with its two bones, in the same way that the Brachial did for the fore-arm. In the leg, however, both branches cling to the *Tibia*, or shin bone, for shelter and protection, and one passes in front of that bone, while the other goes behind it (Figs. 56 and 57). To distinguish them accordingly we have one named the *Anterior Tibial artery*, because it runs on the front of the leg, and the other the *Posterior Tibial*, because it passes down at the back. On arriving at the ankle they both come nearer the surface and they both enter the foot, the *Anterior Tibial* on the top of the instep in front of the ankle, and the *Posterior Tibial* on the inner side of the ankle (Fig. 58). Here the latter passes free from any pressure to *the sole of the foot*, and dividing into two branches forms an *arch* (on the same plan as those existing in the hand), for the supply of the several toes.

Such is a brief description of the course and situation of the *main blood vessels* of the body, and the ambulance pupil should follow them on the different diagrams and should also lose no opportunity of identifying them on the living body by their pulsation. He will notice the similarity of distribution in the upper and lower extremities, and will observe that in nearly every case changes in the direction of the arteries are with the object of increasing their safety, just as the Brachial and Popliteal arteries are more protected from danger on the tront and back of the arm and leg respectively, than if their situations had been reversed.

But there are another set of blood vessels in the body besides those whose office it is to convey the blood to the different districts. We made acquaintance with them when describing the general anatomy of the body. To understand the necessity for them, we have to recall the fact that the blood not only ministers to the wants of the tissues, but also carries off their waste products, so that when loaded with these it ceases to be useful and becomes positively harmful. This radical change in its qualities is made apparent even to the eye by an alteration in its colour, which is no longer bright and scarlet but has assumed a dark purple blackish tint. The natural thing to do would be to get rid of useless poisonous blood like this, just as in a city the water after it has become dirty and unwholesome by use in the various houses and manufactories is taken away by another series of pipes called drains and sewers. The same principle is brought into play in the human body, and accordingly we find that the dark and impure blood, laden with the waste matters of the tissues, is conveyed away by a separate set of vessels. These are the *Veins.* To understand how the Veins are laid down and distributed will best be done by remembering that the blood, as soon as it has become impure, is not allowed to run away as the waste water of a city is. Nature does not act in such an extravagant and thoughtless manner. She has devised a plan by which the blood can be purified in the body and so made available for use over and over again. This is accomplished *by driving* *it through the Lungs*, where the Oxygen of the air removes its impurities and changes it once more to a crimson colour. To enable this to be done the services of the Right side of the Heart (or Second Heart, as it really is) are called into play, and to it the impure blood is brought by the Veins, which at their origin are small, but by uniting with one another as they go along they eventually terminate in two large trunks known as the *Superior and Inferior Venæ Cavæ*, which enter the Right Auricle of the Heart and pour their contents into it. The *Superior Vena Cava* brings back the blood that was sent to the Head, Neck, and Upper Extremities, while the *Inferior Vena Cava* returns that which has nourished the Trunk and Lower Extremities. From this it will be seen that just as the *Arteries* are the vessels going off *from* the Heart, the *Veins* are the vessels going *to* it. As to the distribution of the Veins throughout the body, some are lodged quite superficially under the skin and are quite apparent to the eye, while others run deeply and accompany the larger arteries. These last are designated the *Venæ Comites* or "Accompanying Veins." Speaking generally, the large venous trunks run close to the main Arteries and in some instances have the same name, so that a knowledge of the direction of the Arteries supplies the necessary information about the Veins.

A few words had better be said here as to how the Arteries and Veins communicate with one another. They do so by means of a series of very small vessels, of such minute size that they have been likened to a hair, and have consequently been termed *Capillaries*—from *capillus*, which is the Latin word for a hair. They are of extremely fine calibre, and their walls are so delicate and thin that the fluid part of the blood, and even some of the white corpuscles, can pass through them and nourish the tissues. Indeed, it is through the agency of the Capillaries that all the different nutritive changes in the body and its numerous organs take place. They are generally arranged like the meshes of a net; and in this way little islets of tissue are formed, which are bathed, consequently, on all sides with blood stored with nutriment. Between these islets and this fluid there is only the thin, almost porous wall of the Capillaries, so that a constant interchange goes on—the tissues absorbing what nourishment they need, and giving back, instead, their waste products. This renders the blood impure, and to get rid of it the capillary network merges into one or more small *Veins*. These carry it off and pour it into larger veins, which, in their turn, sooner or later join the main venous current going to the Heart. Small, then, though they be, the Capillaries are an important portion of the system of blood vessels in the body, for not only do they permit of nutritive changes going on, but they put the Arteries in communication with the Veins, and thus allow the complete circulation of the blood, which, as already pointed out, means that this fluid returns to the same spot from which it started.

Structure of the Blood Vessels.—Owing to the Blood Vessels of the body being likened to the water-pipes of a city, it might be thought that they are of the same rigid and unyielding character. This is not so; and they must on no account be regarded as firm tubes, resembling ordinary lead or copper pipes. On the contrary, they are soft and dilatable, and are more like ordinary elastic tubing, the walls of which, as is well known, can be *stretched out*, while, at the same time, they are quite contractile and can be *squeezed together*. These characteristics of the Blood Vessels must never be lost sight of, as they play an important part in the circulation, and allow of means being taken for the arrest of bleeding that would otherwise be of no avail. To understand what confers these qualities of *Elasticity* and *Contractility* on the Blood Vessels, resort must be had to the microscope, which shews that the walls of the Arteries and Veins are composed of three coats, the middle one of which contains elastic and muscular tissue. The Arteries contain more of these substances than the Veins, and some of the large Arteries have so much elastic tissue that they do not collapse when empty, while, if cut across, their orifices gape, owing to the stoutness and thickness of their walls. The smaller Arteries and the Veins have no elastic tissue in their walls, and only a small amount of muscular fibres, so that their walls are thinner; while the Capillaries are entirely destitute of both, their walls consisting exclusively of a structureless and delicate homogeneous membrane, which allows of the passage of fluids and even blood corpuscles through it. There are thus important *structural* differences in the walls of these various vessels, differences arising largely from the part they respectively play in the mechanism of the circulation. Their *contents*, too, are not the same—the Arteries being filled with pure red blood (known as *Arterial*), the Veins with dark impure blood (known as *Venous*), and the Capillaries partly with one and partly with the other. There is, however, another very distinguishing feature to which reference has not yet been made, and that is the existence in the Veins of *Valves*. The necessity for these arises from the fact, that the Veins have to convey the blood to the Heart, and so its current must of necessity be up-hill, especially in the upper and lower limbs. To prevent the tendency the blood must have in these situations to fall backwards, Valves are placed at intervals, and usually in pairs. They look towards the Heart, and only come into action if the current of blood attempts to set in a backward or downward direction. They are most numerous in the veins of the extremities, as one would expect, and their presence in the arm can easily be demonstrated by tying a strip of bandage round it and so arresting temporarily the upward flow of venous blood.

The course of the Circulation.—From the description that has just been given of the Circulatory Apparatus the ambulance pupil should have no difficulty in keeping before him the course or direction of the blood through the body. Briefly, it is as follows:—The impure *Venous* blood returned to the Heart by the Superior and Inferior Venæ Cavæ is emptied into the Right Auricle, on the contraction of which it is forced into the Right Ventricle and distends it. By the contraction of the Right Ventricle the blood is propelled into the Pulmonary artery, which divides into two branches, one for each Lung. In the capillaries of these two organs the blood is exposed to the oxygen of the air and purified, as shewn by its change of colour. This pure Arterial blood is now collected by the four Pulmonary veins (two from each Lung), and is then poured into the Left Auricle, from which it passes into the Left Ventricle and fully distends it. Upon the contraction of the Left Ventricle, the blood is driven into the Aorta, and by means of its several branches it is distributed to the different districts of the body, to be again returned from them to the Heart by the veins. To ensure the blood moving always *in this one and fixed direction* it must not be forgotten that a number of valves are introduced at the various openings inside the heart, and at the orifices of the large blood vessels, by the action of which any regurgitation of blood is entirely prevented. When these valves are diseased, the blood does get backwards, and we have one of the commonest forms of Heart Disease. Besides the general course of the circulation sketched above, the ambulance pupil should keep in mind the direction of the blood current in the different districts of the body. Thus, in that of the Head and Neck it is upwards in the Carotids and their branches, and downwards in the Jugular veins; in the Upper Extremities it is downwards to the fingers in the arteries, and upwards in the veins towards the shoulders; in the Lower Extremities it is downwards towards the toes in the arteries, and upwards towards the groins in the veins; while in the Trunk it is downwards in the Aorta, and upwards to the Heart in the veins.

The Forces that carry on the Circulation.—Of these, no doubt, the Heart, with the alternate contractions of its Auricles and Ventricles, is the main one; but the *Elasticity* of the Arteries is another very important factor. Each time that the Left Ventricle drives its contents into the Aorta, this vessel, already full, can only find space for this additional amount of blood by its walls dilating, which they are enabled to do by reason of the elastic tissue they contain. After being stretched, the walls return again to their original size, and so contract on their contents, which, of necessity, are forced *onwards*, as the Valves at the commencement of the Aorta prevent the blood going back into the Ventricle. Although, then, the blood in the Arteries has a jerky and intermittent character from the pulsations communicated to it by the contractions of the Heart, yet the elasticity of these vessels gives to the contained fluid a certain amount of continuity in its flow. In this state of matters, then, we have another distinction between Arterial and Venous blood, for the passage of the blood through the Capillaries so slows the current that the Venous blood has none of the Heart pulsations communicated to it, and moves along steadily and evenly; just as in the fire-engine, by the intervention of an air-chamber, none of the strokes of the pump are felt by the water, which, accordingly, issues in a continuous stream.

There are many other facts connected with the Circulation that might be dwelt on, but the points that bear on Ambulance work are the ones that at present it is important to bring forward, and that is the principle on which the present chapter has been written. Should the Ambulance pupil desire to pursue the subject further in any work on Physiology, he will find much to delight and charm him, not the least interesting part of which would be the history of *the discovery of the circulation of the blood*, some 200 years or more ago, by the immortal Harvey.

> "Here did'st thou trace the blood, and first behold
> What dreams mistaken sages coined of old.
> For till thy Pegasus the fountain brake,
> The crimson blood was but a crimson lake,
> Which first from thee did tyde and motion gaine,
> And veins became its channel, not its chaine."

CHAPTER VIII.

THE ARREST OF HÆMORRHAGE.

Scene.—A hut in the wilds of Braemar; a big gamekeeper fast sinking from a gunshot wound in the lower part of the thigh. Dr. Adams, *loquitur*—"Get a handkerchief, and the spurtle" (the porridge stick), "and now for a pad for our tourniquet. This will do," putting his little Elzevir "Horace" down upon the femoral. Gamekeeper's life saved, and, by good guidance, the leg too.—*John Brown, "Horæ Subsecivæ," first series, p. 265.*

Having made himself acquainted with the leading facts about the circulation and the mechanism by which it is carried on, the Ambulance pupil should now be in a position to understand the *"first-aid" treatment* of bleeding, or Hæmorrhage as it is very generally called,—from two Greek words, *haima*=blood, and *rheo*=to flow.

Definition of Bleeding.—Inasmuch as the blood of the body is always inside blood-vessels of some sort, be they arteries, veins, or capillaries, bleeding may be defined as *the escape of blood from the blood-vessels, within which it should properly remain, and its discharge from the body.* This last proviso is important, because the blood may escape from the blood-vessels, as when they are ruptured in a bruise, and yet not escape from the body. Under these conditions the bleeding passes under the name of "*extravasation.*"

Different Varieties of Bleeding.—From what was said in the last chapter, the Ambulance pupil will probably have already surmised that there may be different kinds of bleeding, according as the arteries, veins, or capillaries are injured. This is so, and we find that there are three varieties recognised,—viz., (1) Arterial; (2) Venous; and (3) Capillary. These can be distinguished as follows:—

Arterial Bleeding is of a red scarlet colour, and issues from the divided artery in jets or spurts, owing, of course, to the contractions of the left ventricle of the heart, which make themselves felt on the blood contained in the arteries.

Venous Bleeding is of a dark purple colour, and flows in a continuous stream.

Capillary Bleeding consists of a general oozing from all parts of the wound, because of the great slowing of the blood current that takes place in the capillaries. The blood is usually of a scarlet colour, the oxygen of the air acting on it as it trickles down.

The Ambulance pupil should always keep clearly before him the differences in the colour and in the character of the flow of arterial and venous bleeding, as these are the kinds that are really dangerous.

The Dangers of Hæmorrhage.—If a large artery is cut across, and no proper assistance is at hand, the person may die in a few minutes, for the effects of the loss of blood are more felt when the artery is large and the blood quickly poured out, than when it issues gradually from a vein or small artery. A sudden loss of five lbs. of blood has caused death. In cases of profuse and rapid bleeding, death ensues from *failure of the circulation*, because the pressure in the arteries sinks so low that the heart labours like an empty pump, and cannot keep the blood in motion. On the other hand, when the loss of blood is gradual, the fatal event may be somewhat postponed, and the constitutional effects of Hæmorrhage have time to shew themselves. These once seen are not soon forgotten. The blanched face, the pallid lips, the cold hands, the heavy drops of perspiration on the brow, and the sighing breathing, all make up a picture that does not soon fade from the memory, intensified oftentimes by the feeling of regret that probably a slight knowledge of what to do might have averted the fatal issue. The circumstances then that regulate the effect of bleeding are not only the amount of blood lost, but also the rate of its loss. It is this last point that so often renders prompt action necessary. Even in cases where immediate death does not follow bleeding, recovery is often slow, especially in the old, and there is the further danger of inter-current maladies making their appearance. Children bear the sudden loss of a quantity of blood badly, but as a rule they make good recoveries.

Causes of Hæmorrhage.—Bleeding may arise from *disease* of the blood-vessels, or from *injury* to them. The former is usually the cause of what is called *internal*, and the latter of *external* hæmorrhage.

Meaning of Various Terms.—When the term *Hæmorrhage* is used, it implies that the blood is coming from the surface of the body; but when it escapes from any of the natural openings of the body it has often a special name applied to it. Thus, bleeding from the nose is *epistaxis;* from the lungs, *hæmoptysis;* and from the stomach, *hæmatemesis.* It is advisable that the Ambulance pupil should keep these three terms in mind.

Varieties of Wounds.—As injuries are the leading cause of *external hæmorrhage,* and as this most frequently demands "*first-aid*" *treatment,* it is necessary to mention the different kinds of wounds. In medical language they are arranged in four classes:—(1) Incised; (2) Lacerated; (3) Contused; and (4) Punctured. All of them have their own characteristics and their own dangers. The *Incised* have clean and smooth cut edges, having been inflicted by some sharp instrument. They bleed freely. The *Lacerated* have irregularly torn edges. They usually result from tears by machinery, or from the bites of animals. As a rule very little bleeding accompanies them, but they do not heal kindly. The *Contused* are caused by blows from blunt instruments, such as a policeman's baton, and do not bleed. They are apt to inflame afterwards. The *Punctured* wounds are generally deep, as they are inflicted by a sharp-pointed instrument. With them there is often considerable bleeding, and deep internal injuries. In addition, however, to the variety to which it belongs, a wound is influenced by the violence with which it was inflicted, and the cleanliness or otherwise of the instrument causing it.

Natural Arrest of Hæmorrhage.—Before taking up the treatment of bleeding, it is advisable to indicate briefly what Nature herself does to arrest the hæmorrhage from injured blood-vessels, for a preliminary knowledge of this will render more intelligible to the Ambulance pupil the steps the surgeon takes in these cases, and he himself will learn how he can act in the surgeon's absence and until his arrival.

The *Spontaneous or Natural arrest of bleeding* depends on the coagulating power of the blood, and on the structure of the blood-vessels. These last contain in their walls elastic and muscular fibres, so that, under the stimulus of an injury, they are both able to *retract* into the tissues and also to *contract* their orifices. Hence we find, that if only the *capillaries* are divided, the coagulation of the blood is sufficient to plug their apertures, and stop the flow of blood; while if the *small arterioles or veins* are the source of the hæmorrhage, their retraction within the tissues, and the contraction of their muscular coats on the clots of coagulated blood, still further strengthen the natural arrest of the bleeding by coagulation. When a large artery is cut across, a more complicated series of changes takes place than those just mentioned. By virtue of its elasticity, the divided artery immediately *retracts* into the tissues, and its orifice *contracts*. The blood in the vicinity of the mouth of the vessel coagulates, and forms an *external clot*, which, of course, plugs the artery and stops further bleeding, unless the pulsation of the heart is so strong that it washes it away. In this case it is only a matter of time, and the injured person dies. But we may suppose that the clot remains in place, and the hæmorrhage ceases. Further changes then follow in the shape of a localized inflammation at the mouth of the artery, in consequence of which an adhesive lymph is poured out, and the retracted coats of the artery are glued together, until finally they form a firm fibrous mass, which most effectually blocks the mouth of the divided vessel. Another useful provision of Nature is the formation of an *internal clot* for some little distance up the artery. The value of this is, that it serves as a barrier to the current of blood, and prevents it interfering with the inflammatory changes which permanently close the artery. It will be readily understood that the loss of blood which occurs in any case of bleeding, if considerable, has a beneficial effect in this way, because the faintness it causes lessens the force of the heart's contraction, and the blood current moves more slowly. In consequence of this the external clot is not washed away, and the loss of blood ceases. Many a person has been killed by having large doses of stimulants administered during the faintness following loss of blood. The effect of the stimulant has been to increase the force of the heart's action, and so of the blood current, with the result that the plugs of coagulated blood have been washed away from the orifices of the cut vessels, and a fresh and fatal bleeding has taken place. This point should always be borne in mind in administering stimulants in cases of bleeding. Make the non-recurrence of hæmorrhage secure by proper *"first-aid" treatment*, and then administer stimulants with a free hand if the faintness is great. Another very interesting fact is, that the greater the loss of blood the greater the coagulating power of what is left,—as if Nature was putting forth a special effort to avert a fatal issue. I have gone thus fully into this point of the spontaneous or natural arrest of bleeding, because I feel that the mere knowledge of the fact that in many ways Nature is on his side, should encourage the Ambulance pupil, and should help to remove the helplessness that is felt by all when brought face-to-face with a case of bleeding, calling for immediate aid. There are, of course, a certain number of people known as "bleeders," in whom the above natural changes do not take place, and whose blood will not coagulate. With them the slightest cut is of very serious import; but fortunately this class of persons is very limited, and they need not be taken into account owing to their rarity.

The Surgical Treatment of Hæmorrhage.—A short outline of how the surgeon deals with cases of bleeding will not be out of place here, as it will indicate to the Ambulance pupil how he can help in his "*first-aid*" *treatment* of such emergencies.

The object of all surgical treatment is to *permanently close* any bleeding vessels, and there are various methods for attaining this end, as each individual case has its own peculiarities, and calls for its own special plan of treatment. But in cases of emergency and accident, the means for carrying out this *permanent treatment* may not be at hand, and some time has often to elapse before it can be applied, so that the surgeon has, of necessity, to adopt a *temporary or provisional treatment* to put an immediate stop to the loss of blood. What he uses first is *local pressure*, and he never feels alarm in a case where the bleeding spot is within reach, and he can put his finger on it. As a rule, in the majority of cases this suffices to control the bleeding. Besides its simplicity, this method has the further advantage that, in a special emergency, the wounded person can be made to exercise this pressure, and so free for a moment or two the person assisting. But as pressure with the finger can only be kept up for a limited time without causing fatigue, the surgeon makes use of a substitute in the form of a *dressing* of sufficient firmness to cause pressure on the wound, and this he binds on with a bandage. This *direct compression of the wound* is then the first plan of *provisionally* controlling the bleeding that the surgeon resorts to, and it is very commonly successful, especially if there is a hard surface, such as that of a bone, to make pressure on, and against which the walls of the vessel may be compressed.

Another point on which the surgeon relies in the *temporary treatment* of bleeding is the *position* of the wounded part. In the case of the limbs, for instance, material help is given to stopping the blood from a wound by elevation of the part. Blood cannot run uphill any more than water, so that in this way the current of blood in the vessels may be very much slowed and time given for the retraction of the vessel and the coagulation of the blood, which are such powerful factors in Nature's arrest of bleeding. In *Venous* bleeding, good is often done, too, by the removal of constrictions, such as braces, stays, collar of shirt, and waist-band of trousers.

Should, however, the above means not suffice, and it is seen that the flow of blood continues, then the surgeon next proceeds to *temporarily* cut off the blood supply of the district in which the wounded vessel is situated. This he does by *distant compression of the main artery carrying blood to it.* The pressure must be *between* the wound and the heart, and can be made by the fingers (*digital pressure* it is called) at those points where a hard basis of support is furnished, as by a bone underneath. But as this digital pressure is fatiguing even for strong hands, it is customary to replace the fingers with an instrument, known as a Tourniquet, which derives its name from the French word *tourner*—to turn.

There are several varieties of this instrument, but they are all more or less modifications of the simple one devised by the French surgeon Morell, in 1674, at the Siege of Besançon. It consisted of a strong bandage passing through two slits in a piece of leather, a pad stuffed with horse hair, and a stick for inserting in the loop. By *turning* or twisting the stick, any amount of pressure could be exercised. Morell took his idea of the instrument from the plan employed by the Spanish muleteers to tighten the ropes round their bales of goods; and I have mentioned it here, as the "improvised tourniquet" the Ambulance pupil may sometimes have to fall back on is constructed on the same principle. One drawback to Morell's tourniquet was that it required an assistant to hold the stick and prevent it untwisting, so we find that some years later, Petit, another French surgeon, instituted a *screw* to obviate this difficulty, and to allow of the pressure being regulated more easily.

This instrument has held its ground ever since. It can be seen applied in Fig. 31 of the Triangular Bandage. Another step in advance in the construction of the instrument was made when Luer introduced the *field tourniquet*, which consisted of a strap and buckle, with a pad for pressure on the artery. In it the pad is placed over the artery, the strap is drawn sufficiently tight to arrest the current of blood, and then it is fastened by means of the buckle. It will be noticed that whatever the form of tourniquet, the principle is the same in all,—namely, a *strap* to go round the limb, a *pad* to place over the artery, and some means of *tightening the strap*. Useful, however, and invaluable as any of the above instruments are, it must be admitted that they are somewhat awkward to apply, and require a fairly accurate knowledge of anatomy. Besides, they are expensive and bulky to carry. Recent years have, accordingly, seen the introduction of *elastic band tourniquets*, on the recommendation of Professor Esmarch of Kiel. If a limb is encircled several times in one place with such a band, and the ends secured so as not to slip, the soft parts and the vessels in them are so firmly compressed that not a drop of blood can pass through them. In consequence of their simple uncomplicated structure, and their ease of application in any emergency, these elastic tourniquets are now in very general use, and perhaps the form that is most popular is that suggested by the late Dr. Foulis of Glasgow, a representation of which is given in Fig. 46 of the Triangular Bandage. Should none of the above tourniquets be available, then the surgeon must be content with digital pressure on the *main artery*, or he must improvise an impromptu instrument. This can always be done by means of an ordinary handkerchief, folded narrow, and tied round the limb. This represents the *strap* of the ordinary tourniquet. The *pad* may take the form of a stone, a cork, a reel of cotton, or any other hard substance that is at hand, and the whole may be *tightened up* by a piece of stick, or any other straight object, such as a ruler, walking-stick, or truncheon, which is passed under the handkerchief and twisted until sufficient pressure has been put upon the part. Figs. 30 and 40 of the Triangular Bandage shews such "improvised" or "stick" tourniquets, and their similarity to Morell's original instrument will be at once apparent. With the object of having an "improvised" elastic tourniquet always at hand, Professor Esmarch proposed an elastic trouser-suspender or braces, which might be utilized for this object, and in Germany many workmen wear them. Amongst ourselves the ordinary elastic belt worn round the trousers at cricket and tennis might be advantageously employed in an emergency.

The surgeon uses sometimes also "*forced flexion*," a very powerful means of temporarily controlling hæmorrhage in the limbs. By it the main artery is so acutely bent that the current through it is almost completely arrested, just as when the india-rubber pipe connected with a water-tap is raised and bent sharply no water can flow through it. This method is applicable to the upper extremity, where to stop bleeding from the fore-arm or hand, the flexing of the elbow at an acute angle on a firm pad will so bend the brachial artery that no blood will pass through it, as shewn by the absence of the pulse at the wrist. (See Fig. 59). Then, in the case of the lower extremity, hæmorrhage from the foot and leg may be at once stopped by forced flexion of the knee, and bleeding from the thigh low down by forcible flexure of the thigh on the abdomen. (See Figs. 60 and 61). It must be remembered that the flexion required to stop the bleeding must be rather severe, and so cannot be borne long; and this plan has only been alluded to as one that in an emergency might be available for a short time, until, perhaps, the materials for an "improvised" tourniquet had been obtained.

By some such means, then, as those mentioned above, the surgeon *temporarily* controls the bleeding, but he does not rely on them, and without delay he proceeds to carry out the *permanent treatment*. It is possible that the tem-

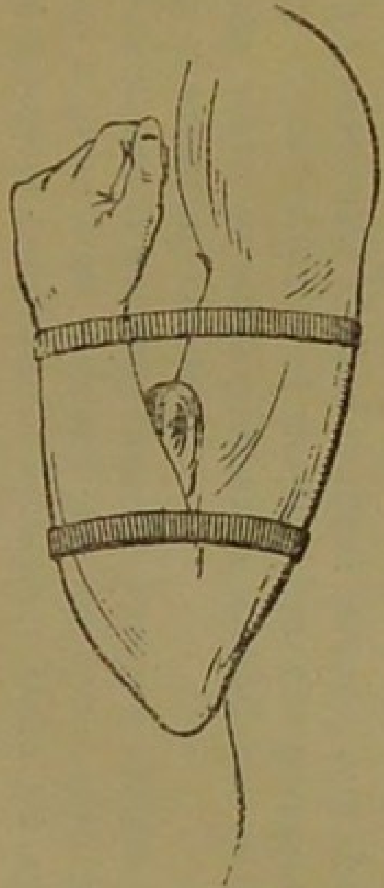


Fig. 59.
"FORCED FLEXION" OF THE ELBOW.

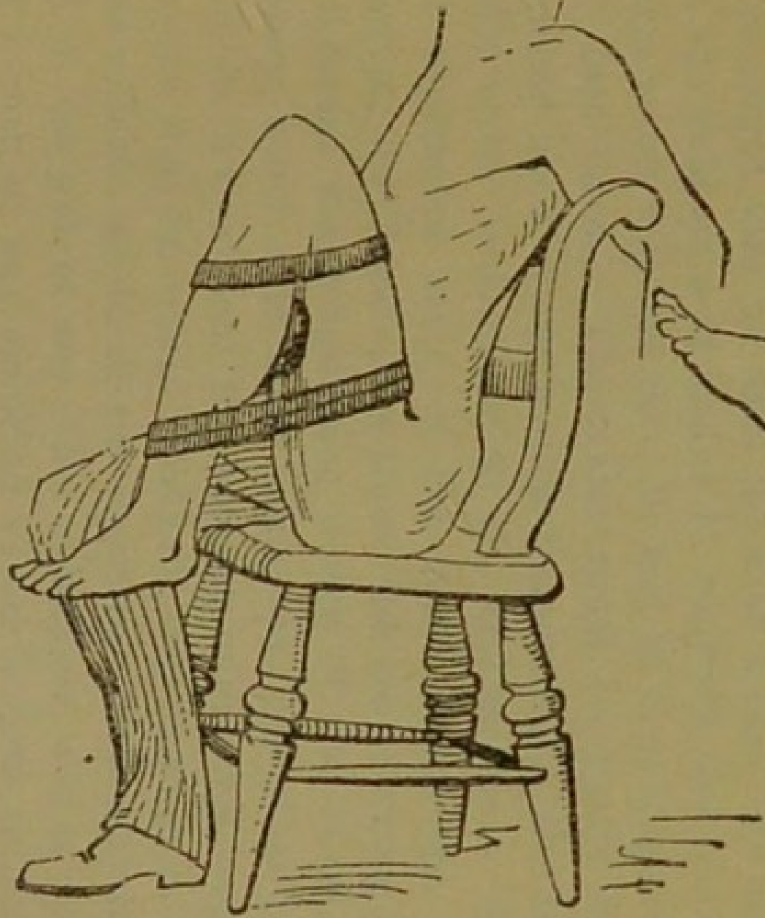


Fig. 60.
"FORCED FLEXION" OF THE KNEE.

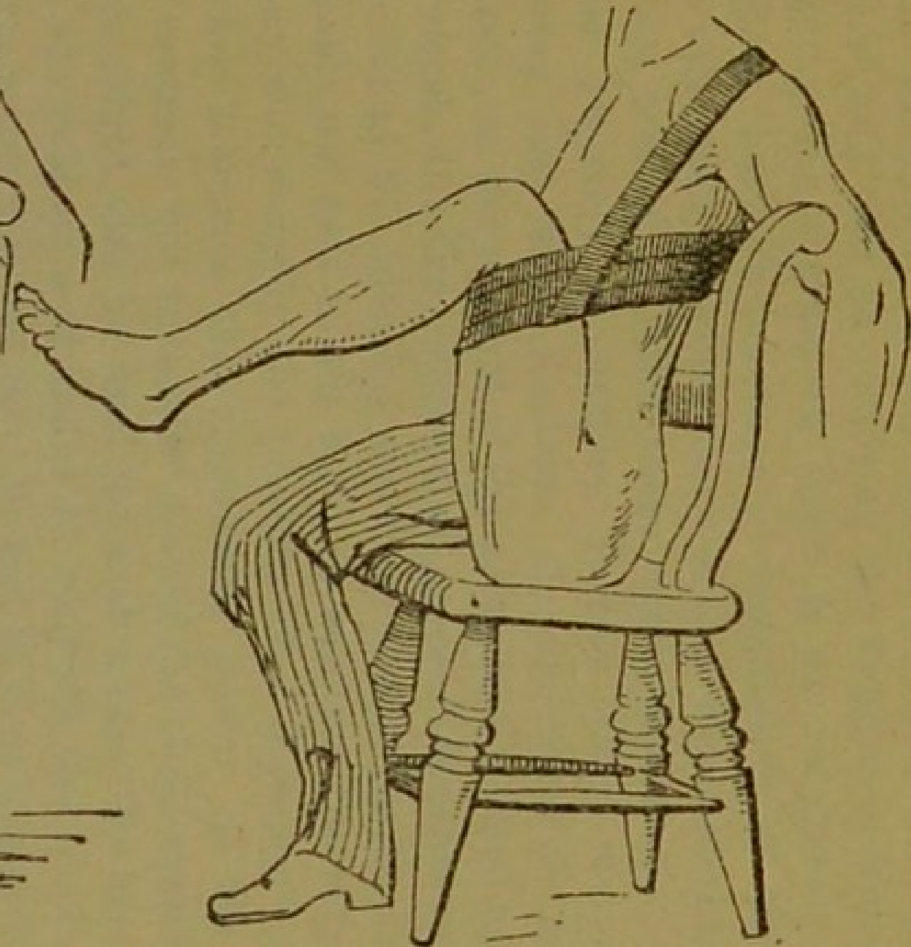


Fig. 61.
"FORCED FLEXION OF THE THIGH.

porary treatment, as say by local pressure, may have sufficed, and that on removing the temporary dressing, or loosening the tourniquet, there is no recurrence of the bleeding, nature's processes of coagulation of the blood with retraction and contraction of the vessels having closed the cut orifices. Under these circumstances the surgeon would probably do nothing further than re-apply the dressing, and watch the case. In a number of instances, however, on the removal of the pressure the bleeding breaks out afresh, and the surgeon then proceeds to other measures. If he found the bleeding was from small vessels, he would probably use *cold* in the form of washing the wound with water, and re-apply the pressure of a dressing. Cold so applied increases the coagulating power of the blood, and contracts the muscular coat of the blood-vessels. *Hot* water might also be used for such a case, the heat acting like the cold as a stimulus to contract the blood-vessels. Warm water will not do. In fact it encourages bleeding, and does harm. The water must be really *hot*. The blanched hand of the washer-woman while she is working in *hot* water is familiar to all, and is due to the empty and contracted state of the small arterioles. Should, however, the bleeding continue, the use of stronger *styptics* to increase the coagulating power of the blood, and the *cautery*, which acts in the same way, are other permanent methods of treatment the surgeon might fall back on, but the one that he would most probably employ as being the most reliable would be the *ligature*. This may be made of silk or cat gut or any other substance, and to apply it the cut mouth of any spouting vessel is first pulled forward with a particular kind of toothed forceps, and then securely tied. Under the use of the ligature, the permanent closure of the vessel is accomplished in accordance with Nature's plan of arresting bleeding.

Sometimes it happens that the surgeon arrives at the case when a great loss of blood has occurred, and the patient is in a serious condition of collapse. Here, of course, steps are first taken to prevent any fresh loss, and then to ward off the death by failure of the heart's action that is so impending. This is done by keeping the body lying on its back, with the head low, so as to let all the blood that is possible gravitate to the brain, and supply the nerve centres for the heart and breathing. Then warmth would be applied to the limbs and trunk, along with small quantities of stimulant, while an attempt would be made to increase the amount of blood in the trunk by elevating the limbs, and pressing all the blood out of them. Lastly, in some cases where death is imminent from simple loss of blood, and the heart is not acting from a deficiency of fluid in the circulatory apparatus, benefit of a very striking kind has followed the transfusion of blood.

As regards *Venous* hæmorrhage, the surgeon usually relies on *pressure* to stop it, the pressure being made on the side of the wound *away from* the heart.

Such is a brief outline of the ordinary surgical procedure in cases of bleeding from wounds, and its principles should be fairly intelligible to the Ambulance pupil. Its aims, it will be seen, are to at once put a stop to the loss of blood (*temporary treatment*), and then to so close the vessel that there will be no recurrence of it (*permanent treatment*). It is with the former that the Ambulance pupil has alone to do.

The "First-aid" Treatment of Bleeding.—It will be as well to consider the subject under the two heads of (*a*) *Internal* and (*b*) *External Hæmorrhage*, for in both kinds the Ambulance pupil may be of assistance.

(1) Internal Bleeding.

Under this come the three conditions of bleeding, from the lungs, from the stomach, and from the nose. The first, it will be remembered, is called *hæmoptysis;* the next, *hæmatemesis;* and the third, *epistaxis.* Some disease of the blood-vessels of lungs, stomach, or nose is very frequently the *cause* of such hæmorrhage, though *injury* may also cause it, as from blows on the chest and face.

Bleeding from the Lungs.—Blood from the lungs is usually of a scarlet colour, is coughed up in mouthfuls, and has a frothy appearance, from the air that has got mixed with it. It may come suddenly, and in a large quantity, as a basinful, or in a very limited amount, as mere streaks, and so may really be a "spitting of blood," as this form of bleeding is popularly termed. It very often occurs in the course of disease of the lungs, or where they are in any way congested, that is, with their capillaries very loaded with blood, as in heart disease or after any violent exertion, as running, singing, speaking loudly. It is an alarming occurrence, though fortunately very seldom suddenly fatal, and those around have time to give valuable assistance until the medical man is summoned, which he ought to be at once if the bleeding is profuse. If the amount is very slight, there is not the same urgency to send for him, but he should be *consulted* without any undue delay. As a rule, there is no great difficulty in recognising bleeding from the lungs. The gurgle in the throat, the loose cough, and the spitting of frothy red blood, all tell a bystander what is wrong.

The *treatment* in such cases is directed to encouraging those steps in the natural arrest of bleeding which have been already detailed, and which take place just the same within the body as in an external wound. Everything, then, should be done to favour the contraction of the bleeding vessel, and the formation of the "clot" which blocks its orifice. This is best done by laying the person down, with the head and shoulders raised on a pillow, and keeping him absolutely quiet in this position of repose. The patient should not talk or make the slightest exertion. Plenty of fresh air should be admitted, so that he should breathe a cool atmosphere, and, if the weather allows, this is best attained by opening the window. In addition, ice, if it is at hand, should be given to suck, and a cold cloth may be applied to the chest, all constrictions of clothing being removed. There are certain substances which, given internally, are supposed to have some effect in increasing the coagulating power of the blood. They are spoken of as astringents by some, and by others as styptics, though this last term is more generally applied to external applications. Several household substances have this reputation, of which vinegar and turpentine are the most generally used. These, accordingly, may be administered internally. A small tea-spoonful of vinegar in a little water, or 15 drops of spirits of turpentine in milk or white of egg, may be administered every half-hour, if required, up to four doses, should the doctor not arrive. The vinegar and turpentine might also be administered by inhalation,—a table-spoonful of the former, and a tea-spoonful of the latter being put in a jug of boiling water, and the steam breathed. Other substances, as common salt, alum, and the tannin in tea have their advocates; and if neither vinegar or turpentine were available, a strong solution of alum in cold water, or a cup of strong cold tea, with a lump of ice in it, might be given to the patient to sip. Should there be at hand any of *Ruspini's Styptic* (a patent preparation which seems to possess very remarkable powers in arresting bleeding), it might be administered instead of anything else. The dose of it is 5 to 30 drops in water for children, according to age, and for adults, 20 to 60 drops in water; this amount to be repeated in two hours if necessary. Lastly, there comes up the question of stimulants in these cases. If the loss of blood has been severe, faintness comes on, and the ghastly pallor of the patient impels those around to give brandy and other spirits. Great mischief often follows this course. The spirit acts on the heart, which beats with more force and vigour, and washes away the clots that have formed at the bleeding point. Fresh hæmorrhage takes place, the patient is further exhausted, the stimulant is repeated with the same effect, and eventually the patient sinks. In all these cases, then, of bleeding from the lungs, give stimulants with caution, using, preferably, Smelling Salts to the nostrils, remembering that the faintness that comes on is to some extent salutary, and that the chief reliance should be placed on quietness and rest, so as to lessen in every way the heart's action, and thus favour those changes on which the natural arrest of bleeding depends. No harm would follow applying warmth to the feet, while any nourishment that is given should be cold and small in quantity. An attack of bleeding from the lungs is always a shock to the system, both afterwards and at the time, and the patient naturally feels alarmed. It is seldom quickly fatal, so that a word of re-assurance as to the absence of any immediate danger may be given, and is often comforting in a great degree.

Bleeding from the Stomach.—This is commonly spoken of as a "vomiting of blood," and this fairly represents the attack. Like bleeding from the lungs, it is generally the result of some *disease*, as, for instance, an ulcer of the stomach which has opened into a blood-vessel. Its occurrence is preceded by faintness, accompanied by a feeling of weight at the pit of the stomach. As the loss of blood goes on, the face becomes pale, the pulse feeble, and sometimes the person faints quite away. As a rule, in a short time vomiting takes place, the quantity brought up being sometimes considerable. In character, it is usually of a dark colour, and it may even be coagulated and mixed with particles of food. Sometimes it has the appearance of "coffee grounds," and when this is so, it shews that the blood has been poured out slowly, and in small quantities, and has been acted on by the gastric juice. It is this fluid that darkens the blood, so that by this point alone it is often possible to distinguish between bleeding from the stomach and that from the lungs. Any one standing by would not have much difficulty in deciding on the case, but a patient is usually so alarmed that a clear account cannot always be obtained as to whether the blood was brought up by coughing or vomiting. Speaking generally, blood from the stomach is dark in colour, and is sometimes brought up coagulated, and mixed with bits of food, while the attack has been preceded by a sense of faintness and uneasiness in the stomach. Blood from the lungs, on the other hand, is florid and frothy, and is coughed up, any symptoms preceding being more referable to the chest, as cough and difficulty in breathing.

Although an attack of vomiting of blood is seldom immediately fatal, the "*first-aid*" *treatment* should be prompt, and is on the same lines as that laid down for bleeding from the lungs. The recumbent posture, perfect quiet, ice to suck, avoidance of stimulants internally should faintness come on, and the administration of vinegar, turpentine, or Ruspini's Styptic, are the lines to work upon. In such a case no food of any kind should be given, unless under medical advice.

Bleeding from the Nose.—This, of course, is common after injuries to the nose, as blows and falls, and in some cases is indicative of serious injury to the skull; but it is also a mere symptom of various conditions of the system, as in a full habit of body, to which it seems to afford a certain amount of relief. As long as the bleeding is moderate in quantity, it need create no alarm. It is usual for the blood to come from one nostril, but sometimes from both. Should the blood trickle backwards into the throat, then it is spat out, and is apt to cause alarm that it is from the lungs; while, should it be swallowed and subsequently vomited, the same anxiety is felt as to its being from the stomach.

"*First-aid*" *treatment* is called for only when the hæmorrhage seems unduly prolonged, and shews no tendency to cease spontaneously, as it usually does. The ordinary domestic remedy of *cold* to the back of the neck, in the form of a wet sponge or cold keys, and to the root of the nose in the shape of cold water cloths, generally suffices to arrest the bleeding, provided attention is paid to the position of the patient, who should, *on no account, hang the head over a basin,* but should sit on a chair or couch, with the head thrown slightly back. Any constrictions about the neck, as the collar or neck-tie, should be undone; and there is a widespread idea that elevating both arms to their full length above the head has a very powerful influence in arresting the bleeding. The patient should also be kept cool, and opening the window is helpful. If the bleeding still proves troublesome, and the person is at all of weakly habit and elderly, a medical man should be sent for. In the meantime, vinegar and cold water, or a solution of alum of the strength of a teaspoonful to a teacupful of cold water, should be sniffed up the nostrils or injected by a small syringe. Should these means be unsuccessful, then a strip of lint, soaked in cold water and squeezed dry, might be pushed into the nostril by means of any blunt instrument, such as a penholder or bodkin, pressure being made by the fingers from the outside on the nose. These are the only remedial measures I would advise the Ambulance pupil to undertake before the doctor arrives. When the bleeding stops, let there be no hurry to remove any clots from the nostrils, and let there be no vigorous blowing of the nose. Stimulants should only be given in exceptional cases.

While the above are the chief forms of *Internal Hæmorrhage*, there is another variety which in no way shews itself by any outward sign. It is often the result of injuries, as blows on the trunk, or falls from a height, and it is connected with the rupture of some one of the several vessels that go to supply the internal organs of the body. The indications of its occurrence have been already given when speaking of the constitutional effects of loss of blood on the system, as coldness of the surface, pale face, fluttering pulse, and sighing breathing. In such cases nothing further can be done than to keep the patient quiet in the recumbent posture, and to favour in every way the arrest of the hæmorrhage by nature's means. If the vessel that has given way is a small one, a clot may form, the bleeding may cease, and recovery take place; but if it is a large one, nothing can save the patient.

(2) *External Bleeding.*—The "*first-aid*" *treatment* of this form of hæmorrhage must be largely a repetition of what was said under the heading of how a surgeon would

act under such circumstances; for what he would do to *temporarily* arrest the flow of blood is what the Ambulance pupil must aim at being able to carry out. This question of hæmorrhage and how to treat it will be somewhat simplified for non-professional persons, if they will still keep up the analogy between the blood in the body and the water supply of a house. In each case there is a set of tubes with fluid circulating in them—blood in one case, water in the other. When a pipe in a house bursts, or has had a hole knocked in it, what is done, in the majority of cases, under the promptings of common sense? An attempt is at once made to stop the leak by local pressure of some sort, usually by pressing on the hole in the pipe with the *finger* until a piece of soap or wax, or some other substance that will close the opening, can be got; this again being supplemented by the pressure of a firm mass of cloths. In many cases this succeeds; but should it not, or should it seem that the burst is a serious one, an urgent message is despatched for the plumber. Until his arrival further steps are taken by the inmates to stop the escape of water in the shape of cutting off the supply from the main, by turning the usual stop-cock put for that purpose, or by flattening the pipe with a hammer, so as to let no fluid pass through it. This at once stops the supply of water to the whole house, and, consequently, to the leak. As soon as the plumber arrives he deals with the local burst, and then turns on again the supply at the main, as its absence is, of course, a great inconvenience. In a case of Bleeding in the human body a similar course should be pursued. First and foremost, *local pressure* by finger, and subsequently by a "*dressing*" of some sort, should be used—position not being forgotten, as well as the application of *cold* or *hot* water locally, if these are at hand, in the hope that their stimulus may contract the vessels, and favour the coagulation of the blood. Should these means prove unavailing and things seem serious, then an urgent message should be sent for medical aid, and the Ambulance

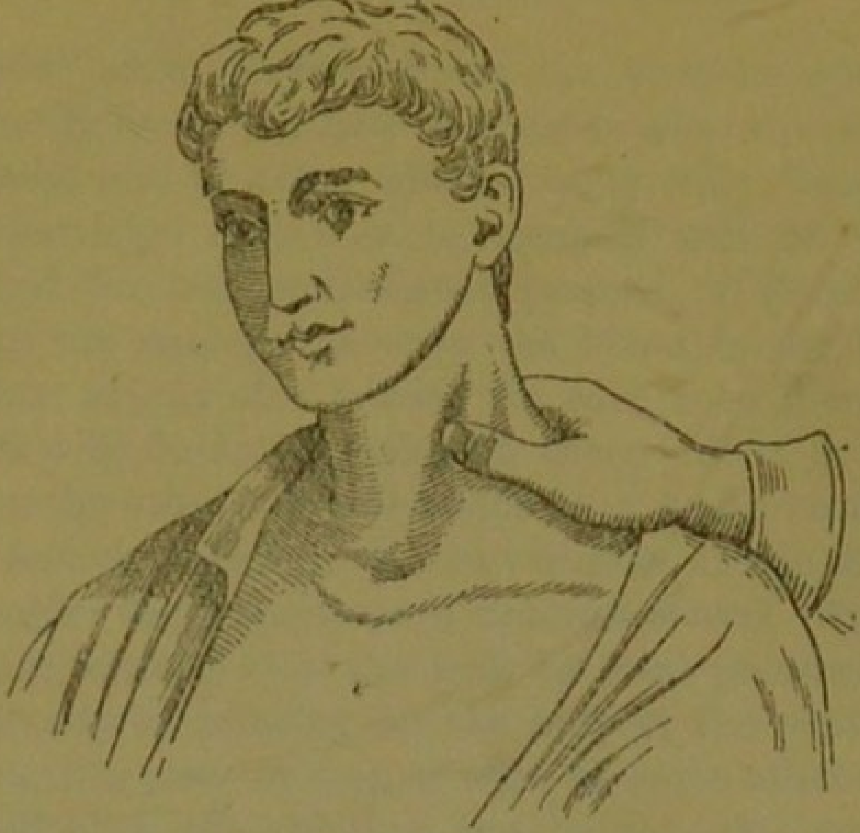


FIG. 62.

ARREST OF BLEEDING.—COMMON CAROTID ARTERY.

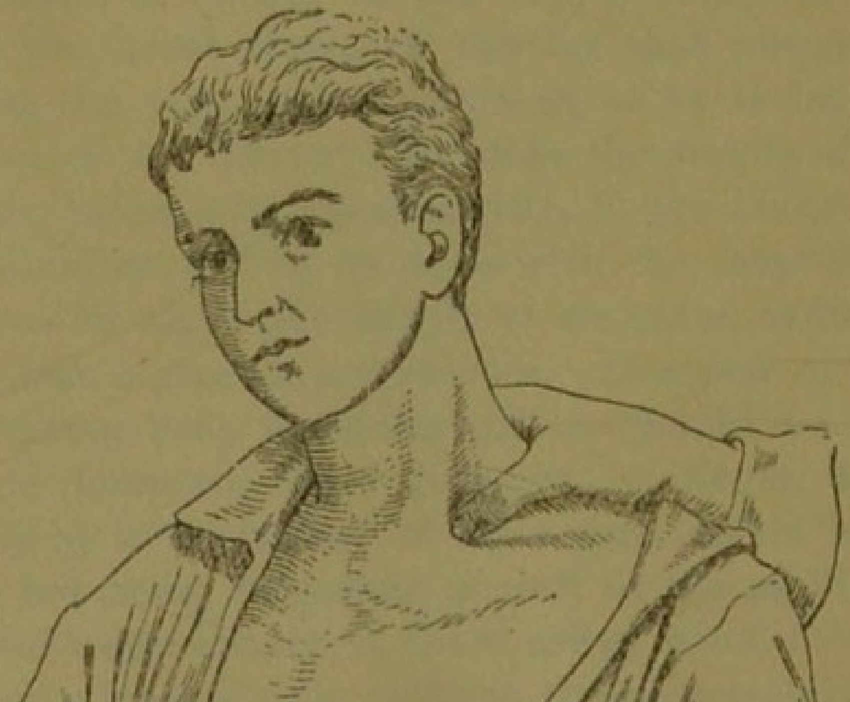


FIG. 63.

ARREST OF BLEEDING.—SUBCLAVIAN ARTERY.

pupil should at once proceed to cut off, by tourniquet (stop-cock) or "improvised" tourniquet (flattening the pipe), the supply of blood to the district in which the wounded vessel lies. When the doctor arrives, like the plumber, he will proceed to deal with the local bleeding, by ligature, or whatever means he deems best; and having made everything secure, he will then at once remove the tourniquet from the main vessel, as the other tissues cannot do without blood. He will also put a suitable dressing on the wound, and give all necessary instructions. From this it follows that the Ambulance pupil should know exactly where the main vessels can be compressed, just as the occupants of a house should know where the main pipe is.

Points where Arterial Circulation may be arrested by Pressure.—Taking the blood supply of the body, according to the districts mentioned in last chapter, the following are the points *where a hard support is furnished by bone underneath*, and where, consequently, pressure on the main arteries can be successfully carried out:—

The Common Carotid, supplying the district of the Head and Neck, can be compressed against the vertebral column on either side,—the pressure being made with the thumb inwards and backwards behind the wind-pipe, and on a level with the larynx. (See Fig. 62 and Fig. 24 of Triangular Bandage.)

The Subclavian, supplying the district of the Upper Limb, may be very effectually compressed against the first rib as it passes over it,—the pressure being made in a downwards direction behind the collar-bone in the "bird's nest" depression there. Pushing the shoulder and collar-bone forwards rather renders the procedure easier, and it is more convenient to stand behind the patient's shoulder and make the pressure with the thumb. (See Fig. 63 and Fig 25 in Triangular Bandage.) The Subclavian is usually compressed in wounds high up near arm-pit.

The Brachial artery, which is a continuation of the above, can be very easily compressed at any point against the humerus in its entire length on the inner side of the arm. (See Fig. 29 of Triangular Bandage.) It is the vessel usually compressed in wounds of fore-arm or hand.

The Femoral artery, which supplies the district of the Lower Limb, can be most certainly compressed just below Poupart's Ligament, against the ileo-pectineal eminence. (See Fig. 39 in Triangular Bandage.) Below this point, of course, it might be compressed against the femur as far down, perhaps, as the lower third of the thigh; but the thickness of the muscles prevents the fingers being used, and it would require all the compression of a tightly-applied tourniquet. The upper point is the one usually selected for pressure in wounds of lower extremity, as it commands all the vessels below.

The blood supply of the districts of the Chest and Abdomen are not accessible for pressure at the hands of the Ambulance pupil, and so no reference is made to them. In the same way no points of pressure have been given for the radial and ulnar or anterior and posterior tibial arteries, because in the one case the Brachial, and in the other the Femoral artery commands them, and pressure can be more readily and quickly made on these main vessels. Lines of direction have already been given for the chief arteries, so they need not be repeated here. It is not easy to give an exact idea of the size of the different arteries. By some the femoral is spoken of as being as big as the ring finger, the popliteal as a cedar pencil, and the radial and ulnar as goose-quills. This is rather an over-estimated view of their size; but the great point for the Ambulance pupil to remember is that, as they are the main channels in which the blood runs, when they are wounded or cut across, death may rapidly ensue, but that, as they are generally placed in sheltered positions, running very much under the protection of the bones, owing to the yielding nature of their walls, they can be so much compressed against these that no fluid will pass through them.

As to which method of distant pressure on the main artery the Ambulance pupil will adopt will depend on circumstances. Of course, digital pressure with the fingers must be *at once* resorted to if local pressure on the wound is failing, or if it is seen that from the quantity of blood escaping a large vessel has been divided. It would never do for the patient to be bleeding while a tourniquet was being sent for or improvised. The digital pressure may subsequently be exchanged for the screw, field, elastic, or improvised tourniquet, if any of these are at hand. Sufficient has been said about the mode of using these instruments that a further detailed account of them need not be given here, especially as a practical demonstration from the lecturer of *how* to apply them will be of greater service than any lengthy description. One or two words of caution may, however, be given, and that is not to use too much force when pressing with the fingers. Under the excitement of the accident the Ambulance pupil presses with so much energy that the fingers get soon wearied. Just as very gentle pressure with the foot will stop the flow of water through the garden hose when it is passing over the firm ground, so *moderate firmness* obliterates the lumen of an artery when pressed against a bone. Another point is, that if the *elastic tourniquet* is used it must not be too tightly applied. The india-rubber exercises so much *traction* that the tissues may be seriously compressed and great harm done. It has happened more than once that the elastic band has been so tightly applied by Ambulance pupils in their anxiety to make all secure, that the parts underneath it have never recovered their circulation and have consequently mortified. Great caution then should be exercised in the use of this valuable instrument, and it should be put on just tight enough to stop the flow of blood and nothing more. Any tourniquet put on the main vessel should remain on until the doctor comes, provided he does so within a reasonable time, say four to six hours, or until the patient has reached the hospital. Another point the Ambulance pupil should attend to is always thoroughly to *expose a wound* so as to get at it and have any local dressing properly applied. This may necessitate the removal of some of the patient's clothing, and the directions given in the chapter on fractures must be observed here,—all undue exposure of the body being avoided and care being taken not to needlessly destroy anything.

This chapter may be very appropriately ended by briefly applying to the various districts of the body, whose blood supply has been sketched out previously, the principles of treatment laid down for the arrest of *arterial bleeding*.

I.—District of the Head and Neck.

(*a.*) *Bleeding from the Tongue.*—Here reliance must be placed on ice to suck or *hot* water to rinse out the mouth, while the removal of all constrictions from clothing and a cool atmosphere to breathe, are also helpful, as in Epistaxis. Should the bleeding be severe, and apparently far back, pressure on the Common Carotid in the neck, as in Fig. 62, might be resorted to, as that would stop the flow of blood in the External Carotid, from which the blood supply of the tongue is derived.

(*b.*) *Bleeding from the Face.*—In connection with this, the great vascularity of the face must be borne in mind. It is its plentiful supply of blood that enables the face to bear so well exposure to all weathers without any protective covering. It is also the reason why cuts or wounds of that region bleed rather freely, and consequently create a good deal of alarm, especially in the case of a child who runs shrieking about and smearing the blood with its hands in every direction. Under circumstances like these a teaspoonful of blood makes a great show and naturally frightens every one. As a rule, in wounds of the face the use of cold or *hot* water for bathing them, followed by the *local pressure* of a dressing of wet lint firmly secured on by a bandage, will nearly always suffice to stop the hæmorrhage; but should this fail, pressure on the *Facial* artery, or main artery for the face, can be resorted to. The point most suitable for pressure is two fingers' breadths in front of the angle of the jaw, where the artery winds over the edge of the lower jaw to supply the face. (See Fig. 53). In hæmorrhage from the *lips,* which are very vascular and therefore bleed rather profusely, pressure should be made on the part by taking the lip between the forefinger placed inside and the thumb outside. On account of the disfigurement that may follow badly healed wounds of the face, always call in, in these cases, medical advice.

(c.) *Bleeding from the Head.*—Wounds of the scalp are often accompanied by severe hæmorrhage, but whether they are situated on the front, side, top, or back of the head, *local pressure* by a pad of lint as a rule suffices to arrest the bleeding, owing to the admirable support furnished by the bones of the cranium.

(d.) *Bleeding from the Neck.*—Should this come from a wound of the Carotid, the only thing to trust to is *pressure with the thumb*, and, as the current of arterial blood is upward toward the head, this should be made below the wound, as in Fig. 62. Owing to the important structures in the neck, nothing but *digital pressure* can be resorted to, and it must be maintained until medical aid arrives. Cases of attempted suicide furnish the greatest number of wounds of the neck.

II.—District of the Upper Extremity.

(a.) *Bleeding from the Hand.*—The blood-vessels of the fingers run very well protected along the sides of the fingers, and they are not so commonly injured. The most alarming hæmorrhage is from the palm of the hand, when the palmar arch has been wounded, as it often is in the dangerous accident of a bottle breaking in the hand while the cork is being drawn. In these cases *local pressure* by a firm pad in the hollow of the hand, with the fingers secured tightly over it by means of a bandage, and *elevation of the hand* in a sling, are the means to be first tried. If they fail, the blood supply of the part may be cut off by *forcible flexure of the elbow* or *compression of the Brachial artery* against the humerus by the hand or tourniquet of some kind.

(*b.*) *Bleeding from the Fore-Arm.*—Wounds of the fore-arm, if involving the radial or ulnar arteries, as happens often in falling through a glass window, are accompanied by severe hæmorrhage. If *local pressure* on the wound fails, the blood supply to the part must be stopped by *forcible flexure of the elbow* or by *compression of the Brachial artery* against the humerus by the hand or tourniquet. The latter is called for where the bleeding comes from a wound at bend of elbow.

(*c.*) *Bleeding from Upper Arm and Armpit.*—If the hæmorrhage is from a wound at the lower end or middle of the upper arm, there may be room for compressing the brachial artery at its upper portion by hand or tourniquet, but if the wound is high up in the arm or involving the region of the arm-pit, then recourse must be had to *pressure on the Subclavian*, as it crosses the first rib. This may be done by the thumb as in Fig. 63, page 206, but also by the handle of a door key wrapped round with lint or cloth.

III.—District of the Lower Extremity.

As the blood-supply of the Trunk is not amenable to ordinary "*first-aid*" *treatment* by the ambulance pupil, the only remaining district to notice is that of the Lower Extremity.

(*a.*) *Bleeding from the Foot.*—This may follow any injury, but the most common cause of it is treading on a piece of broken glass, as when bathing or wading. Under these latter circumstances the clothing is already off and *local pressure* with the finger can be at once resorted to, the finger being replaced as soon as possible by a pad or dressing of lint bound firmly on. Should this prove ineffectual to stop the bleeding it will be remembered that the *Anterior and Posterior Tibial vessels* enter the foot on the front and inside of the ankle-joint respectively, where they may be compressed by the finger and thumb or by two firm pads tied tightly on. If necessary, these means may be further supplemented by *forcible flexure* of the knee with a pad behind it (Fig. 60), or as a last resort the *Femoral* artery may be compressed in the thigh by an improvised tourniquet.

(*b.*) *Bleeding from the Leg.*—The arteries of the leg are very deeply placed for protection, one on the front and the other on the back of the shin-bone or tibia, so that it is not an easy matter to make sufficient *local pressure* on a wound of the leg to stop bleeding. Accordingly in these cases pressure with the fingers must be at once made on the *Femoral* artery at the groin, and then steps taken to arrest the hæmorrhage by *forcible flexure at the knee* with a pad behind it, or by an improvised tourniquet applied to the thigh.

(*c.*) *Bleeding from the Ham or Popliteal Space.*—The artery in the ham, or space behind the knee, is deeply situated, and though its presence is shown by the movement communicated to the limb when the knees are crossed yet it is difficult to feel its pulsation. When it is wounded, pressure on the Femoral with the fingers must be at once made until a tourniquet is applied in the thigh.

(*d.*) *Bleeding from the Thigh.*—When this is from wounds at or below its middle, the treatment is the same as that given for a wound of the *Popliteal* artery. Immediate digital pressure on the *Femoral* artery at the groin, followed by the application of an improvised tourniquet above the wound, and supplemented, if thought necessary, by *forcible flexure* of the thigh on the abdomen. When the bleeding comes from a wound very high up in the groin, giving no room for the application of a tourniquet, then reliance must be placed on *pressure with the fingers* until medical aid comes. It is in these cases that it is advisable to remember the advice to press with one thumb over the other, and not too forcibly, lest the fingers get tired.

Such, briefly, is an outline of the "*first-aid*" *treatment* of *Arterial* bleeding in the different regions of the body, and if the ambulance pupil has grasped its principles, there should be no difficulty in dealing temporarily with even a case of serious hæmorrhage. Fortunately, however, this latter is not of such common occurrence as the less grave variety known as *Capillary* bleeding, which accompanies the majority of cuts and is recognised by its red colour and by the free stream in which it flows from all parts of the wound. It is this variety of bleeding that will have to be most frequently dealt with, and it is satisfactory and encouraging to know that it nearly always can be thoroughly commanded by such *styptics* as cold air, cold water, ice, or their opposite, *hot* water, followed, if necessary, by *local pressure* and attention to *position.* No doubt there are other *styptics,* such as cobwebs, cold tea, tobacco leaf and cotton-wool, which are well-known household remedies, and act by increasing the coagulating power of the blood, but their use involves the risk of introducing septic or poisonous matters into the wound, and so they have not been so strongly recommended as many may think they should. They are, however, mentioned here as aids that may be kept in mind.

Bleeding from Veins.—A few words must be said on this subject as it often assumes a serious aspect, especially if from the bursting of, or injury to, a *varicose vein* of the leg. Many a death has occurred from this latter cause that very simple means might have averted. At the same time hæmorrhage from a cut vein anywhere in the body may prove fatal unless properly dealt with. The distinguishing characteristics of *venous* bleeding have been already given and the direction of the current of blood in the various districts of the body alluded to.

In the *Head and Neck* the *Jugular* veins may be wounded and direct pressure by the thumb *at the seat of injury and rather above it* must be made. As a rule, bleeding from even a large vein may be stopped by the thumb, and this local pressure also prevents the admission of air into the vein, which is a serious matter should it occur.

In the Upper Extremity.—Any of the superficial veins or of the deeper ones accompanying the main arteries may be injured, when *local pressure* on the wound, together with pressure *below* it if necessary, should be made. When bleeding was so much in vogue it was one of the superficial veins at the bend of the elbow that was usually opened, and the treatment adopted to stop the flow of blood was the pressure of a pad bound firmly on the wound, the fore-arm being bent at the elbow and raised.

In the Lower Extremity.—It is in the lower limb that *varicose veins* are generally found, as in cooks, laundresses, and others who have much standing. These varicose veins are often of great size, and if one of them bursts or gets cut an immense volume of dark bluish blood flows out. The current of venous blood being upwards in the leg, the greater quantity should come from the end of the vein away from the heart; but as the vein is so much dilated its valves cease to work and, consequently, the whole column of blood above falls backwards and comes out at the wound, so that many hold that the chief source of the bleeding is from above. The rule accordingly in treating *venous bleeding* of the lower extremity is, that while ordinary wounds of veins should have a pad *on the wound and one below*, in the case of a cut or ruptured *varicose vein* pressure should be made not only on the wound but also *above and below it*, so as to completely control the source of the hæmorrhage. In conjunction with this, of course, the limb should be raised.

Treatment of Compound Fractures.—These are fractures accompanied by a wound and so open to the possibility of hæmorrhage. Should it occur, it must, of course, be treated on the same principles as in a wound of the soft parts; but the existence of the fractured bone does not always allow of the necessary amount of *local pressure*. Accordingly, should cold, gentle pressure with a suitable "first dressing," and elevation of the first part, not suffice to stop any bleeding, it is preferable to compress the main vessel above the wound by an improvised or other form of tourniquet. Of course, in many cases of compound fracture the wound is of the *lacerated* variety, in which the bleeding is scanty owing to the blood-vessels being twisted; but sometimes the hæmorrhage is free, and then no time should be lost in *commencing digital pressure on the main artery*, and this should not be relaxed until a tourniquet has been applied. The subsequent steps in the procedure are the proper exposure of the wound, the application of a suitable "*first-dressing*," and the preparation of splints, as already explained in the chapter on Fractures.

CHAPTER IX.

RESPIRATION.

"And the Lord God formed man of the dust of the ground, and *breathed* into his nostrils the *breath* of life, and man became a living soul."—Gen. ii. 7.

THE first thing any of us ever did in this world was *to draw a breath*, for without doing so existence would not have been possible. In the same way, as soon as we cease to do so, life comes to an end. Why this should be so, it is the purpose of the present chapter to explain.

From what has been already stated in the chapter on the Blood, it is quite evident that this fluid must be freed from the impurities poured into it. This necessary purification of the blood is accomplished by the process of Respiration, which may be defined as *The function by which oxygen is absorbed into the Blood, and Carbonic Acid given off.*

To understand the necessity for this Respiratory process, it must be remembered that the leading feature of the chemical changes that go on in a *living* body is of the nature of a burning up or *combustion* of the tissues, as shewn by the production of bodily heat. To allow of this combustion going on and continuing, a certain amount of oxygen is absolutely required, just as an ordinary fire could not burn if no air, or in other words, no oxygen reached it. But it is also a well established fact, that there can be no combustion without the formation of waste products, one of the chief of which is carbonic acid. The tissues of the body are no exception to this latter law, and they freely give off carbonic acid as one of their waste products. Proof of this can be furnished by examining the blood in an Artery *going to*, and in a Vein *coming from* any part of the body. From a pint of each of these varieties of blood, about half a pint of gas could be obtained by means of the air-pump, but there would be a great difference in the composition of the respective gases. That obtained from the Arterial blood would be made up of some Nitrogen, a good deal of Oxygen, and a considerable quantity of Carbonic Acid, while that got from the Venous blood would be composed of some Nitrogen, but of only half the amount of Oxygen, with a corresponding *increase in the amount of Carbonic Acid.* From this it is quite apparent that as the result of nourishing the tissues the Blood has lost Oxygen and gained Carbonic Acid. In fact, it is the presence of this large amount of the latter gas that constitutes the chief difference between Arterial and Venous blood, aud accounts for the difference of colour between the two.

There is then going on in every part of the body a conversion of the red Arterial into dark Venous blood, owing to the tissues using up, or breathing, as it were, the Oxygen of the blood, and pouring back into it the waste products of combustion, in the form of Carbonic Acid and other substances. As long as this interchange of gases goes on regularly, everything works smoothly; but if it is in any way interrupted, and the blood that comes to the tissues contains no Oxygen, then combustion ceases, the nutritive changes stop, there is a complete slowing, if not an entire cessation, of the machinery of the body, and death results. The problem then is how to get rid of this excess of Carbonic Acid and at the same time obtain a steady and regular supply of that Oxygen which is so absolutely essential. Both these objects are accomplished by the process of Respiration, the mechanism of which will be rendered clearer by a short preliminary account of the Respiratory Apparatus.

The Respiratory Apparatus.—This consists of three distinct portions, the larynx, the trachea, and the lungs. (See Fig. 64).

The *Larynx* is situated at the commencement of the Respiratory apparatus, and is joined to the Trachea, on which it stands like a statue on its pedestal. It is really a

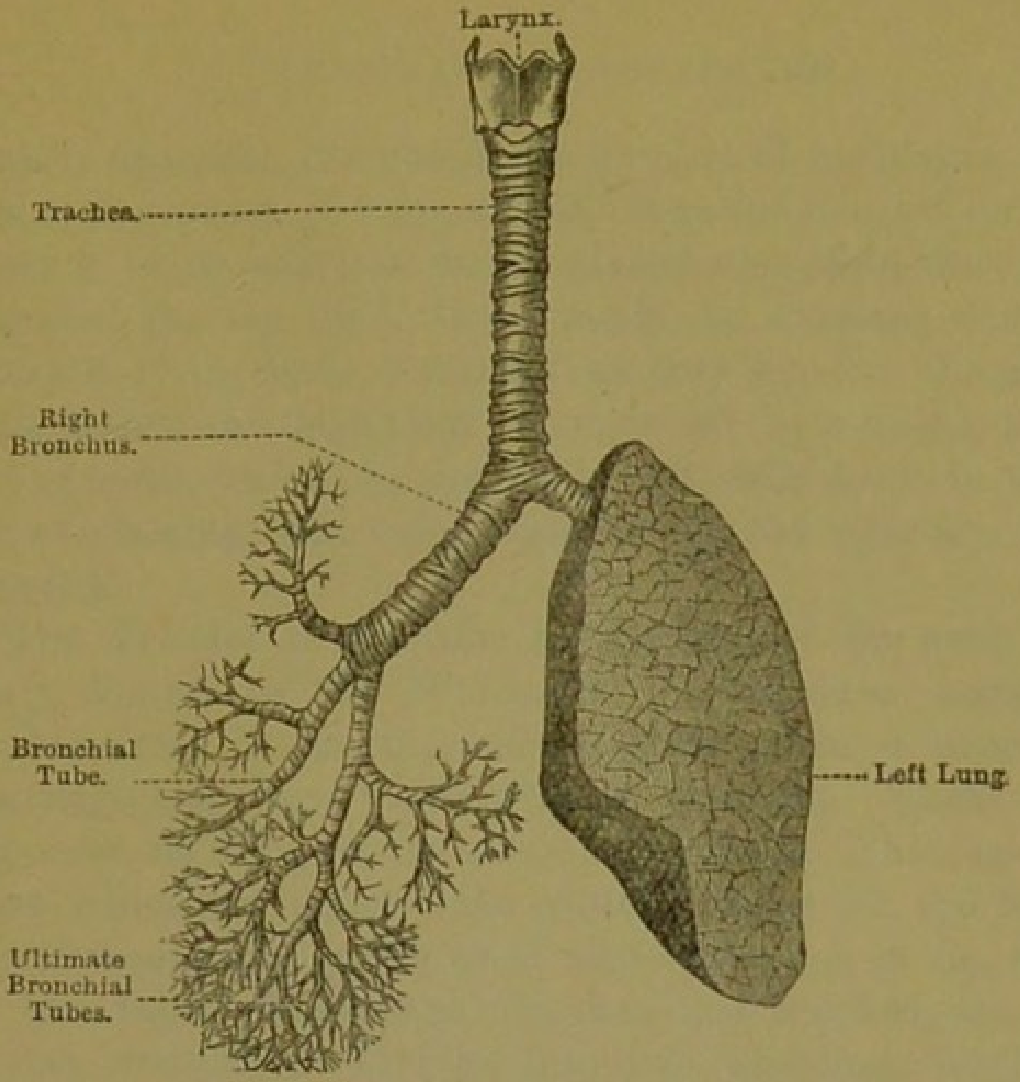


FIG. 64.—THE RESPIRATORY APPARATUS.

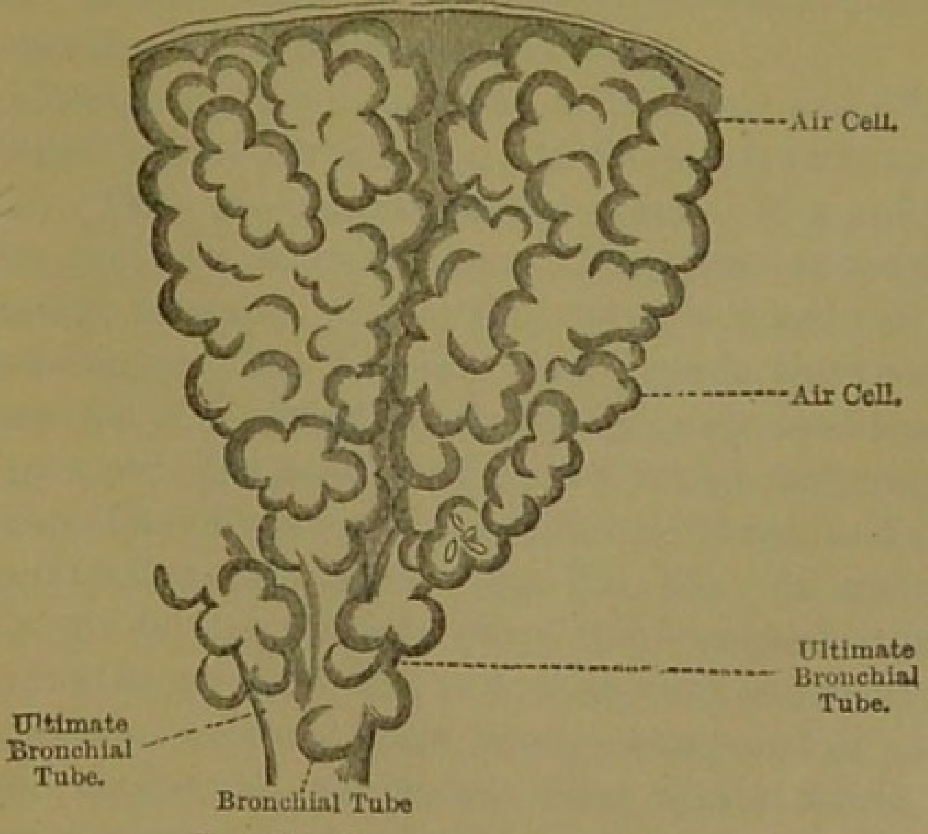


FIG. 65.—STRUCTURE OF THE LUNGS.

box or chamber, composed of a number of cartilages, which holds the organs of voice and the muscles that act on them. Owing to its entrance being placed alongside that of the channel for the food, there would be constant danger of morsels of the latter finding their way into it. To prevent this there is an ingenious arrangement by which a kind of lid or cover, known as the Epiglottis, falls down in the act of swallowing, and completely covers the aperture of the Larynx.

The *Trachea* is the tube in the front of the neck popularly known as the Windpipe. It measures some five inches or so in length, and is made up of a number of cartilaginous rings which give it firmness. These rings, however, do not pass the whole way round. Their posterior part, which lies against the gullet or tube for the food, is membranous and so allows of some variation in the calibre of the tube. When the Trachea has reached the third dorsal vertebra it divides into two branches, which are called the Right and Left Bronchus, and they pass respectively to the Right and Left Lungs, in which each of them further divides and subdivides into numerous smaller branches known as the Bronchial Tubes.

The *Lungs* are two in number, a Right one and a Left one, the former having three lobes, and the latter only two. (See Fig. 2.) They are conical-shaped organs, of a soft spongy texture, and of a pinkish colour. They possess the property of floating in water, and so they have received the popular designation of "the Lights." As regards their structure, they consist of a collection of small minute bladders or *air-cells*, grouped, like bunches of grapes, round the terminations of the smallest divisions of the bronchial tubes, and in direct communication with them. (See Fig. 65). In consequence of this, air finding its way down the bronchial tubes must pass into the air-cells, and it does so with sufficient force to *distend* them, for their walls, though composed of a thin and delicate membrane, yet contain some elastic fibres, and in this way possess both *elasticity* and *distensibility*. Over these elastic bladders or air-cells is grouped a close net-work of small arteries, veins and capillaries, so that each individual air-cell has a covering of blood-vessels arranged around it in much the same way as the net-work of red string that is so commonly placed over children's india-rubber balls. By this arrangement the air that is in the air-cells and the blood that is in the blood-vessels stretched over them are only separated from one another by the delicately thin walls of the air-cells and blood-vessels respectively, and consequently this allows of an inter-change of gases between the air and the blood. In fact, the whole aim of the structure of the lungs is to ensure as large a surface of blood as possible being brought into contact with as large a surface of air, and there is no doubt this object has been most successfully attained, the extent of the vascular net-work of blood-vessels and the number of air-cells in the lungs being almost fabulous.

The Mechanism of Respiration.—It will be remembered that the chest or thorax is bounded laterally by the Ribs, behind by the Vertebral column, and in front by the Breast-bone, while the muscular Diaphragm shuts it off below from the rest of the Trunk. Although, when completely closed by the soft parts, it is practically an air-tight cavity, yet its walls are not entirely rigid and immovable. On the contrary, they are capable of such movement that they can enlarge the chest in all directions, that is, downwards, forwards, and from side to side. Now, within the chest lie the Lungs, and they fit the cavity so closely that, if any increase in its size takes place, they undergo a corresponding expansion, with the result that more air rushes in to fill the increased space created by their distension. Subsequently, when the chest resumes its original dimensions, the Lungs are pressed on and a corresponding quantity of air is forced out of them. This is exactly the condition of things that takes place in the two movements of Inspiration and Expiration, which go to make up the process of Breathing. Every act of breathing consists of three periods:

(1) Inspiration, (2) Expiration, and (3) a Pause, of which Inspiration is shorter than Expiration, owing to the air finding more ready admission into the lungs than escape from them. The Pause follows Expiration and is very faintly marked, being quite absent in rapid breathing. *Inspiration* admits air into the chest, and this it does by enlarging the chest in all its diameters. The increase *downwards* is brought about by the contraction of the Diaphragm or floor of the chest. This muscle when at rest has an arched shape, but as soon as it contracts it descends and becomes flat, increasing the capacity of the chest from above downwards. The enlargement *forwards* and *from side to side* results from a rotation and elevation of the ribs by the muscles which pass between them, and are known as the Intercostals. Owing to the oblique position that these bones occupy, the effect of this double movement is to throw them out sideways, and to thrust the Breast-bone forwards, so that greater space is obtained in the two directions named.

In *Expiration* the reverse of the above takes place. By the ascent of the Diaphragm, together with the fall of the Ribs and Breast-bone, all the diameters of the chest are diminished, and air is expelled from the chest.

From what has been said of the relation of the Lungs to the chest walls, it follows that these organs accommodate themselves to any variations in the size of the thorax, so that when they dilate along with the chest in Inspiration air rushes into them, and similarly when they contract again in Expiration air is forced out of them. In this way there is a constant admission and rejection of air into and out of the lungs,—ordinary tranquil Breathing taking place some 15 to 18 times per minute. As to the amount of air taken in every time we breathe, it may be estimated at about as much as would fill a *pint* measure, a similar quantity being given out at each expiration. It must not be thought that the Lungs empty themselves of air at every breath. The very reverse of this is the case. A large amount of air always remains in the lungs, and as it does not move it is termed the *Stationary air*, just as that which is constantly passing in and out of the chest is called the *Tidal air*, because, like the tide, it comes in and goes out. When we speak of the Chemistry of Respiration, we will see that it is this *Tidal air* which serves to purify the *Stationary air*.

The Cause of the Respiratory Movements.—One has only to hold one's breath for a short time to feel a certain amount of discomfort and an irresistible desire to take a deep inspiration. The reason of this is, that the movements of Respiration are *involuntary*, and go on independent of the will, although we can hasten them if we wish. What calls them into play is *the excitation or irritation of a distinct Centre or spot in the Nervous System.* As long as this Centre is stimulated, it sends forth nerve energy and dispatches an order to the Diaphragm to contract and to the Intercostals to elevate the ribs, so as to enlarge the chest. The stimulus that acts most powerfully on this Centre is Venous Blood, so that when blood loaded with Carbonic Acid comes *directly* into contact with it it is immediately excited, and it sends forth its messages to the Respiratory Apparatus to carry on its work of alternately dilating and contracting the chest. If this command is voluntarily resisted for any length of time, then an uncomfortable feeling arises and one is, as it were, compelled to take breath. From this it is quite clear that a constant command is transmitted to the Respiratory Apparatus to execute its movements, and that this is done apart altogether from our will, so that our Breathing, like the work of the Heart, goes on independent of us, thus allowing us to lie down to rest, and engage in the everyday duties of life without troubling ourselves about it. At least, this is the case as long as Breathing is "ordinary" and "tranquil," and is carried on simply by the Diaphragm and the Intercostal muscles. But there are occasions when greater respiratory efforts are required, as when we are engaged in any active exercise or exertion, or when there is a very venous condition of the blood, as in asthma and other diseases. Under these circumstances, muscles not ordinarily employed in Breathing come into play, and we have Forced or Laboured Respiration. In the same way there are two minor varieties of Breathing that may be alluded to here. They are possible, inasmuch as the chest can be enlarged in two ways, either by the elevation of the ribs or the descent of the Diaphragm. The former is called *Costal* breathing, the latter *Diaphragmatic*. They may go on to a large extent independent of one another, and the advantage of such an arrangement is seen in the case of fractured ribs, where we restrain to a large extent the movements of the chest walls by a firm bandage, and yet the thorax dilates, thanks to the working of the Diaphragm. If we compare a man's breathing with that of a woman, it will be observed that the type of the former is Diaphragmatic and that of the latter Costal, as shewn by the more apparent rise and fall of the chest walls.

Having thus explained how it is and why it is that there is a steady flow of air into and out of the chest, the next point to consider is how the Tidal purifies the Stationary air in the lungs. This is essentially a chemical process, and brings us to what may be called the Chemistry of Respiration.

The Chemistry of Respiration.—To understand the process of purification, the composition of ordinary air must be kept in mind. It is really a mechanical *mixture* of about 21 parts of Oxygen and 79 parts of Nitrogen gas, with a faint trace of Carbonic Acid, and a small amount of watery vapour. The *tidal* air that enters the chest in every act of breathing has this proportion of gases, provided the atmosphere around is healthy. As soon as it enters the chest, it mixes or mingles with the *stationary* air that is present in the lungs. This it does by the law of the diffusion of gases, in virtue of which gases of different weight or density freely mingle with each other and become thoroughly mixed. It is not altogether easy to realize the working of this extraordinary yet beautiful law of Nature.

When liquids of different density, as oil and water, are mixed together, they will never blend. Shake them together as much as one likes, they always separate as soon as they come to rest, the oil, as the lighter of the two, floating on the top. The very opposite of this occurs with gases of different weight, and they freely mix with one another. Thus, if a globe of light hydrogen gas was placed above a globe of heavy carbonic acid, and connected with it by a glass tube, the two gases would ascend and descend through the tube, the carbonic acid going up and the hydrogen coming down, until there was as much of each gas in one bottle as in the other. It is by this same law that the air introduced through an open window mingles with and diffuses itself through the air already in a room, serving to ventilate or purify it. The *tidal* air, then, having been introduced by the act of Inspiration, as far probably as the trachea and larger bronchial tubes, finds its way into the deeper parts by this law of diffusion. Now, the *stationary* air lies in close contact with the venous blood in the capillaries surrounding the air-cells, and the walls of both of these are so thin and delicate that they allow of gases passing through them. As the result of this we find that the *stationary* air parts with its Oxygen to the blood, and receives instead Carbonic Acid, thus becoming more and more impure. It is this that makes it absolutely necessary that there should be some means by which it can get a fresh supply of Oxygen, and have its Carbonic Acid removed. This it does by means of the *tidal* air, which furnishes Oxygen to it, and takes away its Carbonic Acid. In this way it is continually being purified.

Under these circumstances it should follow that the air breathed out of the chest in Expiration should have less Oxygen and more Carbonic Acid than that which goes in on Inspiration. And we find that this is the case. Instead of possessing 21 parts of Oxygen, Expired air has only 16 parts, and instead of having only a trace of Carbonic Acid it has 5 parts of this gas. The presence of this Carbonic Acid may be demonstrated by the simple experiment of breathing into a glass vessel containing clear lime-water. The water immediately assumes a turbid or milky appearance, from the formation of the white *carbonate of lime*, due to the presence of the Carbonic Acid evolved by the lungs. Besides Carbonic Acid, *Expired air* carries off some ammonia and other substances of a poisonous and harmful nature, while at the same time its temperature is raised, and it becomes saturated with watery vapour. One has only to breathe on a looking-glass or bright steel knife, when this watery vapour shews itself in the form of dew deposited on them, and one has only to blow into one's hand on a cold day to feel the extra warmth of the air breathed out. As regards this last point, it may be mentioned here that there is a special arrangement in the Respiratory Apparatus for warming the air before it goes into the chest. This apparatus consists of a series of bony plates covered over with numerous blood-vessels and coiled up, as it were, within the nostrils. When the chest expands air is drawn into it, as into a pair of bellows. This air enters the nose first, and passing over these bony plates in the nostrils they impart heat to it, just like the warming plates in a stove, so that by the time it diffuses itself through the *stationary* air it has lost much of its coldness. A consideration of this fact should teach us the importance of breathing through the nostrils and not through the mouth in very cold weather, and it also explains how babies run a certain amount of risk by long crying in the open air on cold days, for in crying they breathe through the mouth and thus inspire largely the chilly air, which may so cool down the temperature of that already in the lungs that these organs may suffer, bronchitis or inflammation being set up.

The following, then, is a brief summary of the leading facts connected with Respiration. The object of the function is to introduce Oxygen into the system, and get rid of Carbonic Acid. To accomplish this there is a Respiratory

Apparatus, which consists of air-passages—the nose, pharynx, larynx, trachea, and bronchial tubes—communicating with an immense number of small sacs, or air-vesicles, filled with air, and covered externally by a dense network of blood-vessels. This apparatus is placed within the chest or thorax, which acts like a bellows, alternately contracting and dilating, and thus moves the air within the lungs. These movements of the chest walls are the result of nerve energy, and are usually carried on by the diaphragm and intercostals at the rate of 15 to 18 a minute; but under special circumstances supplementary muscles are called into play, and the number of respirations are increased. At each inspiration about a pint of air (called *tidal*) enters the lungs, and mingles with the air (called *stationary*) that is always present in these organs. The changes that take place in the air thus breathed are that it becomes warmer, gets saturated with aqueous vapour, loses its Oxygen, and absorbs several harmful substances, of which Carbonic Acid is the chief. After being in contact with the air in the lungs, the blood in the capillaries that surround the air-cells is materially affected and it loses heat, watery vapour and Carbonic Acid, gaining instead an increase of Oxygen. The result of all these physical and chemical changes in the lungs is that the Venous blood is returned from these organs to the left side of the heart rich in Oxygen, for conveyance round to the different tissues.

It remains now to draw some practical lessons from the above facts, and the first one is *the necessity for a constant supply of Oxygen to the stationary air in the lungs.* If this does not take place, a very definite train of symptoms follow. First of all, the ordinary breathing becomes hurried, and assumes the character known as Laboured, which is characterized by increased respiratory movements, both of Inspiration and Expiration. Should the Oxygen starvation continue, in about a minute and a-half this condition passes into what may be called a Convulsive stage of short duration, in which the efforts of Expiration are most marked. In about a minute this stage is followed by that of coma or exhaustion, the leading features of which are insensibility with slow deep inspiratory efforts, which eventually become feebler and gasping, until at last the breathing altogether ceases and death ensues. To this latter series of symptoms the term *Asphyxia* has been given, from two Greek words, *a* = not, and *sphyxis* = pulse, so that when we speak of *Death from Asphyxia*, we mean death from a kind of suspended animation, due to "Oxygen Starvation,"—the supply of Oxygen to the lungs being either diminished or entirely cut off, and the Carbonic Acid retained in the blood. The explanation of the symptoms enumerated above is quite simple. If no Oxygen gets to the *stationary* air in the lungs, as soon as that which it contains is used up, the Venous blood coming to the lungs is no longer purified, and returns in an impure state to the left side of the heart, from which it is driven through the body. The effect of Venous blood circulating through the tissues, is to stimulate the Respiratory centre in the nervous system, thus causing hurried breathing. If still no Oxygen gets admission, the blood becomes more and more venous, and the Respiratory centre is stimulated to such an extent that a convulsive condition is set up. The effect, however, of this over-stimulation on the Respiratory nerve centre, is to exhaust it, and it becomes more or less paralyzed, in consequence of which the chest movements get slower, and in from 3 to 5 minutes stop, the heart, also, in a few seconds afterwards ceasing to beat. No doubt the heart is enfeebled by the action of the Venous blood on its muscular fibres, but the real cause of death in these cases is *paralysis of the heart* from over-distension with Venous blood. It should perhaps be noted that it is only when the deprivation of Oxygen is sudden that all the above phenomena shew themselves. Where the venous condition of the blood is produced slowly, Asphyxia may occur without any sign of hurried breathing, and death may occur very quietly and gradually. Some of the circumstances that give rise to sudden deprivation of

Oxygen, such as Drowning, Hanging, and the Breathing of Poisonous gases, will be considered in the next chapter with their appropriate treatment; but it may not be out of place to close this present chapter with a few words on the great lesson that it teaches—namely, the importance of Ventilation as bearing on the matter of Health. When we remember the need the system has for a sufficiency of Oxygen being introduced at each breath, and think of the impurities given off by every expiratory effort, we can realize how necessary it is to have a renewal of the air of any room in which we may be placed for any time, and what ill effects and even disease may be engendered by breathing and re-breathing an atmosphere loaded with harmful gases and products of a deleterious nature. In fact, a great deal of ill-health results from want of attention to this matter, and not unfrequently painful illustrations of the general ignorance that prevails upon the importance of fresh air occur from time to time. One notable instance is that of the tragedy enacted on board the steamer "Londonderry," sailing between Liverpool and Sligo. While on one of her voyages, stormy weather came on, and the 200 passengers were sent below into a cabin 18 feet long, 11 feet wide, and 7 feet high. Crowded together in this narrow space with the hatches fastened down, they soon used up all the Oxygen of the air, and before they were released the appalling number of seventy-two were dead, while many others were in a dying condition, and eventually succumbed. A tragic experience of this kind brings home forcibly the fact that the interchange of Oxygen and Carbonic Acid that takes place in breathing is not the simple occurrence we are apt to consider it, but that it may be fraught with consequences immediately fatal as well as slowly detrimental to health. This is not the place to enter on the bearing this question has on the general health of the nation; but it should be the aim of every one in authority, both in the workshop, the factory, the school-room, the dwelling-house and (above all) in the sick-room, to see that the air within is kept as pure as the air without.

CHAPTER X.

DROWNING AND SUFFOCATION.

O Lord! methought what pain it was to drown!
What dreadful noise of water in mine ears!
What sights of ugly death within mine eyes!
Methought I saw a thousand fearful wrecks;
A thousand men that fishes gnawed upon;
Wedges of gold, great anchors, heaps of pearls,
All scattered in the bottom of the sea.

King Richard III., &c. &c.

As to whether the sensations felt while drowning are of a painful or pleasant nature, there seems to be a difference of opinion. Shakspeare's lines just quoted would make us take the former view, while Captain Marryatt would have us believe the opposite, for in his life he tells us that "the first struggle for life once over, the water closing round me assumed the appearance of green waving fields. There was no feeling of pain, but more like sinking down, overpowered by sleep, in the long soft grass of a cool meadow." This, however, is not the subject for consideration in the present chapter. It is the much more practical one of the "*first-aid*" *treatment* of cases of Suspended Animation, of which those the result of Drowning are, after Fainting, the most common. This is brought out by the following table, which embodies a general analysis of the 17,000 fatal accidents that occur annually in the United Kingdom:—

Mode of Death.	Number.
Drowning,	3,700
Falls,	2,200
Street Accidents,	2,000
Burns,	1,500
Railways,	1,200
Mines,	1,000
Poisons,	400

By the term *Suspended Animation* is meant a condition in which all the usual manifestations of life are at a stand-still, so that the person lies motionless and unconscious, with the breathing stopped, and with scarcely any perceptible evidence of the heart's action. It may be due to *Fainting*, or to *Failure of the Respiratory function*, this last giving rise to that series of phenomena, described in the last chapter, to which the general term "Asphyxia" has been given. Between Fainting and Asphyxia there is this very important difference, that in the former the lips and mucous membrane are pale and bloodless, while in the latter they are somewhat livid and dark coloured. Just as Fainting may arise from several causes, so may Asphyxia; and we find that the failure of Respiration which occasions it may be due to any of the following:—

1. Mechanical obstruction of the air-passages from foreign bodies in them, as in choking, or from external pressure, as in hanging.

2. Breathing irrespirable or poisonous gases, as carbonic oxide, sulphuretted hydrogen, &c.

3. Immersion in water or other liquid medium, as drowning.

The above are the chief forms of Suspended Animation that the ambulance pupil may be called upon to treat, so attention will be confined to them; and as Drowning is the cause of more accidental deaths in this country than anything else, it may be as well to take it up first, considering, in the first place, what exactly the expression *Death by Drowning* implies, and, secondly, the best means of treating such cases.

DROWNING.—When any one tumbles into a river or other water and is "*drowned*," what is meant by the expression is that the person has been suffocated from want of air, the fluid in which he has been immersed offering a physical impediment to its introduction into the lungs. The effect of the air not getting entrance is that the Venous blood does not become aerated and is sent back impure to the left side of the heart, from whence it is pumped out through the body. As a result of this vitiated blood circulating through the tissues there is quickly developed the condition of "Asphyxia" or pulselessness, the leading features of which, it will be remembered, are that Respiration and all the other functions have apparently ceased, while the heart, distended on its right side with Venous blood, is still pulsating so feebly as not to be felt, and the small arteries are so contracted that the passage of the blood through the capillaries is quite prevented. For a short time the action of the heart goes on, even though the Breathing has ceased, but if relief does not come quickly, it, too, stops, and Death takes place.

The fatal issue then, in cases of drowning, is due *primarily to a want of Oxygen*, for it is the absence of this gas that sets in motion those secondary symptoms that actually cause death. This fact is not sufficiently borne in mind, and amongst many, even in the present day, there still lingers the idea of our forefathers, that in Drowning death results from the body being full of water. Probably these people are not prepared to put into practice the old barbarous plan of treatment, founded on this doctrine, of hanging the drowned person up by the heels to let the water drain out, yet they are inclined to be dilatory in carrying out the treatment that modern scientific investigation has shewn to be correct, because they do not quite see how it can be beneficial. This is unfortunate, as the treatment of the apparently drowned should be carried out *instantly* without a moment's delay. The aim of all treatment should be to deal with the condition of Asphyxia which has developed during immersion, and which will prove fatal if not relieved. How then is recovery from Asphyxia best accomplished? First of all, by removing the cause of it. That is to say the man found hanging must be cut down, the person overcome by poisonous gases must be removed into the open air, and the drowning man pulled out of the water. Secondly (and this point is most important), by establishing Respiration. In this way Oxygen is introduced into the lungs, and if the heart has not entirely ceased its movements, the necessary interchange of gases will take place. As soon as this interchange begins, and it is evident that the Respiratory centre is recovering, then everything should be done to stimulate the circulation by friction, warmth and the cautious administration of stimulants. In short, the aim of all "*first-aid*" *treatment* of those apparently drowned is to procure the admission of air to the lungs and not to waste time in trying to empty water out of the body. No doubt a certain amount of water is swallowed and finds its way into the minute air-tubes and cells of the lungs by the violent efforts at breathing that are made during immersion, but the quantity is nothing so great as is generally supposed, and does not call for any special measures to obtain its removal beyond a brief reversal of the body into the prone position. The worst effects produced by this water are, that it develops a good deal of frothy mucus in the air passages and renders the lungs physically incapable of receiving or expelling air themselves. In this way it lessens the chances of recovery, but it in no way demands any modification in the "*first-aid*" *treatment.* As already said, the aim of this is to re-establish Respiration.

To understand how, under the circumstances, this can be best accomplished, it is necessary to revert to what was said in the last chapter about the Mechanism of Respiration. It was there shewn, that the movements of Inspiration and Expiration caused an enlargement and diminution in the size of the chest, and that the lungs filled and emptied with every dilatation and contraction of that cavity, so that, in reality, the distension and subsequent emptying of the lungs are entirely dependent on the chest movements. If these latter cease, so do the former. This is what happens in the Asphyxia due to drowning; and in the unconsciousness that marks that condition, there is no prospect of their being spontaneously resumed. Until they do so, there is no chance of resuscitating the person drowned. Nothing then is left but to take means to mechanically enlarge the chest, and so compel air to enter it,—in other words, to do *artificially* what is accomplished *naturally* and involuntarily in health. This is known as *performing artificial respiration.* At first sight it may not seem possible, but fortunately it is so, and medical men, by studying how the respiratory machine works, have devised several methods by which, if efficiently performed, air must enter the lungs. The three best known plans are (1) Dr. Benjamin Howard's "Direct Method;" (2) Dr. Marshall Hall's "Ready Method;" and (3) Dr. Silvester's Method. In America, Howard's "Direct Method" is thought to be the best, and has been adopted by the United States Government Life Saving Service, and by other societies; but in this country Silvester's is regarded as the most efficient, and it is the one that the St. Andrew's Ambulance Association has at present sanctioned. It is also the one advocated by the Royal Humane Society, and by the Royal National Life-boat Institution. Howard's method is performed by kneeling like a rider astride the body, and making rhythmical compression of the chest and abdomen with the hands. Its strong point is, that it is said to keep the passage through the larynx free, without the aid of any assistant or any contrivance for the purpose. In Marshall Hall's ready method, the body is placed on one side, and alternately rolled on to its face to compress the chest, and on to its back to give the elasticity of the ribs play. By placing the patient on the face, the weight of the body forces the air out; when turned on to the back, this pressure is removed, and air enters the chest (see Figs. 66, 67). In the absence of any assistance, this is probably the best form of Artificial Respiration to carry out. Silvester's plan aims at imitating the movements of breathing by traction on the arms. The operator, standing at the patient's head, grasps the arms just above the head, and *keeps them stretched* upwards for two seconds. By this means air is drawn into the lungs. He then turns down the patient's arms, and presses them gently and firmly for two seconds against the sides of the chest. By this means air is pressed out of the lungs. In all of the above methods the movements are repeated alternately, deliberately, and perseveringly about fifteen times in a minute, until a spontaneous effort to respire is perceived (see Figs. 68, 69). As to what is the explanation of the good effects of such a purely mechanical act as that of Artificial Respiration, it is probable that they are due to its supplying oxygen to, and removing carbonic acid from, the blood, and to its aiding the movement of the blood within the heart and the large blood-vessels of the chest.

After these preliminary remarks on the subject, the ambulance pupil should be in a better position to understand the following more detailed account of the treatment for restoring the apparently drowned. It embodies the directions sanctioned by the Royal Humane Society, and the Royal National Life-boat Institution :—

1. Send immediately for medical assistance, blankets and dry clothing, but proceed to treat the patient instantly, securing as much fresh air as possible.

2. The points to be aimed at are—first, and immediately, the restoration of breathing; and secondly, after breathing is restored, the promotion of warmth and circulation.

3. Treatment to restore Natural Breathing :—

(*a*) *Maintain a free entrance of air into the air passages.* —With this view remove all tight clothing constricting the neck and chest. Then, look to the mouth, and cleanse it of all mud, weeds, lumps of food, false teeth, or anything that has been suicidally placed there. Draw the tongue well forward, and, if possible, secure it there, as by an elastic band passed over it and under the chin. See, too, that the nostrils have been freed from any obstruction

(*b*) *Drain off any water from Chest and Stomach.*—To this end turn the body on the face, the pit of the stomach being raised above the level of the mouth by a large hard roll of clothing placed beneath it. Make steady pressure, upon the patient's back, over roll of clothing so as to press all fluids in the stomach out of the mouth, and repeat it once or twice until fluid ceases to flow from the mouth.

(c) *If breathing has ceased, adjust the patient's position, and commence Artificial Respiration.*—The patient should be placed on his back on a flat surface, inclined a little from the feet upwards, the head and shoulders being raised and supported on a small firm cushion or folded article of dress placed under the shoulder-blades. The movements of respiration should then be imitated by Silvester's method, in the way already described (care being taken that the patient's tongue is kept well forward), and they should be continued until a spontaneous effort to respire is perceived, when they may be stopped.

(d) *Additional aids to recovery that may be carried on while Artificial Respiration is being performed.*—During the carrying on of Artificial Respiration, should any assistants be at hand, they might dry the body with *warm* towels, if possible, and on the arrival of dry clothing or blankets, they might strip off the wet things and cover the body with blankets or gradually re-clothe it. Efforts may also be made to induce Inspiration by exciting the nostrils with smelling salts or snuff, if they are present, or tickling the throat with a feather. The use of a warm bath is advocated by some, but it is of doubtful utility, and should only be resorted to if the body is extremely cold. Quite as much benefit is derived from dashing hot and cold water alternately on the chest and rubbing it briskly afterwards. Useful as these different proceedings are, they are of minor importance, and the carrying out of them should never be allowed to interfere with the efforts to restore breathing by Artificial Respiration.

4. When Natural Breathing has been restored, everything should be done to encourage circulation and warmth. The former is best attained by wrapping the patient in dry blankets, and by rubbing the limbs upwards, firmly and energetically, so as to favour the flow of venous blood

towards the heart. The latter may be materially promoted by applying hot flannels, bottles or bladders of hot water, heated bricks, &c., to the pit of the stomach, the arm pits, between the thighs, and to the soles of the feet. Should warm clothing be needed, it can generally be obtained from bystanders. When the power of swallowing has returned, the question of the administration of stimulants will come up. They should be given in small quantities, and warm. The patient should subsequently be put to bed, and encouraged to sleep. During re-action the breathing is often very oppressed. This condition is best met by large mustard and linseed poultices to the chest, both in front and behind. During the period of convalescence, the aim of medical treatment is to keep down undue excitement, and to maintain the restored vital action, for there is a tendency to relapse into a condition of prostration.

The above directions embody what may be regarded as the recognised teaching in the present day on the immediate treatment of the apparently drowned, but the following practical suggestions of Dr. Benjamin Howard will bear repetition :—

1. *Avoid Delay.*—Promptness is of the first importance. Waste no time in gaining shelter. When gained, it oftener harms than helps the patient. Remember that a *moment* lost may be a *life* lost.

2. *Prevent Over-crowding around the Patient.*—This must be enforced, no matter what may be the difficulties. Do not allow friends to obstruct the circulation of the air, or to carry on conversation with the patient when rallying.

3. *Avoid attempts to give Stimulants before the Patient is well able to Swallow.*—It helps to obstruct respiration, and may choke the patient.

4. *Avoid Hurried and Irregular Motions.*—Perform the movements of Artificial Respiration with deliberation and rhythm. Under the excitement of the moment it is not easy to follow this rule, but it is none the less essential.

5. *Avoid an Over-heated Room.*—The animal heat which is needed cannot be supplied from without, but must be generated within the system. This is best promoted by a free supply of cool air and internal stimulants. The vital heat resulting is best retained about the patient's body by blankets alone.

6. *Avoid giving up the Patient too soon to Death.*—Efforts at resuscitation must be carried on methodically and regularly for at least half-an-hour; and there have been several cases where, after several hours of steady application of the above described treatment, a successful result has been obtained.

As to the length of time that a person can be submerged in water and yet recover, there is a difference of opinion. It may be put down at from two to five minutes, and varies probably with the age, sex, and strength of the person. It certainly is rare for recovery to take place in any one deprived of air for more than five minutes. Cases have been brought forward where this has happened, and in explanation it has been suggested that probably the person fell into the water in a faint, in which state of course the heart beats very feebly and so the Oxygen in the blood and in the *Stationary* air is not used up so quickly. The absence, too, of any struggling would be beneficial, as no water would be inspired and find its way into the air-cells. And here it may be mentioned that every one that falls into the water and is taken out insensible is not necessarily drowned. A sudden faint, or an attack of apoplexy, or being stunned by a fall, may have led to the tumbling into the water, and so the insensibility may not be due entirely to the Asphyxia.

There is a very popular belief that a drowning person rises and sinks three times before life becomes extinct. This is a perfectly groundless idea. It is not sufficiently remembered that the specific gravity of the human body is so near that of water that a comparatively slight effort will suffice to bring a sinking person to the surface again. By this is meant that a human body is only a little lighter than a quantity of water its own bulk, in other words it is lighter than the amount of water which it displaces when immersed. It is owing to this that the swimmer is able to float, or so to balance the body in the water that it supports itself on the surface without any apparent efforts of either arms or legs. In his "First-Aid to the Injured" Esmarch has dwelt on this very important point. He says, "If a person who has not learnt to swim falls into the water, he can save himself from drowning, first, by keeping his face upwards; secondly, by keeping his lungs well filled with air (by long inspirations and short expirations); and thirdly, by not raising his arms out of the water. If the arms should be raised, as when calling for help, then it follows that the head must necessarily sink so much deeper. As this is not generally known, I will prove it to you by the following experiment on this doll. As long as its arms are under water the mouth remains as you see, above it; but no sooner are the arms raised than the mouth sinks under the surface of the water." What really causes the body of a drowning person to sink and not to rise again is the increased specific gravity of it caused by swallowing water, and by the weight of the clothes, if they are on. Until this increase has taken place the body will reach the surface as the result of the exertions made, so that a drowning person may really sink and rise several times. Those cases that happen from time to time where expert swimmers become seized with what is called "cramp," and sink immediately, are not easy of explanation. One of the latest theories is that there is no "cramp," but that there has been a spasm of the larynx from water being drawn into the windpipe suddenly, a condition identical with that produced by getting a crumb of bread "down the wrong way," as it is popularly termed.

When we think of the numberless victims that the sea has claimed, we should consider it a duty to learn to swim, not only from a sense of self-preservation, but to be able to render assistance to others in distress. It is no exaggeration of language to say, as Abernethy does, that it is of far higher consequence and of more general utility than any other kind of gymnastic manual exercise or sport. In connection with the rescue of a drowning person, it should always be remembered that if he is taken by the arm from behind, between the elbow and shoulder, he cannot touch the person attempting to save him, and whatever struggles he makes will only assist the person holding him in keeping his head above water. A good swimmer can keep a man thus above water for a long time. If seized anywhere else, the probability is that he will clutch the swimmer with the result, as, alas! is too often the case, both will be drowned. While on this subject of the best way of rescuing those drowning, one or two hints may be given. In the absence of a rope or oar to reach or throw, pull off the coat, hold it by one of the sleeves, and throw the other or the coat tails to the drowning person. This establishes a means of communication with him that does not involve the serious risk of being pulled in by him. In ice accidents, a pole, ladder, or plank, should be stretched over the opening to enable the person immersed to extricate himself. As a rule he cannot do so, because the edges of the ice break away with him as soon as he clasps them. In cases like this, assistance can also be rendered by a very ingenious "pocket grapnel" which has been brought out by the St. John's Ambulance Association, and is very useful to skaters, anglers, oarsmen, fishermen, and others, for saving life. It consists of a line with a wooden reel at one end and a grapnel at the other. To use it, the wooden reel is first thrown, retaining the hooks of the grapnel in the hand; but should the person in peril sink, then throw the grapnel, retaining hold of the line, and endeavour to hook the clothes. In its absence, Esmarch's advice of attaching a skittle ball to a long cord, by means of an iron hook, and rolling it to the person in distress, to hold only until help arrives, is a good suggestion. In the Swimming Manual, written by Mr. William Wilson of Glasgow, there is an excellent and well illustrated chapter on how "To save life from drowning."

Bathers are sometimes very severely stung by the large "Jelly-fish," which in some seasons are very plentiful around our coasts. The fluid they contain is very acrid and irritating, so that it frequently blisters the skin. When this is extensive, the pain is sometimes severe, and we have a condition of faintness coming on, followed by retching, vomiting, and nausea. Whenever any one feels, by the burning sensation experienced, that he has been stung, he should leave the water. If any faintness comes on, he should lie down and take a little weak spirit and water or twenty drops of Sal Volatile in water every hour until recovered. Bathing the part with soda and water relieves the heat and itching.

By the kindness of the Secretary of the National Life-boat Institution, permission has been granted to publish *in extenso* their instructions for restoring the apparently drowned, and to use their woodcuts for illustrating the modes of performing Artificial Respiration.

DIRECTIONS FOR RESTORING THE APPARENTLY DROWNED.

The leading principles of the following directions for the Restoration of the Apparently Dead from Drowning are founded on those of the late Dr. Marshall Hall, combined with those of Dr. H. R. Silvester, and are the result of extensive inquiries which were made by the Institution in 1863-4, amongst medical men, medical bodies, and coroners throughout the United Kingdom. These directions have been extensively circulated by the Institution throughout the United Kingdom and in the Colonies. They are also in use in His Majesty's Fleet; in the Coast-guard Service; at all the Stations of the British Army at home and abroad; in the Light-houses and Vessels of the Corporation of the Trinity House; the Metropolitan and Provincial Police Forces; the Metropolitan School Board Schools; and the St. John's Ambulance Association.

I.

Send immediately for medical assistance, blankets, and dry clothing, but proceed to treat the patient *instantly* on the spot, in the open air, with the face downward, whether on shore or afloat; exposing the face, neck, and chest to the wind, except in severe weather, and removing all tight clothing from the neck and chest,—especially the braces.

The points to be aimed at are—first, and *immediately*, the *Restoration of Breathing;* and secondly, after breathing is restored, the *Promotion of Warmth and Circulation.*

The efforts to *restore Breathing* must be commenced immediately and energetically, and persevered in for one or two hours, or until a medical man has pronounced that life is extinct. Efforts to promote *Warmth* and *Circulation*, beyond removing the wet clothes and drying the skin, must not be made until the first appearance of natural breathing; for if circulation of the blood be induced before breathing has recommenced, the restoration to life will be endangered.

II.—To Restore Breathing.

To Clear the Throat.—Place the patient on the floor or ground with the face downwards, and one of the arms under the forehead, in which position all fluids will more readily escape by the mouth, and the tongue itself will fall forward, leaving the entrance into the windpipe free. Assist this operation by wiping and cleansing the mouth.

If satisfactory breathing commences, use the treatment described below to promote Warmth. If there be only slight breathing—or no breathing—or if the breathing fail, then—

To Excite Breathing.—Turn the patient well and instantly on the side, supporting the head, and excite the nostrils with snuff, hartshorn, and smelling salts, or tickle the throat with a feather, &c., if they are at hand. Rub the chest and face warm, and dash cold water, or cold and hot water alternately, on them. If there be no success, lose not a moment, but instantly—

To Imitate Breathing.—Replace the patient on the face, raising and supporting the chest well on a folded coat or other article of dress.

Turn the body very gently on the side, and a little beyond, and then briskly on the face, back again, repeating these measures cautiously, efficiently, and perseveringly, about fifteen times in the minute, or once every four or five seconds, occasionally varying the side.

On each occasion that the body is replaced on the face, make uniform but efficient pressure with brisk movement, on the back between and below the shoulder-blades or bones on each side, removing the pressure immediately before turning the body on the side.

During the whole of the operations, let one person attend solely to the movements of the head and of the arm placed under it.

[*The first measure increases the expiration—the second commences inspiration.*]

*** The result is *Respiration* or *Natural Breathing;* and if not too late, *Life.*

Whilst the above operations are being proceeded with, dry the hands and feet, and as soon as dry clothing or blankets can be procured, strip the body, and cover or gradually reclothe it, but taking care not to interfere with the efforts to restore breathing.

III.

Should these efforts not prove successful in the course of from two to five minutes, proceed to imitate breathing by Dr. Silvester's method, as follows:—

Place the patient on the back on a flat surface, inclined a little upwards from the feet; raise and support the head and shoulders on a small firm cushion, or folded article of dress, placed under the shoulder-blades.

Draw forward the patient's tongue, and keep it projecting beyond the lips: an elastic band over the tongue and under the chin will answer this purpose, or a piece of string or tape may be tied round them, or by raising the lower jaw, the teeth may be made to retain the tongue in that position. Remove all tight clothing from about the neck and chest,—especially the braces.

To Imitate the Movements of Breathing.—Standing at the patient's head, grasp the arms just above the elbows, and draw the arms gently and steadily upwards above the head, and *keep them stretched* upwards for two seconds. (*By this means air is drawn into the lungs.*) Then turn down the patient's arms, and press them gently and firmly for two seconds against the sides of the chest. (*By this means air is pressed out of the lungs.*)

Repeat these measures alternately, deliberately, and perseveringly, about fifteen times in a minute, until a spontaneous effort to respire is perceived; immediately upon which cease to imitate the movements of breathing, and proceed to *induce Circulation and Warmth.*

IV.—Treatment after Natural Breathing has been Restored.

To Promote Warmth and Circulation.—Commence rubbing the limbs upwards, with firm grasping pressure and energy, using handkerchiefs, flannels, &c. (*By this measure the blood is propelled along the veins towards the heart.*)

The friction must be continued under the blanket, or over the dry clothing.

Promote the warmth of the body by the application of hot flannels, bottles or bladders of hot water, heated bricks, &c., to the pit of the stomach, the arm-pits, between the thighs, and to the soles of the feet.

If the patient has been carried to a house after respiration has been restored, be careful to let the air play freely about the room.

On the restoration of life, a teaspoonful of warm water should be given; and then, if the power of swallowing has returned, small quantities of wine, warm brandy-and-water or coffee should be administered. The patient should be kept in bed, and a disposition to sleep encouraged.

General Observations.

The above treatment should be persevered in for some hours, as it is an erroneous opinion that persons are irrecoverable because life does not soon make its appearance, persons having been restored after persevering for many hours.

Appearances which generally accompany Death.

Breathing and the heart's action cease entirely; the eyelids are generally half-closed; the pupils dilated; the tongue approaches to the under edges of the lips, and these, as well as the nostrils, are covered with a frothy mucus. Coldness and pallor of surface increase.

Cautions.

Prevent unnecessary crowding of persons round the body, especially if in an apartment.

Avoid rough usage, and do not allow the body to remain on the back unless the tongue is secured.

Under no circumstances hold the body up by the feet.

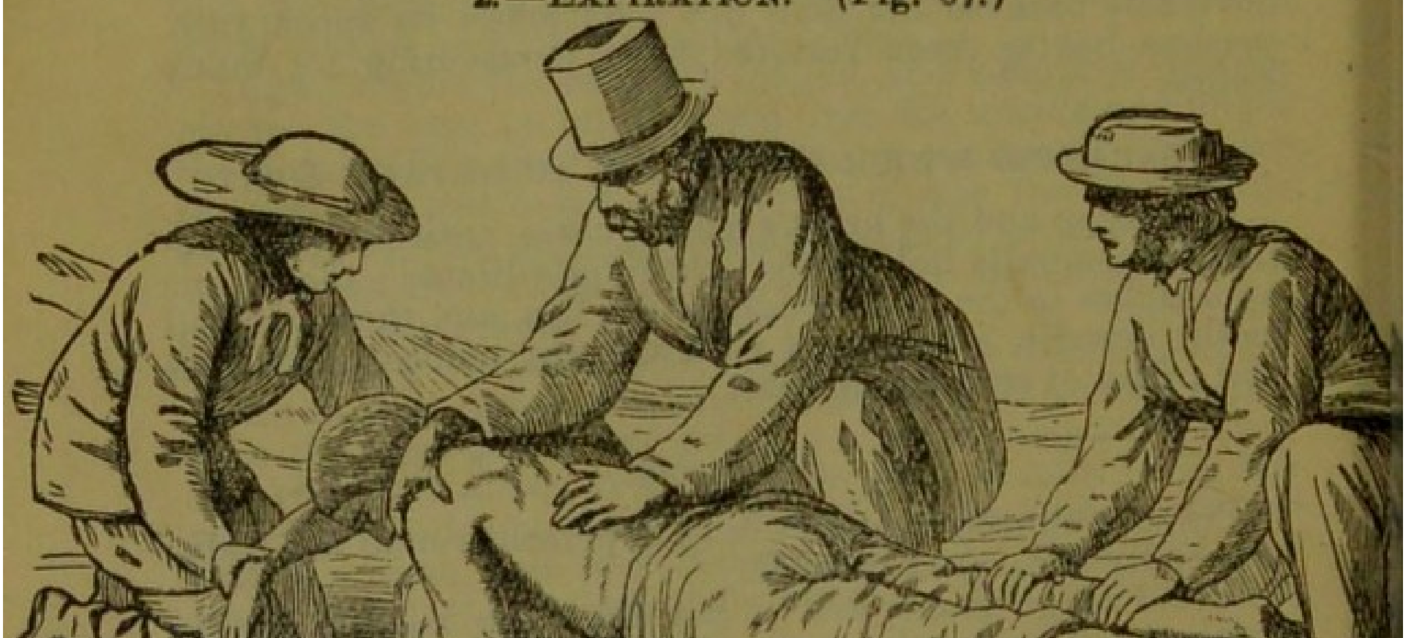
On no account place the body in a warm bath, unless under medical direction, and even then it should only be employed as a momentary excitant.

MARSHALL HALL'S READY METHOD.

1.—INSPIRATION. (Fig. 66.)

[By placing the patient on the chest, the weight of the body forces the air out; when turned on the side, this pressure is removed, and air enters the chest.]

2.—EXPIRATION. (Fig. 67.)



The foregoing two Illustrations shew the position of the Body during the employment of Dr. Marshall Hall's Method of Respiration.

THE SCHÄFER METHOD.

FOR RESTORING ANIMATION IN THE APPARENTLY DROWNED, SUFFOCATED, ELECTRICALLY SHOCKED, AND NARCOTICALLY POISONED.

INSTRUCTIONS.

Immediately (after removal from the water, &c.) lay the patient face downwards with the arms extended and the face turned to the side. Kneel astride or on one side of the patient (Fig. 1, A, B).

Place the hands on the small of the patient's back, one on each side, with the thumbs parallel and nearly touching (Fig. 1).

Bend forward with the arms straight so as to allow the weight of the operator's body to fall on the wrists and thus make a steady, firm, downward pressure on the lower part of the back (the loins), as shown in Fig. 2. (This part of the operation should occupy the time necessary to count—slowly—*one, two, three.*)

Immediately after making the downward pressure, swing the body backwards so as to relax the pressure, but without lifting the hands from the patient's body (Fig. 1). (This part of the operation should occupy the time necessary to count—slowly—*one, two.*)

Repeat the forward and backward movements (that is, the pressure and the relaxation of pressure) without any marked pause between the movements. The downward pressure forces the air out of the lungs and the relaxation of pressure causes the air to be drawn in again.

Continue the movements at the rate of about 12 per minute until natural respiration has recommenced.

When natural respiration is fairly resumed, cease the artificial movements. Watch the patient closely, and, if

A

B

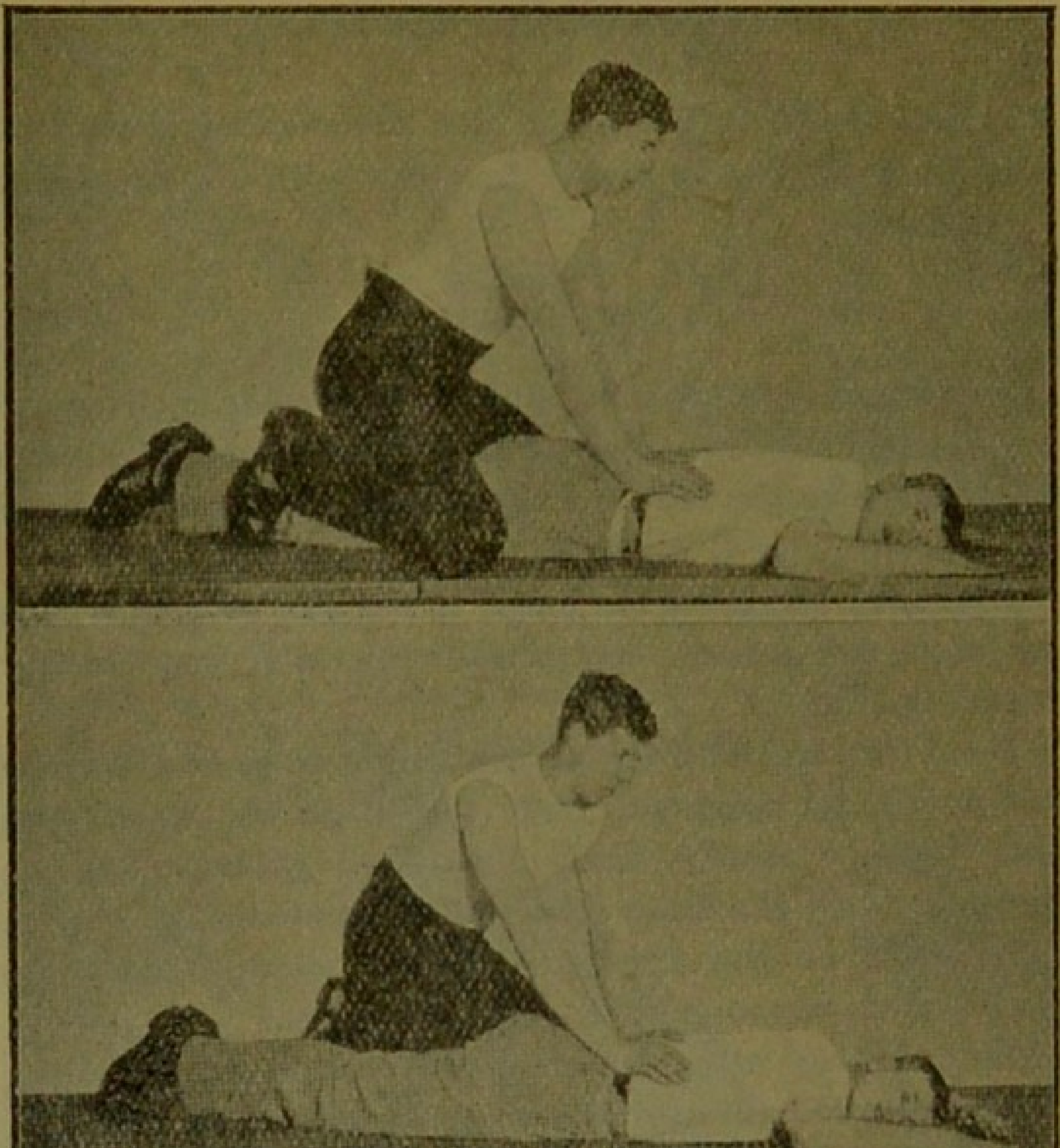


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Fig. 1.

natural respiration ceases, repeat the pressure and relaxation of pressure as before.

The movements of artificial respiration should be commenced the moment the patient is removed from the water, &c., and no time should be wasted in removing or loosening clothing.

When natural respiration has commenced, the patient should be allowed to lie in a natural position on one

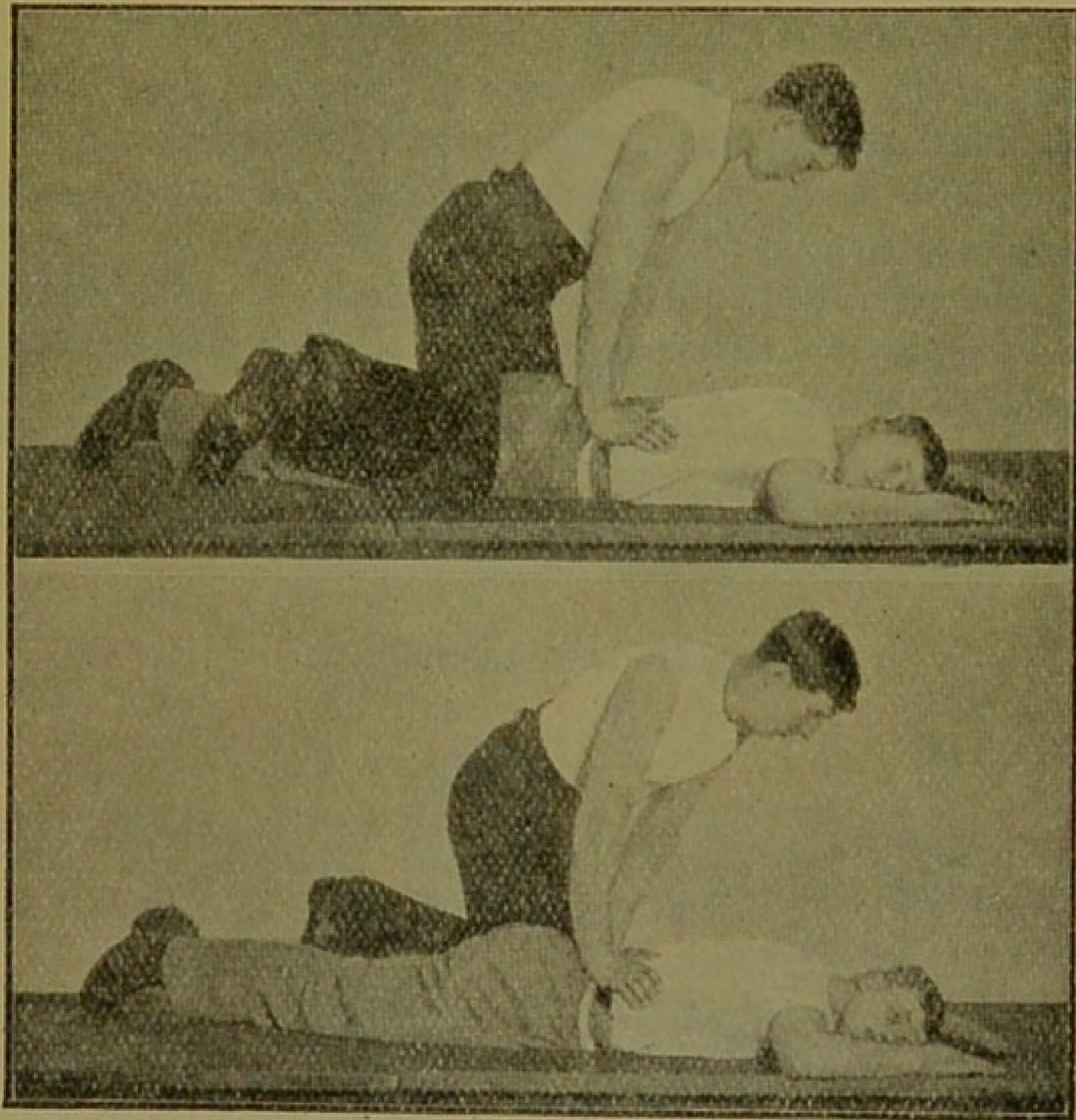

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Fig. 2.

side, and treatment for the promotion of warmth and circulation may be proceeded with.

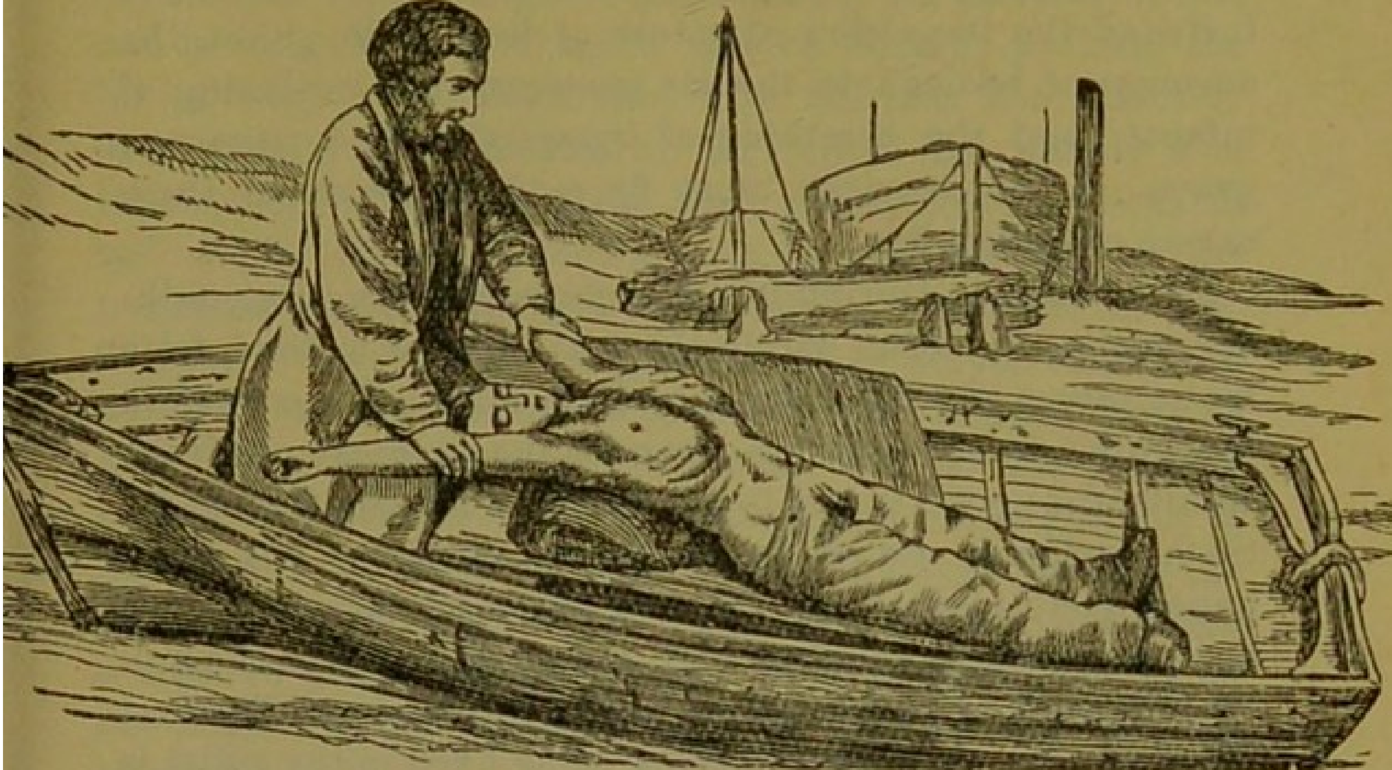
The movements of artificial respiration are of the first consequence. If the operator is single-handed, he must attend to these alone until natural breathing is restored. If other assistance is at hand, warm wrung-out flannels, hot bottles, &c., may be applied between the thighs, and to the armpits and feet; but the movements of artificial respiration must not be interfered with.

After natural breathing is restored, wet clothing may be removed and a dry covering substituted. This must be done without disturbing the patient, who should be allowed to lie quiet and watched for at least an hour, and encouraged to sleep.

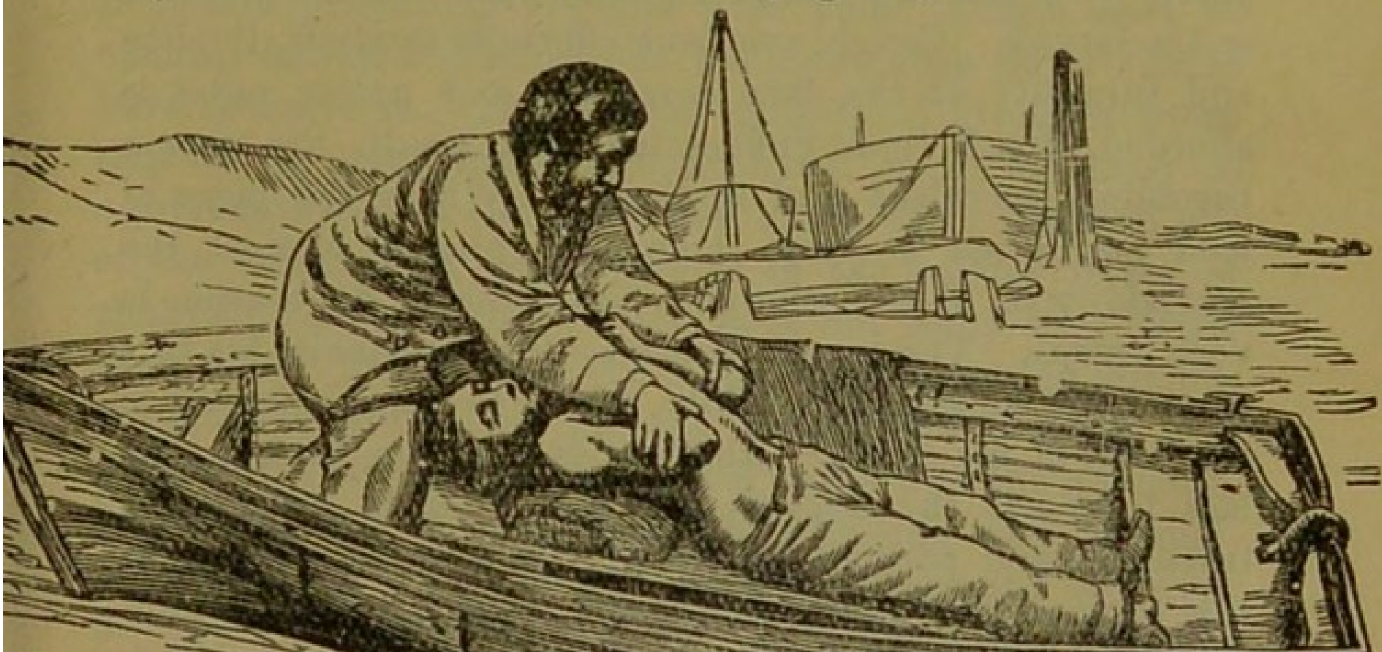
The patient should not be allowed to go home until certified by the Divisional Surgeon or other medical man as fit to be removed.

SILVESTER'S METHOD.

1.—INSPIRATION. **(Fig. 68.)**



2.—EXPIRATION. **(Fig. 69.)**



The foregoing two Illustrations shew the position o, the Body during the employment of Dr. Silvester's Method of inducing Respiration.

Suffocation.—This is the general term used to signify death by agents which do not *compress* the windpipe yet stop the supply of Oxygen to the blood. Under it are included the impaction of pieces of food in the gullet, the entrance of bodies into the air passages, the over-laying of infants, and the breathing of irrespirable and poisonous gases. A few remarks must be made on each of these causes of Suffocation.

(*a*) *Choking.*—During meals, especially if laughing, talking busily, or eating carelessly, bits of meat or bone, false teeth, pieces of potato, crust, or tripe may become fixed in the gullet from being too large for the passage. If death results, the person is said to have died from being "choked." Such accidents are of frequent occurrence, as our daily papers continually shew, but in a few cases foreign bodies, such as a sock or handkerchief, find their way into the gullet purposely at the hands of would-be-suicides. The first effect of any of the above bodies being fixed in the gullet is to set up a feeling of Suffocation and difficulty of breathing, partly from pressure and partly from spasm of the aperture in the larynx. Cough, constant efforts to swallow, lividity and turgidity of the face come on, and unless relief is afforded, death from Suffocation may result, the person becoming convulsed and insensible. Where the piece of food swallowed is very large and presses against the posterior wall of the windpipe, the sense of Suffocation is very urgent. The person starts up from the table, his face turns livid, he struggles wildly, trying to pass his fingers to the back of his throat with the head thrown back (which last increases the danger), and soon falls to the ground insensible and perhaps convulsed. In a condition such as this the person's life is in imminent danger, and practically is in the hands of those immediately around. The "*first-aid*" *treatment* is to send, of course, for medical aid, but some one should at once pass the forefinger to the back of the throat and base of the tongue and try to extract the mass by hooking it forwards. The finger should be passed preferably to the side of the throat, and gently, as this allows of it getting behind the mass, and so facilitates its extraction. If the finger is thrust boldly in, as some direct, and in the central line, harm may be done by pushing the bit of food lower down, and thus increase the difficulty of getting it out. Instead of the finger, the handle of a tablespoon or even a button-hook might prove serviceable and might get farther down. As to the position of the patient, too much thought must not be expended on this. The recumbent posture is probably the best for extraction with the head turned to one or other side. Should there be any difficulty in opening the mouth, this is best done by introducing a flat body, as the handle of a paper-knife or of a latch-key between the teeth, and in this way levering the jaws open, after which a bit of wood or other firm substance should be placed between them. The advantage of using the finger in the way described is that it often sets up vomiting, and this has occasionally ejected the foreign body. Nothing has been said about pushing the food downwards, as it is a proceeding fraught with some danger save in medical hands, and is not one the ambulance pupil should have recourse to. The popular remedy of giving a sharp slap on the back with the open hand, so as suddenly to compress the air in the chest and shoot the substance out of the throat, is of more service in the milder forms of choking, where the bit of food does not completely block the gullet. It is in these cases, too, that drinking copious draughts of water, and gulping them down quickly, will sometimes move on the obstructing mass into the stomach. Should this fail, then the effect of vomiting may be tried, and an emetic of salt, or mustard and water, may be given, or the throat may be tickled with a feather if swallowing is impossible. If this does not succeed, there is nothing left but mechanical means for the removal of the foreign body, and these can only be carried out by a medical man. In the case of small pieces of bone or fish-bones that are swallowed, if they become fixed in the upper part of the throat, they often cause more alarm than danger, and they may be extracted by the finger. When lower down, eating a crust of bread, or a potato, or even an apple chewed coarsely, will sometimes dislodge them, especially if followed by a draught of water. There is no great danger attending this condition of things, though there is often a good deal of pricking pain felt on swallowing. Usually, in a day or two, all comes right, although it must be remembered that the scratching to which the gullet has been subjected is sometimes felt for a time after the bone has been removed. In all such cases, if the patient has the idea that the bone is still there, a medical man should be consulted.

It may be as well to say a word here on the subject of things *accidentally swallowed*. This is not an uncommon occurrence with children, but even with adults the foolish and dangerous habit of putting things into the mouth to hold is responsible for its happening pretty often amongst them. A list of the substances that have been swallowed by children would be too long for insertion here. Buttons, coins, shells, nails, corks, pins, needles, rings, beads, pebbles, bullets, seals, are some of the most common. Sometimes they become arrested in the gullet and give rise to symptoms of suffocation. An effort must then be made to get them out by the finger as already described, and if any delay occur in this, medical aid should be got. Generally, however, they pass down the gullet into the stomach. This need cause no immediate alarm, but a word of caution may be given here against at once administering a laxative, such as castor-oil, with the hope of getting rid of the foreign body quickly. No purging medicine should be given for two or three days, and preferably then only under medical advice. Meanwhile the diet should be a solid one, such as of porridge and milk, bread and butter, milk puddings, suet dumpling, &c., with the object of covering over the foreign body and preventing it becoming entangled in the bowels. Parents, then, should not be excessively alarmed when an accident like this happens, for, as a rule, where purgation is avoided, everything comes right and the foreign body is sooner or later discharged.

It sometimes, however, happens that these foreign bodies, instead of going down the gullet, *pass into the air-passages*, which is a much more serious matter. It is the smooth and round objects, like peas, pebbles, fruit-stones, buttons, and small coins, that are apt to do this. Every one is familiar with the symptoms of a crumb or small quantity of fluid "going the wrong way." The accident we are considering shews itself by the same symptoms. There is a sense of suffocation with violent spasmodic cough and gasping for breath, both of which continue until the foreign body is expelled. Should this not happen, the symptoms continue, and though they may abate perhaps a little in violence, if suitable treatment is not adopted, they are, sooner or later, followed by other changes which prove fatal.

As to the "*first-aid*" *treatment* of these cases, the ambulance pupil cannot do much. He may, of course, see if the finger can feel anything in the throat or upper part of the air-passages, and if so, he would extract it; but he will do good service if he recognise at once the severity of the case and sends at once for medical aid, as it is only by operative interference relief can be got. On no account should he ever invert, or allow any one else to, a child suffering from this accident. This should only be done under the advice of and in the presence of a doctor, as it may induce immediate suffocation. It may be mentioned as an encouraging fact to anxious parents, that only a small number of these cases prove fatal at the moment of the accident, and not unfrequently the foreign body has been got rid of by the violent fits of coughing. No undue reliance should be placed, however, on this last possibility, and medical aid should be summoned at once.

In all cases of Choking should the person not shew signs of breathing as soon as the foreign body has been extracted, then Artificial Respiration should be at once commenced and continued for at least half-an-hour, unless a medical man has determined that further treatment is useless.

(*b*) *Smothering.*—This is a variety of Suffocation in which the mouth and nostrils get covered, and all ingress and egress of air is prevented. Thus, it occurs when a shawl is wrapped too closely round the head of an infant on a cold stormy day, and again at night, when a child, sleeping with its mother, is overlaid, or the bedclothes get accidentally placed over its mouth and nostrils. Hundreds of babies perish in our midst from this cause every year, and they die apparently without any struggle, the process being a sort of slow poisoning from the impure blood circulating through the body. These cases shew that the popular idea of suffocation, that it is a dreadful and painful struggle, is not altogether correct. As a rule these cases are discovered when it is too late to do anything to restore life, but if there seems the slightest ray of hope Artificial Respiration should be resorted to. If mothers will follow the dangerous plan of having their young children to sleep beside them, they should follow the plan adopted in the Midlands of England for the prevention of overlaying. The baby is wrapped in a shawl with the end so turned up that the child cannot slip out at the bottom. The shawl is then fastened by a safety pin to the pillow at sufficient height that the arms of the mother could not cover the face. Smothering is also the cause of death in those cases where persons are buried by sudden falls of sand or earth; but in addition the ribs are prevented moving by the weight of soil upon them. Extrication of the sufferer should take place as quickly as possible and Artificial Respiration commenced at once.

(*c*) *Breathing Irrespirable and Poisonous Gases.*—Of these gaseous poisons the following are the ones that are most fatal:—

(1) *Carbonic Acid.*—It is produced in the slaking of lime and in the process of fermentation, so that it is always found in the vats of breweries. It is present also in wells, cellars, caves, and vaults which have been long closed up

When it occurs, as it sometimes does, in the shafts and galleries of coal-mines, it is known as "choke-damp." It is a gas that cannot be breathed when quite undiluted. owing to its closing the epiglottis and preventing the entrance of air; but with a certain proportion of air it can be breathed, and then it produces deadly effects.

(2) *Charcoal Vapour.*—When charcoal is burnt a mixture of gases is liberated, amongst them being carbonic acid and another called "carbonic oxide." This last is a distinct poison, and its combination with carbonic acid seems to intensify its deleterious properties.

(3) *Coal and Coke Vapour.*—The products of the burning of these substances in a room which has no vent or chimney are carbonic acid and carbonic oxide along with sulphurous acid gas. Sulphuretted and carburetted hydrogen are also present. All of these are equally fatal to life.

(4) *Vapours of Lime, Brick, and Cement Kilns.*—Persons who have been tempted to sleep near these kilns on a cold night have often been destroyed by the carbonic and other gases given out.

(5) *Coal-Gas.*—The ordinary gas used for lighting purposes is a compound which has often proved fatal when air contaminated with it is respired. Fortunately the peculiar odour it derives from the vapour of naphtha always gives sufficient warning of its presence.

(6) *The Foul Air in Sewers and Cesspools.*—The fatal gas developed here is sulphuretted hydrogen, which often kills instantaneously if breathed unmixed with air.

The "*first-aid*" *treatment* in these cases of suffocation from irrespirable and noxious gases, is to remove the sufferer at once from the deadly atmosphere into pure air, and to commence artificial respiration. Friction and warmth to the body should also be employed, and all constrictions of dress about the neck and chest removed. Workmen in breweries should be cautioned about the risks of entering vats to clean them except under proper precautions, and no one should go down a deep well without first ascertaining the state of the air within it at its lowest part, for it is there the carbonic acid lies, owing to its weight. The popular idea is that if a lighted candle will burn when lowered into a well, it is safe to go down; but this is not a reliable test, for the candle may burn in air that is unfit for respiration, as for instance in the very deadly sulphuretted hydrogen. It is a good plan, before descending into a well or vault, to take some steps to create a movement in the air if there is the slightest suspicion about its purity. In the case of the well, this may be done by lowering an open umbrella, and quickly drawing it up again, or by emptying down quantities of lime-water or even plain water. As regards charcoal, it should never be burnt for warming a room that any one is to occupy, and coke or common coal should not be used in any apartment where there is not an open chimney to give an exit for the fumes.

The task of *rescuing persons overcome by poisonous gases* is one involving often some difficulty and danger, and requires to be carried out with caution, otherwise the rescuer may, in turn, be overpowered by the deadly atmosphere. Entering a room filled with charcoal vapour is very risky. It should only be done after taking a deep inspiration, and covering the mouth and nose with a cloth soaked in vinegar and water. A rush should then be made to the window. Break a pane, and put the face to the aperture. If there is another window, a fresh breath of air is taken again, and then a rush made for it to break another pane or panes, so as to get a thorough draught to disperse the poisonous vapour, and allow the safe removal of the unconscious sufferer. If a person has become insensible at the bottom of a well or deep pit, allow no one to go down after him until he has been properly secured round the chest and shoulders by a rope, and is furnished with another signal rope to let those above know he is all right. Any person, too, going down should have the mouth and nose protected with a cloth dipped in vinegar and water. In all these cases it is a good thing to send at once for ladders and ropes, as they may be made of great assistance in effecting a rescue. Were it not for the frequency with which one reads of the proceeding, it would almost seem unnecessary to warn every one against entering with a light into a room where gas has escaped. Such a proceeding can only end in an explosion. The proper thing to do is to seek for the window in the dark, and at once open it.

(*d*) *Strangulation.*—In this form of death there has been a *compression* or mechanical occlusion of the windpipe, and the admission of air has been prevented. Under it is included hanging, a term which implies that the body is partially or wholly suspended by the neck, and that the constricting force is the weight of the body itself. The constriction may have got there accidentally, as in practical joking, and in those cases where boys have unintentionally destroyed themselves while indulging a morbid curiosity to see what hanging is like. So, too, fatal results have happened in the case of persons carrying weights on their backs, with a band passing round the forehead, and have rested their burden on a low wall with the band pulled down round the neck. The weight has suddenly slipped, and falling down on the other side of the wall has so tightened the band lying temporarily round the neck that the unfortunate person has been strangulated. Independently, however, of suspension, *constriction* may be produced by anything tied tightly round the throat, or by pressure on the windpipe of the fingers, as in the once notorious "Garotte robberies," where, after the manner of thieving followed by the Thugs of India, people were seized from behind, their windpipes compressed by the hands of their assailants, and when thus rendered insensible they were robbed.

Leaving out of the question judicial hanging, in all cases of strangulation, from whatever cause, death is usually very rapid, so that immediately a person is found hanging, he should be at once cut down, one hand severing the cord, while the other supports the body, and prevents it being injured by falling down. Then any rope or handkerchief that may be secured round the neck should be removed; and if the body is warm, and it is clear that the suspension has been recent, steps should be taken to restore animation. Place the body gently on the ground in a position suitable for artificial respiration, the head being slightly raised above the level of the trunk. Loosen any articles of dress that may be constricting the circulation, and at once go on with Silvester's method. Should there be assistance at hand, cold water may be dashed on the chest, and the body and limbs briskly dried. In cases where there is great lividity of the face and chest, bleeding, by opening a vein, might prove beneficial, but it is a proceeding that scarcely comes within the scope of "*first-aid*" Ambulance treatment, and is better left for the medical man to decide upon. The great point to remember in these cases is *promptitude of action*, the person who first comes upon the scene acting at once, and not rushing off in search of assistance, and perhaps losing valuable time.

Fainting.—As fainting is a condition of *suspended animation*, so to speak, it may be appropriately considered here. It is really due to a sudden failure of the heart's action, which may be brought about by several causes, of which breathing impure air is one of the most frequent. To understand how fainting occurs, it is necessary to recall the conditions under which the work of the heart is carried on. No doubt its movements depend upon a special and inherent irritability of its muscular fibres, but they are also very largely regulated by the nervous system, just as those of Respiration are. Accordingly, we find that though the heart beats independent of our will, yet its action is capable of being affected by various influences which make themselves felt on the nervous system, so that its movements may be quickened or become so weak that it cannot accomplish the work it has to do of driving the blood through the body to the different organs and tissues. Fear, grief, sudden fright, joy, are all instances of causes that may so affect the nervous system that the heart may not receive its proper nerve supply, and as a consequence may act so feebly that the person faints away, owing to the blood not reaching the brain. Breathing the heated impure air of a crowded room, with its deficient oxygen, and its excess of carbonic acid, brings about a similar result. The blood in the lungs is not purified, and returns to the heart without its due supply of oxygen. Distributed to the body in this condition, all the organs suffer, and more or less cease to work. The Brain and Nervous system generally are the ones that first feel the deleterious effects of venous blood circulating through them, as shewn by headache, and they do not send out the proper supply of nerve energy which the heart and respiratory apparatus need. Consequently, they work slower and slower, and come almost to a standstill, when we have the condition of Fainting induced. Fainting, then, may be defined as a sudden suspension of the heart's action, accompanied by cessation of the respiratory functions, internal and external sensation, and voluntary motion. The medical term for this is Syncope, from the Greek word *sunkope*—a cutting off.

As to the *symptoms* of Fainting, there are those experienced by the person's own self and those apparent to others. The former consist of a sinking feeling about the stomach, a sense of weakness and giddiness, impairment of vision, and a singing in the ears, all of which are familiar to most of us, for there are few people who have not fainted at some time in their lives. To a spectator the appearance of a person about to faint is very characteristic. The preliminary stage is marked by sudden paleness, a staggering gait, an upward roll of the eyes, and feeble irregular breathing. This is followed by the fall of the patient to the ground, with complete loss of consciousness, and apparent cessation of all the vital functions. As he lies there with pallid face, dilated pupils, cold clammy skin, and almost imperceptible pulse, one cannot help feeling alarmed at a condition that seems perilously near death. And, indeed, it may end fatally, if injudicious measures are taken. Fortunately, in the majority of cases recovery commences almost immediately, and the slow gasping breathing that precedes the return to consciousness is a very welcome sound. So thought Rose, as Sir Walter Scott tells us in the following passage:—"Eveline fetched a fuller sigh, and opened her eyes, but presently shut them again, and letting her head drop on Rose's bosom, fell into a strong shuddering fit, while her faithful damsel exclaimed aloud, 'She lives! She is recovering! Praised be God!'"

The "first-aid" treatment in cases of Fainting consists in removing, where that is possible, the cause, and in taking steps to restore the action of the heart. Before dealing with these two points a word of caution may not be out of place, as to the position a fainting person should be placed in. In all cases, follow Nature's indication. A fainting person always sinks down, so keep the patient lying flat on the back, with the head on the same level with or even lower than the body. If the person has not fallen down, then at once have him placed in the recumbent posture; and if he has sunk down into a chair or on to the seat of the pew in church, never raise him up, but elevate the feet to a level with the rest of the body; or what is perhaps better still pull him or slide him gently down on to the floor. Never be tempted, or allow any one else to raise into the upright position a person in a faint. To lift up any body in this condition has before now caused a fatal result by completely stopping the feebly beating heart. If people will raise something, let it be the feet. With this preliminary injunction, it will be understood, that where an impure atmosphere is the cause of the fainting, and it is deemed advisable to remove the person out of it, this should be done by carrying him in the horizontal posture. In most cases the admission of fresh air by a window or door near is sufficient to revive the person. In the open persons should be prevented from crowding closely round. Compression of the chest and heart by tight articles of dress is another exciting cause of fainting, especially among the female sex, so that all articles of apparel about the neck, chest, and abdomen should be loosened. Of means of restoring the circulation, Alcohol is one of the best, and as soon as the patient can swallow, a small quantity of spirits and water should be given. Sal volatile is another useful stimulant. Thirty drops or more of it in water is a medium dose. Until the patient can swallow, resort must be had to "smelling salts," to the application of Eau de Cologne and water to the forehead and temples, to dashing cold water on the face or upper part of chest, and to fanning. Generally these measures act quickly and favourably, and, in an ordinary fainting attack, recovery soon takes place. Should, however, the faint seem very prolonged, or shew a tendency to recur, medical advice should be at once sent for, as other treatment may be required. Meanwhile, mustard over the heart and warmth to the feet should be applied. It is always a good plan to keep a person who has just recovered from a faint lying quiet for a little time. Assuming the erect position too soon may bring on the attack again. It has been already pointed out, that hæmorrhage may cause fainting, and that in these cases too free stimulation must not be resorted to, until the source of bleeding has been commanded. Unfortunately, fainting sometimes occurs as the result of organic disease of the heart, and is speedily fatal, or the person goes into a protracted faint, and a fatal termination ensues. In these cases the ambulance pupil cannot do more than what has been mentioned above, but working in these lines he will have the satisfaction of knowing that he has done all that could be done in such an emergency. The practice of bending forward the head between the knees is one that is useful in preventing fainting, but it should not be resorted to after fainting has taken place.

CHAPTER XI.

DIGESTION.

"The qualms or raptures of your blood
Rise in proportion to your food,
Your stomach makes your fabric roll,
Just as the bias rules the bowl.
Observe the various operations
Of food and drink in several nations.
Was ever Tartar fierce or cruel
Upon the strength of water-gruel?
But who shall stand his rage and force
If first he rides, then eats his horse!
Salads and eggs, and lighter fare,
Turn the Italian spark's guitar;
And if I take Dan Congreve right,
Pudding and beef make Britons fight."—*Prior*.

From what has been said of the uses and functions of the Blood, it will be readily understood that not only has it to get rid of the impurities that find their way into it, but the losses which it sustains in nourishing the tissues have to be made good. These last are met by introducing into the body, in obedience to the sensations of Hunger and Thirst, a great variety of liquid and solid substances, some of which are derived from the *animal* and others from the *vegetable* kingdom. Taken collectively, these substances are spoken of as Food; but they are in every way so dissimilar to the Blood they are meant to enrich and supply with new material, that it is necessary to reduce them to a condition in which they can be absorbed. This is accomplished by Digestion, a process partly physical and partly chemical, the effect of which is to convert the Food eaten into a bland, white, milky fluid, which can be taken up by the absorbents and by them poured into the Blood. In the present chapter it is proposed to give a short sketch of Digestion, as the Ambulance pupil should be acquainted with its leading facts. These will be best brought out by considering the subject under the following heads:—

1. The Food required by the body.
2. The Digestive act.
3. The Digestive apparatus.
4. The Absorption of the new material.

1. *The Food required by the Body.*—The two uses of Food are (*a*), to build up and repair the waste of the tissues, and (*b*), to generate the necessary heat and force for carrying on the work of the body. Any substance capable of fulfilling either of these conditions is regarded as Food. It is found, however, that some substances are better suited for building and repairing tissue waste than for generating heat, while the reverse holds good with others, so that it is not unusual to arrange the different articles we eat under the general headings of "*tissue foods*" and "*fuel foods.*" The characteristic of the former is that they largely contain *Albumen*, and of the latter that they chiefly consist of *Carbon.* As a consequence of this, the "tissue foods" are commonly spoken of as *Nitrogenous*, because Nitrogen enters very considerably into the composition of Albumen, and the "fuel foods" as *Carbonaceous.* The use of such terms has its advantages, as it keeps us to some extent in mind of the chemical differences in the various articles of diet, and of their separate uses in the human economy.

The *Albuminous* or *Nitrogenous* foods are represented by the flesh of the different animals we eat, by the *cassine* or curd of milk, by the yolk and white of eggs, by the *gluten* of bread, and by various other substances, while starch, sugar, fat, oil, and butter, are common examples of *Carbonaceous* foods. The other materials which the body requires for its support and repair are *Water* and various *Mineral Salts.* These are either taken in separately or are found in the various Albuminous foods. As to the large class of what have been termed "Accessory Foods," of which tea, coffee, alcohol, and cocoa are familiar instances, there can be no doubt that they influence considerably the processes of nutrition, but it is equally true that we could very well do without them, and that in many respects we might be happier and better as a nation had they never been introduced amongst us.

As to the amount of Food required in the 24 hours, a very fair estimate is that which places it at about 5½ lbs., of which 16 oz. should be meat, 19 oz. bread, 3½ oz. fat, and 52 fluid oz. of water, so that, speaking roughly, it may be said that every adult individual consumes rather more than a ton of solid and liquid food in the year. In connection with this subject of Food, it should always be borne in mind that it is essential for healthy nutrition that there should be a proper *combination* of Albuminous and Carbonaceous substances, and that the best diet for any one is such a judicious blending of the two that the greatest quantity of nutriment and the largest amount of heat will be obtained from the smallest bulk of food.

2. *The Digestive Act.*—As it is the Blood which nourishes the various tissues and organs, the different articles of food we take must be first converted into this fluid before they can be of any service in the nutrition of the body. The first steps in this conversion are effected by Digestion. Complicated as this process is, the aim of its different stages is to reduce into a state of *solution* all the different articles eaten, so that they may pass through the thin walls of the veins or lacteals, and thus gain access to the blood. The main factors in causing this solvent action on the food are certain unorganized ferments, of which those in the *saliva* of the mouth, the *pepsin* of the stomach, and the *trypsin* of the sweetbread or pancreas are the most active. Once the food is reduced to a fluid form, then there comes into play the law of *Endosmose* and *Exosmose*, according to which, if a membrane is placed between two mixable liquids of different densities some of each will pass through, but more of one than the other. The transfer of that which passes more rapidly is called *Endosmose*, of the other, *Exosmose*. Foster, in his *Physiology Primer*, thus de-

scribes this process,—"You probably know that many things will pass through skins and membranes in which no holes can be found, even after the most careful search. If you put peas into a bladder and tie the neck, the peas will not get out until the bladder is untied or torn. But if you were to put a solution of sugar or of salt into the bladder, and place the bladder with its neck tied ever so tightly in a basin of pure water, you would find that very soon the water in the basin would begin to taste of sugar or salt—and that without your being able to discover any hole, however small, in the bladder. By putting various substances in the bladder, you will find that solid particles and things which will not dissolve in water keep inside the bladder, whereas sugar and salt, and many other things which dissolve in water, will make their way through the bladder into the water outside, and will keep on passing until the water in the basin is as strong of sugar or salt as the water in the bladder. This property, which membranes such as a bladder have, of letting certain substances pass through them, is called *Osmosis*. You will at once see how important a part it plays in your own body. It is by osmosis chiefly that the raw nourishing material in the blood gets into the little islets of flesh, lying, as we have seen, in the mesh-work of the capillaries. It is by osmosis chiefly that the worn out stuff from the same islets gets back into the blood. It is by osmosis chiefly that food gets out of the stomach into the blood. It is by osmosis chiefly that the waste, worn-out matters are drained away from the blood, and so cast out of the body altogether. By osmosis the blood nourishes and purifies the flesh. By osmosis the blood is itself nourished and kept pure." The membrane through which the passage of nutriment takes place in the case of digestion is the thin and delicate walls of the blood-vessels and lymphatics which lie in that mucous membrane which lines the digestive canal all through its extent, commencing at the mouth and terminating at the end of the intestines.

3. *The Digestive Apparatus.*—(See Fig. 70.) The essential requisites of this are—(1), an orifice through which food may be admitted; (2), a receptacle in which it may be held and there undergo the necessary changes; and (3), some arrangement for carrying off the useless residue of the food and expelling it from the body. Such plan exists even amongst the lower animals as well as in man, though in him these different parts are seen in their highest development. In him they are represented by (1) the *mouth and œsophagus* (or gullet), for the introduction of food; (2), the *stomach* for holding it; and (3), the *intestines* for carrying off its waste and indigestible portions. Conjointly these three separate parts are spoken of as the *alimentary canal*, and it passes right through the trunk. Its walls are made up of three coats, one of which is mucous with numerous glands embedded in it; another is muscular for forcing the contents along; and the third or external one is serous. But accessory organs are needed for that complete *solution* of the food which is the ultimate aim and object of digestion, and we find that in man these are added in the shape of teeth, salivary, gastric and intestinal glands, the liver, and the pancreas. Owing to the presence of these accessory organs the mechanism of the digestive apparatus is rather a complicated matter, and really embraces a series of acts or stages. Briefly, these are as follows:—

(1.) Introduction of the food or its conveyance into the mouth, accomplished by the hands, lips, and teeth (prehension).

(2.) Thorough trituration of the food by the teeth through the movements of the lower jaw and the tongue; this latter keeping the food between the teeth (mastication).

(3.) The incorporation of the food with the saliva (the secretion of the salivary glands of the mouth), and its formation into a bolus or lump (insalivation).

(4.) The swallowing of this bolus, so as to transfer the food from the mouth to the stomach (deglutition).

(5.) The disentegration and dissolution of the food in the stomach by the movements of this organ, and its mixture with the gastric juice secreted by the glands of the stomach (gastric digestion).

(6.) The passage of the food not absorbed by the stomach into the intestines, where it undergoes a further very important elaboration, being acted on by the juices of the intestines, by the bile from the liver, and by the pancreatic juice secreted by the pancreas (intestinal digestion).

(7.) The expulsion out of the body of the innutritious portions of the food that have not been absorbed by the intestines as it passed along (defæcation).

It would be impossible within the limits of a work like the present, to give any detailed description of the digestive apparatus, and of the various secretions that the different accessory organs furnish for the solution of the food, but it may not be out of place to indicate briefly what articles of diet the respective solvent juices act on, and at what stages of digestion they come into play.

From what has been already said on the subject of Food, it will be remembered that the ordinary articles of diet may be classed under the three groups of (1), Starchy, (2), Albuminous, and (3), Fatty; the first and third serving as "fuel-food" for the body, and the second as "tissue food." All of these have to be rendered *soluble*, so that they can pass through the walls of the *alimentary canal* into the blood. In the case of the *Starchy* matters the difficulty is got over by changing them into *sugar*, which is just as soluble in water as starch is insoluble. This is accomplished by the action of the Saliva, secreted in the mouth by the salivary glands, of which the *Parotid* is the most active. The principle in the saliva for this work is a ferment called "ptyalin," and the only point in connection with its action is that it will work only in an alkaline medium, so that it is operative in the mouth and gullet. When swallowed into the stomach it has no further effect if the contents of that organ are acid. One has only to eat a small bit of bread, which, as we know, is chiefly composed of starch, and the sweet taste developed in the mouth as it is slowly chewed is practical proof of its conversion into sugar. Potatoes, and all the other starchy cereals that we eat are in the same way acted on by the saliva, and thus we see that there is a very important "mouth-digestion," which should impress on us the necessity of thoroughly masticating our food, as the more it is mechanically broken up by the teeth the more does the saliva and the other solvent juices get at it. Of course, the saliva has the further physical use of softening and moistening the food, for any one who has been ill and suffered from a dry and parched mouth knows how impossible it is to eat anything. About 3½ pints of saliva are daily poured into the mouth, and its flow is sometimes felt, as when "the mouth waters" at the sight or smell of dainty food. From this we learn that its secretion is largely under the influence of the nervous system, and most of us have experienced how dry the mouth gets under anxiety and fear.

The complex *Albuminous* foods are digested in the stomach, which is a dilatation of the alimentary canal, capable of holding about four or five pints. In shape, it is like the Scotch bagpipe, which is really the stomach of the pig, and it has two openings in it, one for the food to come in at so as to pass from the gullet, and the other for the digested food to get out of it into the intestine. This latter is, to some extent, valvular, and is called the *Pylorus, or Door-Keeper*, because it only allows things that are digested to pass through it, sending back again anything that is not sufficiently acted on. A reference to Fig. 2, in the second chapter of this book, will shew the position of the stomach in the abdomen. The stomach is lined, like the rest of the alimentary canal, by a mucous membrane, and in it lie a great number of glands. As soon as the food enters the stomach, they pour out a large quantity of fluid, known as the *gastric juice*, which is in every way different from the saliva. It is a clear, straw-coloured fluid, decidedly acid, from the presence of hydrochloric acid, and containing a ferment called "*pepsin*," which is only active in an acid medium. This gastric juice has the power of acting on albuminous foods, and converting them into *Peptones*, which are not only soluble in water, but very diffusible, passing readily through the thin membranous walls of the blood vessels. To facilitate the action of the gastric juice, the walls of the stomach exhibit very decided motion during digestion, contracting in such a way that they carry the food round and round as if it were being churned. The effect of this is to further help the sub-division of the food, and allow of the gastric juice coming into thorough contact with all parts of it, so that eventually the contents of the stomach are converted into a grey-coloured pulp of the consistency of pea-soup, and known as *Chyme*. During digestion, both openings in the stomach are closed, but as soon as the Chyme is formed and has become sufficiently fluid, the Pylorus relaxes, and the Chyme passes into the Intestines. The time occupied by Stomach Digestion varies with the articles eaten, but on an average may be said to range from three to five hours, and the amount of gastric juice poured out daily has been reckoned at 14 pints.

As yet, it will be noticed, no effect has been produced by the digestion on any Fatty Matters that may be present in the food. The fact is, they undergo no change in either the mouth or the stomach; unless, perhaps, they are somewhat melted in the latter organ. As soon, however, as they pass into the intestine they meet with the Bile, a golden-brown viscid fluid secreted by the Liver, that large organ which we saw in Fig. 2 occupied the upper right hand corner of the abdomen. The action of the bile on these fatty matters is to emulsionize them and make them capable of absorption. This it does largely by means of its soda salts, which are the real factors in separating the fat into the smallest possible drops, and thus making it soluble or miscible with water. The action of the bile can be very well illustrated by the simple experiment of shaking some oil and water together in a glass. They may apparently mix, but the moment the shaking ceases they separate at once. Add, however, some soda to them, and they will mix together at once, and remain so. If some bile were used instead of soda, the same result would follow. Bile, then, has a very important effect on the unaltered fatty substances that pass out of the stomach, and it is found that from this admixture with bile, the chyme, as it passes along the intestines, loses its grey colour and becomes yellowish. The bile has other uses in digestion, but its power of emulsionizing fats and rendering them capable of being absorbed is its chief one. Besides the bile, the chyme meets in the intestines with another solvent fluid the *Pancreatic Juice*, which is the Secretion of the Pancreas or Sweetbread, a gland that lies underneath and close to the Stomach. It is a transparent, colourless fluid of rather a complex composition, but containing certain ferments which enable it to change starch into sugar; to emulsify oils and fats; and to convert albuminoid substances into peptones. It can only do this in an alkaline medium, and so it comes in very opportunely that the soda salts of the bile change the chyme from being acid to be alkaline. As a result of this, we find that any starch that has escaped conversion into sugar in the mouth is acted on here, that the fats are emulsionized, and that any albuminoid substances are changed into soluble peptones. Lastly, the chyme comes under the influence of the *Intestinal Juice*, which also has some power of turning starch into sugar and of digesting albuminoids, so that by the time it has passed for only a short distance along the intestine, it has completely altered its appearance, assuming a yellowish-white tint, and becoming at the same time more fluid. To this fluid, which has been, so to speak, separated from the Chyme by the action of these three solvents—the Bile, the Pancreatic Juice, and the Intestinal Secretion—there has been given the distinctive name of Chyle, and, as we shall subsequently see, a special set of vessels are arranged to take it up and empty it into one of the large veins, so that it may mingle with the Blood near the Heart. The coarser undigested parts of the Chyme that are left after the separation of the Chyle, and are of no use as nourishment, are finally expelled from the body, their expulsion being largely due to the movements of the intestine set up by their irritation.

We thus see that Digestion takes place in the Mouth and Intestines as well as in the Stomach, and that no matter what the food we take, be it bread, meat, cheese, potatoes, milk, fish, or any of the other numerous articles of diet in common use, its life-history, in the words of Fothergill, is very much as follows:—"First it is chewed by the teeth, then it is rolled over by the tongue, then it is again chewed by the teeth; after this, it is rolled over once more by the tongue, and squeezed by the tongue against the roof of the mouth, and then swallowed. During this time it is well mixed with the saliva, so that the starch is converted into sugar. In the stomach, which is a muscular bag, the food is rolled over and over, and reduced to minute particles; so that it can all the more readily be dissolved by the action of the gastric juice. Two rings, one at the entrance and the other at the outlet of the stomach, keep the food in the stomach while it is being rolled over and digested. When the food is partially digested the ring at the outlet of the stomach relaxes a little, and the digested food passes into the intestines. Here the fatty portions of the food meet with the bile, which unites with the fat and breaks it up into very small, minute particles, so that it can be taken up from the bowels by tiny vessels called '*villi*.' Thus the body is nourished, while the undigested or waste matters pass out of the body by the bowels."

4. *The Absorption of the New Material.*—To understand this part of the digestive process we must remember that the whole of the interior of the *alimentary canal* is lined with a red mucous membrane similar to that of the mouth. This mucous lining, as its redness shews, is full not only of glands but also of blood-vessels, covered only by a single

layer of cells, so that the contents of the canal are in close proximity to the thin delicate walls of these numerous capillaries, and they can, if sufficiently fluid, make their way through them. And that is exactly what happens. The *venous capillaries*, especially of the stomach, become very active during digestion, and absorb or take up all the sugary, saline and other substances, which, like the peptones, are in complete solution, passing them directly into the blood. Then, along nearly the whole of the small Intestine there is a special modification of the mucous membrane, of such a nature as to increase its absorptive power. This consists in the presence of minute filaments on its surface, which have been likened in appearance to the "pile" seen on velvet, and are called *Villi,* which is the Latin word for small hairs. In shape these *villi* are conical, like the papillæ of the skin, and are covered over with a single layer of cells. In the interior of each of them is a network of small capillaries, but in addition there are the fine delicate branches of another vessel called a "*lacteal.*" When speaking of the general anatomy of the body it will be remembered that mention was made of the presence all through the tissues of a number of fine channels, not unlike small capillaries, except that they did not contain blood. They were spoken of as the *Lymphatics*, and their office, it was explained, was to take up and carry into the blood any excess of the nutrient serum or *Lymph* that had exuded into the tissues through the walls of the capillaries and had not been used up. In their course these lymphatics passed through a number of oval bodies, called *Lymphatic glands,* whose function was to serve as filters, so to speak, for the fluid passing through them, and also to help in elaborating it for the blood by the formation of white corpuscles. The "*lacteals*" are really the lymphatics of the small intestine, and they are so called because they are filled with the opaque *milky* (Lat. *Lacteus*) fluid the Chyle, which, as it passes along, adheres to the villi of the bowel and thus is absorbed, much in the same way as

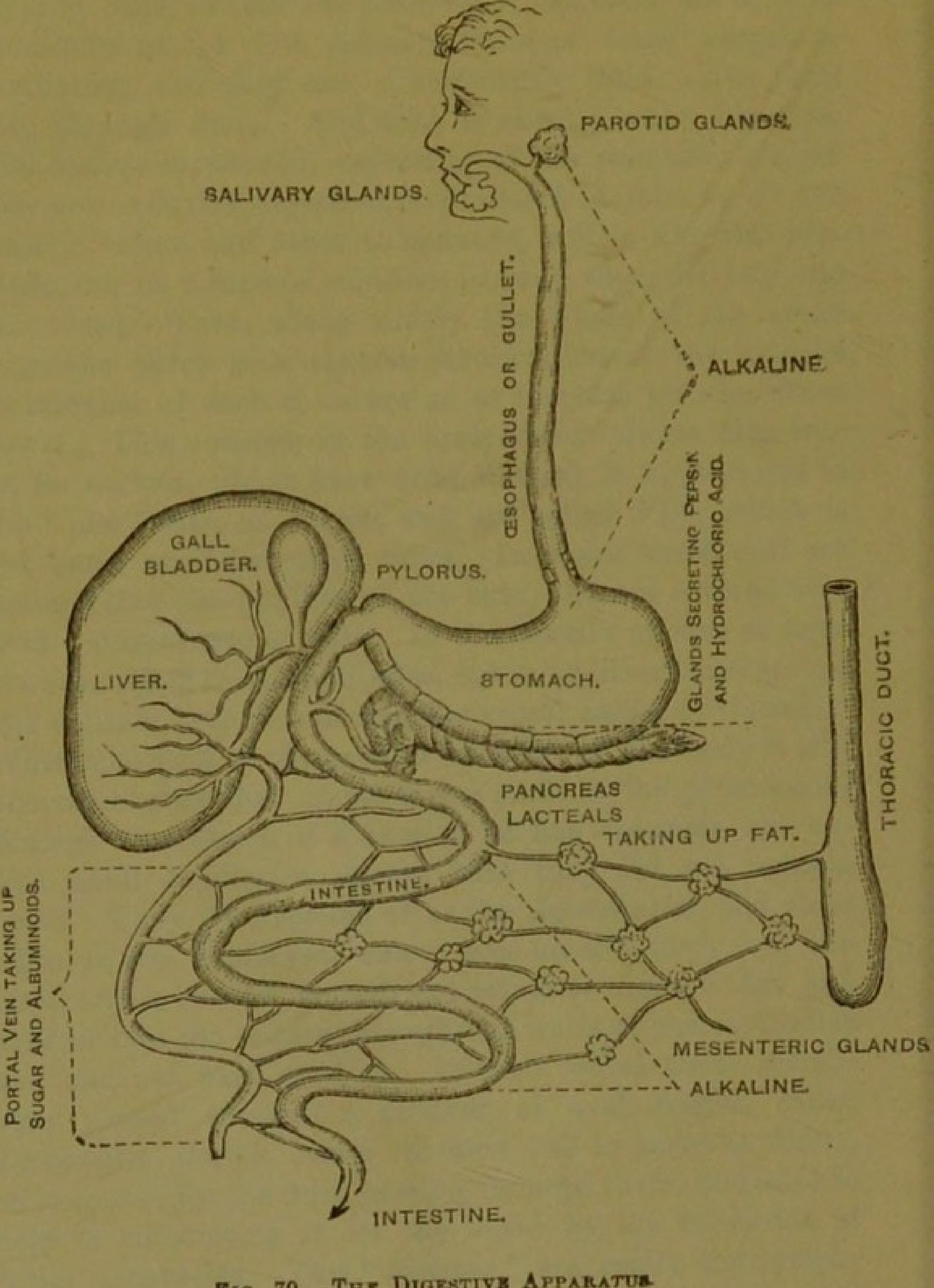


FIG. 70.—THE DIGESTIVE APPARATUS.

mercury will make its way through a bag of wash-leather, if subjected to pressure. This Chyle, it was pointed out, was largely formed by the action of the Bile and Pancreatic juice on the fatty matters of the food. The products of digestion find their way accordingly into the blood by two channels:—

(1.) The water, the peptones, the sugar, and any mineral salts by the veins of the stomach and intestines.

(2.) The fats by the lacteals.

The history of the food after it has entered the *Veins* and the *Lacteals* is not quite the same, and it may be briefly alluded to here. Let us take first the Veins and see what happens afterwards to the products of digestion absorbed by them. These products are, as mentioned above, the water, sugar, peptones and salts of the food. To understand the further progress of events, reference must be made to the diagram of the Circulation, Fig. 51, where it will be seen that the *Portal Vein* which collects the impure blood from the Intestines and Digestive organs does not go direct to the Inferior Vena Cava, but first passes through that large organ the Livèr, in which it breaks up into numerous small branches. This is rather a remarkable modification, for there is no other large vein in the body which does such a thing as to enter an organ and divide and sub-divide within its substance. It can only be done with an object, and what that is we shall shortly see.

Meanwhile, it may be mentioned, that this modification has received the special name of the *Portal Circulation*, evidently after the *Portal Vein*, which was thus named by the old anatomists, because it enters the liver at a spot where the hepatic duct and artery leave and enter the organ, and which was accordingly regarded as the *porta* or gate of entrance to the liver. The blood in the Portal vein, coming as it does from the Digestive organs and Intestines, is rich in the sugar, peptones, salts, and water, which have just been poured into it by the Digestive act.

These, as we know, are in a soluble form, and if poured directly into the general blood current they would probably drain away from the blood by the kidneys or other excretory organs long before they could be used up by the tissues. Hence, we should be constantly needing to take in fresh supplies of food, and the greater part of life would be spent in eating. To obviate this the products of digestion undergo a *secondary digestion* in the liver. This is accomplished by the cells of that organ, which in a very wonderful manner convert the sugar into a kind of insoluble animal starch called *Glycogen* and the peptones partly into *Serum-albumen*, which, as we saw in the chapter on the Circulation, is the nutritious principle of the blood. The remaining portion of the peptones, along with the salts and water, are made into Bile, which is the secretion poured by the liver into the bowel for turning the fats into an emulsion. From this it is clear that the work of the liver is two-fold, namely, the production of Bile, and secondly, the manufacturing of Glycogen and Serum-albumen. This last passes on into the blood by the Hepatic vein, but the Glycogen the liver stores up, as it were, in its cells, reconverting it gradually and slowly into grape-sugar to meet the wants of the system. Nothing could be more wonderful and admirable than this latter function, for, as was said above, it enables us to store up in our bodies a supply of food that will last us while sleeping or engaging in the every-day work of life, and thus does away with the necessity for constantly taking meals.

Passing next to the Lacteals, let us see what is done with the Chyle absorbed by them. It passes along these vessels, which gradually increase in size, and unite into a kind of network. Placed at intervals on them are small oval bodies, called the *Mesenteric Glands*, (see Fig. 70,) which resemble those found on the lymphatics of the body, and have, apparently, the same task of further elaborating the Chyle, so that it comes to contain a number of white bodies like the colourless corpuscles of the blood. Eventually the

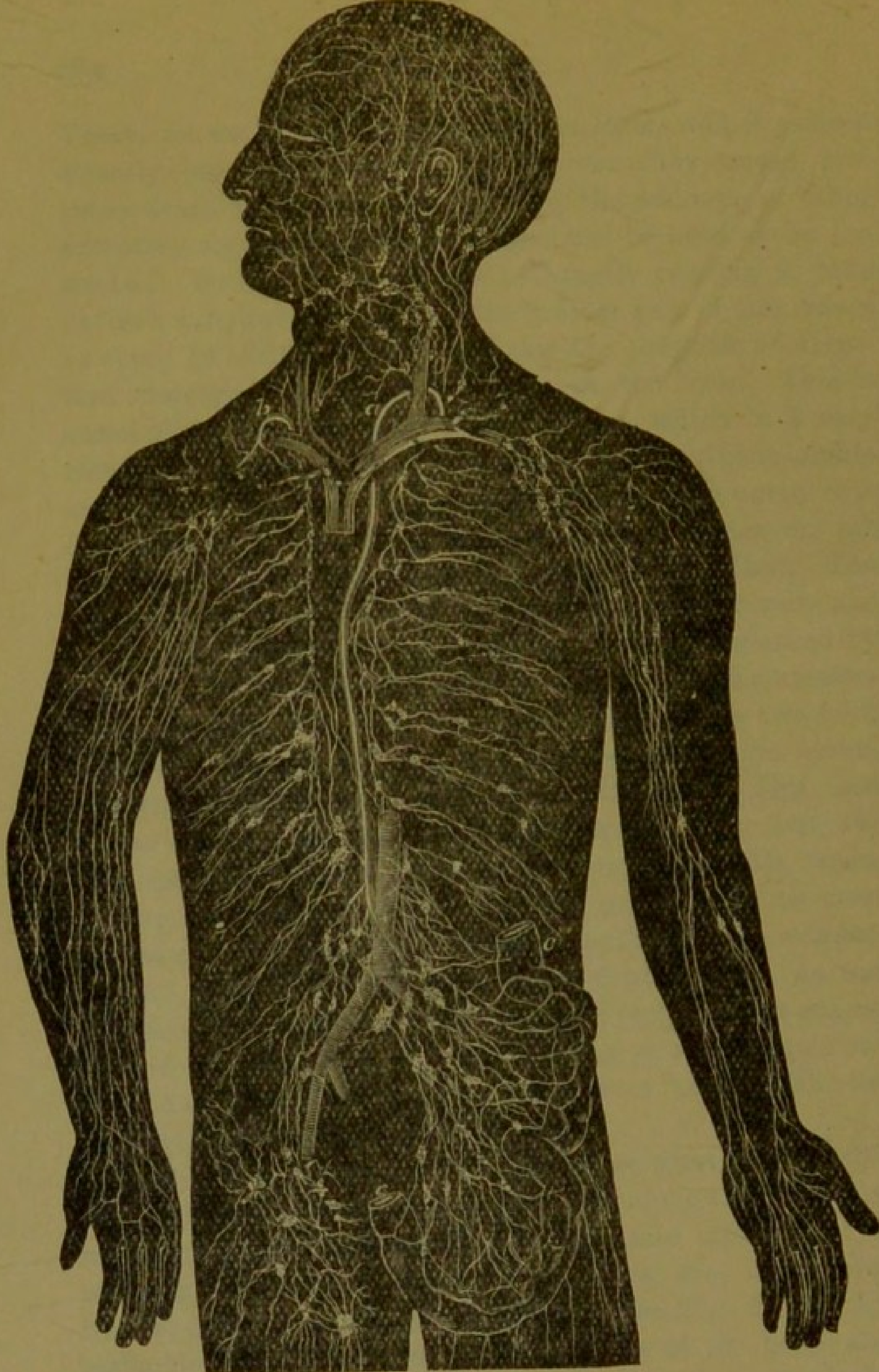


Fig. 71.

Absorbent System.—Diagramatic view of Lacteals and Lymphatics —a, thoracic duct opening into the angle of junction of left sub-clavian and internal jugular veins; b, right lymphatic duct opening into angle of junction of right jugular and sub-clavian veins; c, c, portion of small intestine, with lacteals proceeding from it to the receptaculum chyle. On the right arm the superficial lymphatics are exhibited; on the left the deep lymphatics.

Lacteals unite, and pour their contents into what is called the *Thoracic Duct*, a tube that lies along the vertebral column, and terminates in the veins of the neck, at the junction of the internal jugular and subclavian on the left side. Into this tube the Lymphatics of all the rest of the body also open, so that it may be regarded as the general trunk of the Lymphatic system. (See Fig. 71.) Seeing then that the milky-looking chyle is really composed of the fatty matters of the food, it may be said that the fats pass directly into the blood, and undergo no secondary digestion.

With this short sketch of how the Food finds its way into the blood, the account of the Digestive process may be appropriately brought to a close. A great deal more of interest might be written on this subject of Digestion, but sufficient has been said to acquaint the Ambulance pupil with the leading facts of it. To some it may seem out of place to introduce the matter at all in a book on "First-Aid," but not a few cases of sudden illness are due to indiscretions of diet, of which the Convulsions of young children are an example, and many persons lose their lives every year from the introduction either wilfully or by mistake, of poisonous substances into the system. No apology then is needed for briefly describing that important function of the body, which makes man a self-repairing machine, and has such an important bearing on his bodily health and strength.

CHAPTER XII.

POISONING.

SCENE.—Clinical Wards of Edinburgh Royal Infirmary. John Murdoch, a patient suffering from Thoracic Aneurism of the Aorta, had at his bedside a liniment of Aconite, &c. Under the stress of a paroxysm of pain he drank it off, and was soon dead.

DIALOGUE.—The Physician and his Assistant converse.

Physician.—Well, sir, what about Murdoch? Did you see him alive?

Clerk.—Yes, sir.

Physician.—Did you feel his pulse?

Clerk.—No, sir.

Physician.—Did you observe any frothing at the mouth and nose?

Clerk.—No, sir.

Physician.—Did you count his respirations?

Clerk.—No, sir.

Physician.—Then, sir, what on earth did you do?

Clerk.—*I ran for the Stomach-pump.*

Horæ Subsecivæ, Vol. I., Introd. p. 72.

THE genial author of *Rab and his Friends* gives the above as an admirable illustration of the striking contrast that is occasionally presented between the science and art of medicine, as seen in the conduct of the scientific and the practical physician, respectively, under similar conditions. The one looks very much to essence and cause, and, in his desire to be ignorant of nothing, studies minutely and leisurely the phenomena of every case, even though it be one of poisoning; while the other looks to facts as he finds them, spends no time in studying symptoms, decides at once what is the best thing remedially, and, in such a case as that of poisoning, runs for the stomach-pump with the view of practical action. As the present chapter is to deal with the subject of *What to do in cases of Poisoning*, I have prefaced it with the above dialogue, because the teaching it conveys comes in most appropriately here, and emphasizes that *promptitude of treatment is the leading feature in dealing with cases of this description.* Once it is clear, either from the report of those around, or from the person's own statement, or from the surroundings of the case, that it is one of poisoning, the ambulance pupil should proceed to act without delay, studiously avoiding, of course, all appearance of hurry and excitement. Before detailing the help that an ambulance pupil can give in these cases, it may be as well to make here a few preliminary remarks that will render clearer, I think, the nature and limits of the "*first-aid*" to be rendered.

Cases of sudden Poisoning arise mainly from three causes:—(1) Accidents, (2) errors in administration, (3) attempts at self-destruction. The word *Poison* is connected with a Latin word meaning "drink," and, no doubt, many poisons are taken in a fluid form, but not invariably so, for when we speak of a person being *poisoned*, we mean that there has been introduced into the system, either by the stomach, lungs, or skin, an agent that is capable of producing harmful and even deadly effects upon the life of the individual. It is not easy to say exactly what is and what is not a poison; for a substance that is fatal in large quantities may be positively beneficial or remedial in smaller amounts. Hence it is that we find the ancient Greeks using the same word both for a medicine and a poison. Of course there are substances that are deadly in the smallest quantities, and the popular, though erroneous, idea is that these are the only substances that should be regarded as poisons; but the truth is that, if we analyze the deaths from poisoning in any given year, we will find, in the first place, that a very large number of them are due to the *improper use* of substances that are invaluable in the treatment of the sick, and are otherwise useful agents. Take, for instance, the year 1886. In it 511 deaths occurred from poison, which included 95 cases of chronic poisoning by lead amongst those engaged in the manufacture of this substance. If we omit these, it appears that opium, with its well-known preparations—laudanum and morphia—heads the list of poisons, 82 deaths having been caused by it. Next in the list stands carbolic acid, with 20 deaths; then belladonna, with 9; alcohol, with 7; aconite, chloroform, and hydrochloric acid, each with 6; prussic acid, ammonia, and strychnine, each with 5.

Further examination into the Registrar-General's report, from which the above figures are taken, brings out very clearly that all of the above deaths may be classed under the heads of accident and negligence, and that the two prolific causes of *accidental poisoning* are the following:—

(1.) The giving or taking of overdoses of certain remedies containing poison.

(2.) The substitution of one bottle or substance for another.

Under the first heading may be instanced the giving of overdoses of opiates or soothing preparations to children, and the taking of overdoses of narcotics or sleeping mixtures, as chloral, by habitual users of them. Under the second heading should be placed such mistakes as substituting a bottle containing perhaps a liniment for a mixture meant to be given internally, and the rash and foolish habit of quaffing off a draught from any jug, bottle, or cup, without examining or being sure of its contents. If we add to the above the not uncommon but dangerous custom of congregating together, in the domestic cupboards, a number of different bottles, some of them containing powerful medicines, and hence poisonous in overdoses, it is quite easy to see why the annual mortality from accidental poisoning is so great. It is, however, surprising that, with these facts before them, people should still continue to disregard such well-known rules as never to give opiates to children, never to keep together medicines for external and internal administration, and never to give or take the contents of a bottle until they have read the label on it stating the directions for its use. Especially should this caution be exercised at a time like the present, when the progress of chemistry in recent years has introduced such a vast number of new substances of a powerful nature, and in such quantities that the liability to accidents and mistakes has enormously increased.

Classification of Poisons.—Looking to the great variety ot substances that may be reckoned as poisonous, it is customary, for the sake of convenience, to group them under certain headings. One arrangement is to classify them as follows :—

(1.) *Animal.*—These are represented by the deleterious substances generated by tainted or decomposed meat, bad fish, &c., and by the virus of venomous creatures, as serpents, insects, &c.

(2.) *Vegetable.*—These consist of various products of the vegetable kingdom, many of which are used in medicine, as morphia, strychnine, belladonna, &c.

(3.) *Mineral.*—This group contains such substances as arsenic, the various acids, caustic potash, caustic soda, &c.

(4.) *Aerial.*—Under this division come all deadly gases, germs, and atmospheric impurities. These have already received some attention when the condition known as Asphyxia was dealt with; and as the baneful effects of germs and other atmospheric impurities shew themselves under what is known as blood-poisoning, typhoid fever, &c., diseases that call for medical supervision from the first, they will receive no further notice in a book devoted to Ambulance work. As regards the two groups of vegetable and mineral poisons, it may be taken as granted that the most violent and subtle are derived from the vegetable kingdom. Thus, bulk for bulk, nothing from the mineral world equals, in its deadly effects, some of the poisonous substances used by the South American Indians to dip their arrows in. The mineral drugs which cause harm are comparatively few in number, and, with the exception of arsenic, are not especially violent poisons.

Perhaps the most convenient and most generally adopted classification of poisons is that which arranges them according to *their mode of action or the symptoms they produce.* Following this plan we have three leading groups :—

1. Those that cause great irritation and even destruction of the tender lining membrane of the alimentary canal. These are known as *irritants.*

2. Those that induce sleep, which passes eventually into stupor and death. These are called *narcotics.*

3. Those that give rise to delirium with spectral illusions, accompanied often by convulsions, and followed by death. These are spoken of as *narcotico-irritants.* This latter group is by many authorities regarded as a subdivision of the second one, and they speak of only two classes of poisons,—the irritants and the narcotics.

Symptoms of Poisoning.—Although such an arrangement as this indicates the leading characteristics of the different groups of poisons, it may be as well to mention more in detail the leading symptoms of each.

Irritant poisons, when taken into the stomach, usually excite pain, sickness, and purging, unless they have been taken in very large quantities, when the person affected sinks into a state of collapse and dies quickly. When purging occurs, the matters passed by the bowel are often tinged with blood, and there is a constant desire to go to stool. As several of the irritant poisons corrode or destroy all the parts they come in contact with, the name of *Corrosives* has been applied to those possessing this quality. When swallowed, these latter very often burn the lips, leaving marks and stains on them and around the mouth, thus affording valuable information as to the kind of poison taken. Another symptom that those corrosives give rise to is a burning sensation extending from the throat to the stomach. This is due to the destruction wrought by them on the tender lining membrane of the mouth, tongue, and gullet.

All *narcotic* poisons act specially on the nervous system, that is on the brain and spinal cord. They induce drowsiness, which soon deepens into stupor, and this, in its turn, if not treated, passes quickly into insensibility and death.

Narcotico-irritant poisons produce a kind of compound action. Thus, they cause pain in the throat and stomach, vomiting, and delirium; this last being characterized by spectral illusions, and often followed by convulsions, or the spasms of lockjaw.

Individual cases may, of course, vary in particular symptoms, but the above description of the leading characteristics of the various groups of poisons should assist the ambulance pupil in referring any known or suspected case of poisoning to its proper class, and thus help him in the matter of "*first-aid*" treatment.

The *Irritant* poisons comprise the following:—

1. *Acids*, of which those most commonly taken are oxalic (salts of sorrel), carbolic, sulphuric (oil of vitriol), nitric (aqua fortis), hydrochloric (spirit of salt), &c.
2. *Alkalies*, as caustic soda, or potash, &c.
3. *Metals*, as arsenic, mercury (corrosive sublimate), antimony (tartar emetic), lead (sugar of lead), phosphorus, copper (blue vitriol), iodine, &c.
4. *Vegetable and animal irritants*, as croton oil, tainted fish, meat, or game.

Of the *Narcotic* poisons the most important are—

1. Prussic acid and essential oil of almonds.
2. Opium and its preparations.
3. Belladonna (deadly nightshade).
4. Chloroform, chloral, &c.
5. Alcohol.

The *Narcotico-irritant* poisons include—

1. Strychnine.
2. Aconite (monks' hood).
3. Digitalis (purple foxglove).
4. Hemlock.
5. Poisonous fungi (mushrooms).

Before considering the treatment of cases of poisoning, a few words may be said as to their recognition. There is, of course, no difficulty in those cases where the poison has been taken or been administered accidentally, and the mistake is at once discovered; but there is a difficulty where this has happened unwittingly. Under these latter conditions there is always the danger that the symptoms produced may be mistaken for disease, and treated as such, valuable time being thereby lost. The following indications are useful helps in distinguishing between the two classes of cases. It is always a suspicious circumstance where the *general symptoms* of poisoning—viz., vomiting, purging, cramps, pain in the stomach and bowels, delirium or unconsciousness—appear suddenly while the individual is in health, or soon after a meal, or soon after some kind of food or medicine has been taken, or where they attack a number of persons that have partaken, at the same time, of the same food or medicine. This latter fact is one of considerable importance, for, if we except malignant cholera, there is no disease resembling poison which is likely to attack several healthy persons at the same time and in the same manner. In suicidal cases of poisoning it is not always easy to detect what poison has been used, especially where the individual has become unconscious; but the person's surroundings will sometimes throw some light upon this point; and it may be mentioned here that in all cases of poisoning it is a good plan to carefully preserve, in a clean vessel, any vomited matters, or the remains of any suspected food or drink, as a great deal of valuable information may be got from subsequent examination of them.

Treatment of Poisoning.—A better understanding of the "*first-aid*" treatment of cases of poisoning will be obtained by first indicating briefly how a medical man acts in such cases. In the first place, when summoned to a case of poisoning he goes *at once*, taking with him his antidote bag, or, at any rate, his hypodermic case of remedies and a stomach-pump, not forgetting to extract all the information he can out of the messenger, so as to save time afterwards in questioning and inquiries. On reaching the patient he satisfies himself as quickly as he can as to the poison taken, and as to what has already been done for the case, and without further delay he commences treatment. This is of two kinds, (1) *local*, and (2) *constitutional.* The local treatment is of considerable importance, and has two aims:—

(1.) Preventing the further absorption of the poison.

(2.) Counteracting its irritating effects, or rendering its operation powerless.

The constitutional treatment is directed to antagonizing the action of any of the poison that has been absorbed into the system, and to stimulating the patient where necessary.

In the larger number of cases the means adopted by the medical man for preventing the further absorption of the poison consist in obtaining *its immediate removal from the stomach.* This is accomplished either by the use of a certain class of remedies called *emetics*, which induce vomiting, or by employing the stomach pump. The emetics in general use in medicine are apomorphine, common salt, mustard, sulphate of zinc, powdered ipecacuanha, ipecacuanha wine, sulphate of copper, tartar emetic, antimony, and powdered alum. The stomach-pump, with its long flexible tube for passing down the throat, and its syringe, with special valves, is another very valuable means for pumping in and withdrawing water from the stomach, and thus removing any poison. In some cases, however, the local treatment is rather directed to counteracting the effects of the poison, or in rendering it inert. This is attained by administering a distinct "*antidote*" to the substance taken. Thus, if any of the strong *acids* have been swallowed the proper line of treatment would be to give an *alkali* such as soda, which neutralizes the acid, and is consequently regarded as its antidote. White of egg, milk, flour and water, salad oil and castor oil, are other means often used for counteracting the effects of certain poisons especially those of the irritant class.

As soon as he has satisfied himself that all proper local measures have been taken, the medical man next proceeds to meet the effects of whatever portion of the poison has been absorbed, and this he does by constitutional treatment, which consists in antagonizing the poison by a suitable antidote. This line of treatment is founded on the fact that certain drugs counteract each others effects, and are what are termed their "physiological antidotes." This is very well illustrated by the antagonistic action of opium and belladonna; so that when opium is the poison taken it is customary to administer belladonna as the physiological antidote. Other instances of this antagonism might be given, but sufficient has been said to shew its importance, and the necessity of having early medical aid in these cases, for it is really only on a correct appreciation of the physiological action of drugs that the rational treatment of a case of poisoning can be carried on.

In addition, however, to the administration of constitutional antidotes, the medical man does not lose sight of the depressing action of the majority of poisons, particularly the narcotics, and he meets this by giving suitable stimulants, such as those in ordinary use, or strong coffee, or ammonia, in the form of sal-volatile. As a heart stimulant he sometimes has recourse to nitrite of amyl by inhalation, while mustard over the heart, and warmth to the extremities in the shape of hot towels, hot water bottles, and friction with the warm hand, are also employed. Lastly, artificial respiration, the galvanic battery, transfusion, and bleeding, are occasionally deemed necessary, and are accordingly carried out.

Briefly summarized, then, the three points kept in view in the medical treatment of cases of poisoning are the following:—

1. To get rid of the poison.

2. To counteract its effects by either local or constitutional antidotes.

3. To remedy the evil that has been done, and keep the

patient alive, obviating the tendency to death by the use of stimulants, warmth, artificial respiration, or whatever other appropriate means are called for.

From what has been said, too, it will be observed that the order of procedure in the majority of cases of poisoning is that given above. No doubt a few poisons are better treated by *local antidotes* in preference to emetics, but as a rule the leading indication for treatment is to induce vomiting, and get rid of the poison at once. This being so, it is evident that the ambulance pupil may often be of great service without trenching on the province of the doctor, for though he cannot use the stomach-pump, he can readily and safely induce sickness by the simple expedient of irritating the back of the throat with his finger or a feather, or by administering such a safe emetic as a dessert spoonful of mustard stirred up in a teacup of warm water. Then, the employment of *local antidotes* is not altogether beyond his skill, for the action of many of the most dangerous poisons may be counteracted by the use of articles in daily use, and consequently always at hand. Such common acids as vinegar, lime juice, lemon and orange juice, are useful antidotes to poisoning by alkalies, just as the common calcined magnesia, beaten up with water or milk, and given in considerable quantity, is the best remedy for poisoning by acids. In the same way, white of egg, milk, flour and water, salad oil and castor oil, administered freely, are invaluable where irritant poisons have been swallowed. Lastly, in remedying the evil that has been done, and in keeping the patient alive, the ambulance pupil may often be of the greatest assistance. It requires no special skill to keep a patient awake when yielding to the sedative influence of an overdose of opium, nor to encourage, by diluent drinks, such as linseed tea, gruel, and very thin arrowroot, the vomiting which commonly follows the taking of such poisons as the strong mineral acids.

Emetics.—Before giving special rules for the treatment of the different kinds of poison, it may be as well to mention here a list of the safest and simplest emetics:—

1. Irritating back of the throat with the finger or a feather.

2. Large draughts of *tepid* water.

3. *Mustard* (the flour).—One tablespoonful mixed with half-a-pint of *tepid* water, that is a tumblerful and a-half.

4. *Common Salt.*—Two tablespoonfuls in half-a-pint of *tepid* water. Not a very certain emetic, but its action may be encouraged by irritating the throat as described above.

5. *Ipecacuanha.*—May be employed in the form of the wine or the powder. Two tablespoonfuls of the former may be given in water to an adult, and half-a-teaspoonful of the latter. Ipecacuanha, it must be remembered, is not always very prompt in its action.

6. *Powdered Alum.*—A tablespoonful in half-a-pint of *tepid* water. This is not a very powerful emetic, and its action sometimes requires to be aided by irritating the throat.

7. *Smelling Salts.*—These are composed of carbonate of ammonia, and half-a-teaspoonful or more of these in half-a-pint of lukewarm water will generally prove an efficient emetic.

8. *Gunpowder.*—The contents of one or two blank cartridges mixed with *tepid* water induce vomiting promptly.

The above are perhaps the most efficient and safest emetics, and possess the great advantage of being usually at hand. The doses given are those for adults, and they should be correspondingly diminished for children. Never, however, when face-to-face with a case of poisoning, shew any preference for one emetic over another. Employ the one that is at hand. The majority of people are very readily induced to vomit, and it does not, as a rule, require very powerful means to bring about that result. Tepid water has been mentioned as the vehicle for many of the above substances, and no doubt its action is helpful, but never let valuable time elapse in waiting for it. Employ cold water until it can be obtained, and remember that irritation of the throat with the finger or a feather is always available as an aid to the action of any emetic. The cases where there is most difficulty in inducing vomiting is in opium poisoning, owing probably to some paralysis of the stomach from the action of the drug. Perhaps the safest and quickest emetic that we have is *sulphate of zinc*, which occurs in crystals very much like those of epsom salts. Given internally, in doses of ten grains up to half-a-teaspoonful dissolved in water, it sets up vomiting speedily and surely. This preparation is not always to be got in ordinary households, but it is what a chemist generally sends if asked to furnish an emetic. And here it may be mentioned, that just as *on all occasions of poisoning a doctor should invariably be sent for at once*, so no harm can come of asking the messenger to call, on his way back, at a chemist's, and ask for an emetic. As a rule, twenty grains of sulphate of zinc will be sent, or an ounce of ipecacuanha wine. In those cases where the poison has of itself set up vomiting, then the indication is simply to encourage the symptom by copious draughts of lukewarm water, continuing these until everything seems expelled from the stomach, as shewn by the water coming back clear.

The cases where there is no clue as to what the poison is that has been taken are always difficult and anxious ones, especially for the medical man, who has to aim in his treatment at remedying the effects of a poison. The "first-aid" treatment is, however, clear. Under these circumstances, all that can be done is to give an emetic of mustard and water, followed by a handful of flour made into a cream with water, or two or three eggs beaten up, or even a cupful of milk. The vomiting that will probably quickly come on should then be encouraged by lukewarm water; and when the stomach seems thoroughly emptied, a cupful of hot strong tea should be administered, the person being put to bed to await the arrival of the doctor, who has, of course, been summoned. The only thing that would modify the above procedure would be the noticing of any stains about the lips and mouth of the person poisoned. This would imply that some strong *acid* had been taken, the "first-aid" treatment of which would be *the avoidance of any emetic*, and the immediate administration of cold water, or preferably soap and water, in as large draughts as possible, followed by calcined magnesia beaten up with water or milk in considerable quantity to effect the neutralization of the acid. After that, milk, thick gruel, or a wineglassful of any kind of oil, except the oil of almonds, would be useful. In dealing with cases of poisoning, the ambulance pupil should avoid all appearance of excitement and hurry, and should also check similar indications in others. This is not always easy, but may sometimes be attained by singling out the chief offenders, and giving them something to do in the way of boiling water, making tea, or going on an errand. In the next place, the same rule holds good here as in drowning, never to look upon a case as hopeless until a medical man has indicated that any further efforts are useless. Lastly, remember that, even after apparent recovery, there may be a return of unfavourable symptoms, and cases of poisoning require careful watching for some time afterwards.

Seeing that an Ambulance Handbook is one to which reference will probably be made in cases of difficulty, I feel that it is necessary to give a somewhat more detailed account of the different kinds of Poisons and their Treatment. Following the classification already given, I will commence with the *Corrosives*, substances which belong to the class of Irritants, but yet possess such special characteristics that they are entitled to be considered by themselves.

CORROSIVES.

The following are included in this group, and require a few words of separate notice:—

(1.) *Acids.*—These are derived both from the Vegetable and the Mineral kingdom, and are used extensively both in medicine and the arts. They are known by their sour, sharp taste, and by their power of completely neutralizing the properties of the Alkalies. Some of them have such an affinity for water that they greedily take it up, and if applied to the tissues of the body they shrivel them up and destroy them, owing to the rapidity with which they absorb the fluid in them. It is this feature that has led to their being termed *Corrosives.* Of course all Acids are not of this nature, some being astringent, or irritant only in large doses. The chief Corrosive Acids are six in number, viz. :—

1. Sulphuric (Oil of Vitriol).
2. Hydrochloric or Muriatic (Spirits of Salt).
3. Nitric (Aquafortis).
4. Glacial Acetic (Pyroligneous).
5. Carbolic (Creosote).
6. Oxalic (Acid of Sugar).

The first three of these are the most powerful. *Sulphuric Acid* is a heavy colourless oily fluid, and has been administered in mistake for castor oil. It has figured, too, of late years, somewhat frequently in those miserable and cowardly cases of "vitriol throwing." *Hydrochloric Acid* has generally a yellowish tinge from a trace of iron dissolved in it, and is not an uncommon cause of Poisoning, being mistaken usually for beer or brandy. *Nitric Acid* with its strong fumes is rarely taken accidentally; and the same may be said of the *Glacial Acetic Acid,* used for destroying warts, and a solution of which forms ordinary vinegar. The very reverse holds good with *Carbolic Acid,* which has of late years attained an unenviable notoriety from the number of accidental deaths it has caused. Its use has become so widespread that it is found now in every household, and it has been both administered in error for other medicines and taken by mistake. *Oxalic Acid,* so largely used by dyers and calico-printers, and for cleaning kitchen boilers, bears a strong resemblance to Epsom Salts, and this has frequently led to its being taken accidentally. It is a powerful substance, and very rapid in its action, so that half-an-ounce of it has frequently proved fatal in less than an hour. In connection with this substance, it may be mentioned, that the *Salts of Sorrel*, sold under the rather treacherous name of *Salts of Lemon*, and so much used for bleaching straw, or removing ink stains, act as a poison just as Oxalic Acid does, though chemically differing from it, being a compound of Oxalic Acid and Oxalate of Lime.

The *Symptoms* that follow the taking of any of these strong acids are those already given. We have a burning sensation in throat and stomach, which soon amounts to severe pain, and is accompanied by vomiting, very often of bloody fluids. In a short time all the features of shock or collapse shew themselves, great difficulty of breathing comes on, and the patient quickly succumbs, especially if the quantity of concentrated acid taken has been large, and there has been no food in the stomach. Besides these constitutional symptoms we have local ones in the shape of damage done to the mouth and lips, and the colour of the staining which takes place is at times a guide to the Poison taken. Thus, the Sulphuric and Hydrochloric Acids discolour the lips and mouth *black*, Nitric Acid *yellow*, while Oxalic and Carbolic Acids give them a *whitish* appearance.

The "first-aid" *treatment* in these cases consists in *the neutralization of the Poisons.* This must be the first object. It alone will counteract the baneful local effects. It is best accomplished by the administration of *Alkalies*, which possess the property of neutralizing the strongest acids. The best known of them are *Potash*, *Soda*, and *Ammonia*, this last being what is called a volatile alkali. Hence it is made the chief ingredient in ordinary smelling salts. In addition to the alkalies themselves, we have the alkaline earths, as Magnesia, Lime, and Chalk. *When used as antidotes all the above alkalies must be diluted* *freely with water.* In an emergency every household will furnish some, if not all of them. Thus, we have nearly always at hand washing soda, baking soda, calcined magnesia, Dinneford's magnesia, and lime in the form of lime-water, saccharated solution of lime (which is the best because the strongest), or the scrapings from the walls or ceiling of any room. Chalk, too, is generally to be got as whiting, white crayon for drawing, and tooth-powder. Lastly, in soap, which is a compound of fat or oil with an alkali, we have an excellent remedy, large draughts of soap and water being invaluable in cases of Poisoning by acids. Of the above mentioned substances, I should be inclined to regard the *Calcined Magnesia* as the most effectual. While, however, *neutralization* of the Poison is the great object of treatment, free dilution of it is not to be lost sight of, and indeed, in the absence of any alkali, moderate and frequent draughts of cold water would be better than doing nothing. Subsequently, soothing demulcent drinks, as milk, oil, thick gruel, white of egg and water, gum and water, linseed tea and barley water are all useful. If much pain is complained of in the stomach and bowels, warm linseed poultices to the abdomen are very soothing, while for the difficulty of breathing, that sometimes comes on from the swelling of the mucous membrane of the throat, nothing is better than the application of hot sponges externally to the neck. Nothing has been said here, it will be noticed, about giving an emetic, because, as has been mentioned, it is not the indication for treatment. Fortunately, vomiting nearly always comes on, and it should, of course, be encouraged, as it will be by free dilution of the antidotes administered.

In cases of "*vitriol throwing*" the assistance to be rendered consists in wiping off the acid at once, and washing the face in water with a free use of soap, though a small handful of washing soda in the water is still better. Act as quickly as possible in these cases, and attend specially to the eyes, washing them well out with a weak soda solution, and then dropping some olive or castor oil between the lids.

Carbolic Acid produces the same symptoms of poisoning as other *Corrosives*, and its "first-aid" treatment is on the same lines; but the antidote that should be specially administered is a table-spoonful of the ordinary *Epsom Salts* (Sulphate of Magnesia), in half-a-pint or more of warm water. In its absence, any other sulphate will do, and Glauber's Salt (Sulphate of Soda) is an excellent substitute. The *rationale* of the treatment is that these soluble sulphates form, with the Carbolic Acid, Sulpho-Carbolates, which are harmless in the blood. The administration of the sulphates should be followed by an emetic, and when it has acted, steps should be taken to meet the depression and collapse which so often supervene in these cases. This is best done by free stimulation, by warmth to the extremities, and by giving white of egg in milk or water. In the absence of the *Sulphates*, the administration of lime, with eggs and milk, would probably be the best thing to do.

In poisoning by *Oxalic Acid*, or by the *Salts of Lemon*, it is important to remember that the alkali chosen should be *Magnesia* or *Lime* in some form, as chalk, scraping from the walls or ceiling, white drawing crayons, tooth-powder, &c., because, if Potash, Soda, or Ammonia are used, they form soluble compounds which are absorbed, and are decidedly poisonous. Vomiting, too, is not so important here as the neutralization of the poison, so that the antidote should be mixed with just sufficient water to make it drinkable, and it may be administered in wine-glassfuls until about a couple of ounces of the Magnesia or Chalk have been taken.

(2.) *Corrosive Sublimate.*—This is the name given to a preparation of Mercury, because of its very acrid and poisonous properties. It is a very valuable preparation, and of late has come a great deal into use as an antiseptic in surgical work. It occurs as a heavy white crystalline substance, and has been mistaken for Calomel. When taken in too large a dose, its *Symptoms* are like those of a powerful irritant, such as Arsenic. There are vomiting and purging, with intense abdominal pain, and great depression. Locally, the mucous membrane of the mouth and tongue are white and shrivelled. The "*first-aid*" *treatment* consists in giving an antidote in the form of white of egg (unboiled). As one egg will only neutralize about four grains of the poison, the contents of several eggs should be swallowed. A good plan is to mix the whites of six eggs with a pint of water, beat them up, and give a wine-glassful every two or three minutes, so as to favour vomiting. If this does not take place, one of the ordinary emetics mentioned should be administered subsequently. When eggs are not obtainable, milk, flour and water, barley water, or arrowroot and water, are the best substitutes, and they should be given freely.

(3.) *Alkalies.*—These are substances which, chemically, are the very opposite of Acids. The best known of them are Potash, Soda, and Ammonia. When taken internally in such forms as Caustic Potash, Caustic Soda, Pearl-ash, or strong solution of Ammonia, they give rise to all the *Symptoms* of poisoning by the Corrosive Acids, with intense swelling and inflammation of the lips and mouth. The *treatment* is by the administration of acids, of which the most readily obtained will be ordinary vinegar. It is best given diluted with half its bulk of water. Lime juice, lemon and orange juice, mixed with water, may also be employed. After the poison has been fairly neutralized, soothing and demulcent remedies—as milk, olive oil, raw eggs, arrowroot, and barley water—should be given. The above is also the treatment in poisoning by "Hartshorn and oil," which is a solution of Ammonia in Oil of Turpentine, with other substances, and is a very popular liniment for the chest.

IRRITANTS.

The following are the chief members of this group, several of which, it will be observed, are *metals*:—

1. *Arsenic.*—This substance is always associated in the popular mind with the idea of poison, owing, no doubt, to the fact that it was invariably the agent selected in the notorious wholesale poisonings of the Middle Ages. In the present day what gives arsenic its interest is that it is largely used in the manufacture of various articles. Thus, it is a constituent of a great many pigments and colours, especially in connection with dyeing and calico-printing, and, in consequence of this, some of the well-known aniline dyes have been rendered dangerous by its presence, so that the wearing of articles of dress dyed with them has been followed by all the symptoms of arsenical poisoning, and infants have been known to suffer severely from sucking or chewing bright-coloured ribbons. Again, the well-known and pleasing greens, such as Scheele's green or Vienna green, which are used so much in paints, in wall papers, in artificial flowers, and in colouring children's sweets and toys, all contain arsenic, as well as copper, and serious harm has resulted on many occasions from this fact. This should lead to great care in the selection of the sweets and toys that are so lavishly bestowed in the present day on children at Christmas and other festive seasons, for many of them are anything but safe. Arsenical colours are also very common in the capsules of paint that fill the ordinary paint boxes given to children; and when it is remembered how their artistic efforts are invariably accompanied by a copious application of saliva to the brushes, it is easy to see how danger may arise, and how serious trouble, in the shape of mysterious sickness, nausea, and vomiting, may be due to what has been called one of the "perils of the nursery." Seeing, then, how much arsenic enters into our wall papers, candles, carpets, advertisement cards, playing cards, wrappers for sweets, ornaments for children's toys, india-rubber balls, dolls, japanned goods, artificial flowers, &c., it is no wonder that one writer asserts that "it is an unquestionable fact that the national health is suffering from the use of arsenic and other poisons in the manu-

facture of domestic fabrics to an extent not yet fully appreciated by the public" *(Carr)*.

Besides its presence in the manner above described, arsenic finds its way into households by other channels,—being used alone or mixed with sugar as rat poison, as vermin killers, as fly papers, and in the preparation of animal and bird skins for stuffing. When we remember that arsenic is very like salt or powdered white sugar in its appearance, and has very little, if any taste, it is not difficult to understand how any of it lying near these articles may be innocently used for flavouring food, or how it may easily be eaten by children in mistake for sugar. Of course, the law requires that it must not be sold, even in small quantities, without being coloured with soot or indigo; but this regulation is not always carried out, unfortunately. Powerful as it is, arsenic is a very valuable medicine in many diseases, and is usually administered as Fowler's solution. When this is the case, nothing should be left undone, in the way of precaution, to prevent accidents, and the bottle should always be carefully put away.

From what has been said above it will be clear that many cases of arsenical poisoning are of a *chronic* nature, and drag along a slow and lingering course. With such as these the Ambulance pupil has nothing to do. It is with the *acute* cases, where the drug has been taken accidentally and in considerable quantity, and where the characteristic signs of poison are present:—viz., nausea, shivering, burning pain in the stomach, violent headache, vomiting, and purging, that "*first-aid*" treatment is called for. This consists in giving an emetic at once, unless vomiting is present, when it should be encouraged by large draughts of hot soap and water or salt and water. After this, probably, the best thing to do, with the view of protecting the stomach, is to administer *magnesia* in unlimited quantities, or equal parts of common oil and lime water. A mixture of linseed meal, castor oil, and water, made to the consistency of treacle, is also recommended. If there is great depression, warmth to the extremities and stimulants should be used; while, if the pain in the bowels is great, and the doctor is long in arriving, hot linseed poultices may be applied to the abdomen.

2. *Baryta.*—A white, heavy earth, usually sold in powder, and as a rat poison. It is very poisonous. Its antidote is *Epsom salts* or *Glauber's salts*, just as for carbolic acid, combined with the usual treatment for all irritant poisons.

3. *Cantharides* (Spanish Fly).—This is the active ingredient in blistering fluid, or occurs as powder, when it has been mistaken for jalap. "*First-aid*" treatment consists in emetics, followed by demulcent drinks, as raw eggs, sweet oil, barley water, &c.

4. *Copper.*—Unpleasant effects have followed from the very wrong practice of employing small quantities of salts of copper to give preserved peas, vegetables, and pickles a fresh green appearance, and children have also at times been made seriously ill by sweets coloured in the same way; but the most serious cases of copper poisoning arise from the *green verdigris* which is apt to form on copper utensils left damp and dirty, especially if any acids, such as from fruits used in preserving, are present. In fact, it is not safe to use copper vessels for cooking purposes, unless the precaution is adopted of never allowing the contents to cool in them, for, strange to say, the ordinary fruit acids do not dissolve copper while hot. Fortunately, all the copper salts are in themselves emetic, and no serious results, as a rule, happen, so that "*first-aid*" treatment is to encourage the vomiting, followed by the free administration of milk and raw eggs or other demulcent drinks. Linseed meal poultices to abdomen, if pain severe.

5. *Croton Oil.*—It is a brownish oil, with rather a disagreeable smell, and possessing very powerful purgative properties. Mixed with olive oil, it is a very useful liniment for chest affections. The oil has been mistaken for castor oil, and the liniment also has been swallowed acci-

dentally. Emetics, followed by large quantities of demulcent drinks, as barley water, gruel, arrowroot, raw eggs, &c., are the "*first-aid*" treatment. The intense pain in the abdomen that is always present calls for hot linseed poultices, and the great depression that comes on in these cases requires free stimulation by brandy, whisky, or camphor. The dose of the latter is ten drops of the spirits or three of the essence, repeated each quarter of an hour for four doses, if the doctor has not arrived.

6. *Iodine.*—The tincture—a dark reddish fluid—is the form in which this substance is most used in medicine, but the liniment is also employed. Both are sometimes taken by mistake. If this has happened when there is food in the stomach, the vomited matters have often a *bluish* colour from the mixture of any starch in the food with the iodine. So, too, any starched articles of clothing may be turned *blue* by the vomited matters. The "*first-aid*" treatment is to give starch freely, in the shape of ordinary starch and water, or arrowroot, or gruel, or raw eggs, &c., and subsequently to induce vomiting by an emetic, if it has not come on. Afterwards stimulants may be required.

7. *Lead.*—Chronic lead poisoning, with its wrist drop, lead colic, and lead palsy, is not of the nature of an emergency, so requires no notice here. Acute lead poisoning, however, sometimes occurs, and arises generally from taking the preparation called "sugar of lead," because of its sweet, though rather astringent, taste. It is this sweetness and its white crystalline appearance that lead children to mistake it for sugar, and indulge in it. Fatal results seldom follow, as it is only deadly in large doses, and it is generally soon got rid of by sickness. The preparation known as "white lead" has occasionally been accidentally used for chalk; and "Goulard's Lotion," which is a solution of lead in water, and very popular as a wash for sores, has been drunk instead of wine. Some of the French and coloured crayons and French chalks used for drawing are poisonous from the white lead and arsenic in them, and

children have been made ill by sucking them or eating them as sweets. The "*first-aid*" treatment of lead poisoning is to give an emetic, if vomiting has not come on, and then to administer a full dose (two tablespoonfuls for an adult) of Epsom salts dissolved in water. This should be followed by a demulcent drink, and by warm linseed poultices to the abdomen, if the pain is severe.

8. *Nitrate of Silver.*—This is the ordinary "lunar caustic." It is usually made up in the form of small sticks of the thickness of slate pencil. Portions of these are sometimes swallowed in making applications to the throat. Such an occurrence need occasion no great alarm, as *common salt* arrests its action, and the proper thing to do is to give a copious draught of it dissolved in water, followed, if necessary, by a stronger emetic.

9. *Phosphorus.*—Since the use of the white or poisonous form of phosphorus has been given up, accidents from this substance are uncommon. Formerly deaths among children were not infrequent from sucking or swallowing the heads of lucifer matches. In the present day all "safety matches" are made with the non-poisonous red phosphorus. The phosphorus pastes used for destroying rats, mice, and black beetles, are, however, still a source of danger in any household where they are employed. Besides the severe pain in the abdomen, with vomiting and purging, that accompanies phosphorus poisoning, the vomited matter has a luminous appearance in the dark and a peculiar garlicky odour. Such cases are fortunately rare, as there is no very satisfactory antidote for them. All that can be done is to induce vomiting and administer magnesia freely. Should French turpentine be at hand, half-a-teaspoonful of it may be given in a little milk every half-hour for five doses. Ordinary oils and fats must not be administered, as they dissolve the phosphorus, which is then absorbed.

10. *Strychnine.*—This is the popular name for the active principle, *Strychnia*, contained in Nux Vomica, and derived from certain seeds and beans. It is a power-

ful *irritant* to the muscular system, for soon after being taken twitchings of the head and limbs come on, which develop, in less than an hour, into general convulsions, just as if the person was attacked by acute lock-jaw. The convulsions are so severe that they may twist the body into any shape. They occur every three minutes, and cause a good deal of pain; but the mind remains quite clear. So strong a poison is strychnine that patients either recover or die within a very few hours of the commencement of the attack.

Cases of strychnine poisoning are, unfortunately, not uncommon, and are generally associated with some of the numerous vermin killers, all of which nearly contain the drug. "*First-aid*" treatment, to be of service, must be prompt, as often the convulsions prevent the person opening the mouth or swallowing. Where possible, an emetic should be given, and vomiting induced at once. As death is apt to occur from paralysis of the muscles of respiration during a convulsion, Artificial Respiration should be carried on, if suffocation is imminent.

11. *Tartar Emetic.*—This is a preparation of antimony, which is very valuable, medicinally, but is a powerful irritant to the digestive canal in large doses. Accidents have arisen from its being mistaken for Epsom salts and for washing soda. The quack remedy for hooping cough, called Hooper's or Holt's specific, contains it, and in overdoses has caused harm. The "*first-aid*" treatment is to encourage the vomiting that an overdose usually sets up, and then to give tannin, as in the form of strong tea. Stimulants and warmth will also be required, as shock and collapse are often present, if anything like a large quantity of the drug has been taken.

12. *Zinc.*—The preparation known as "Burnett's Disinfecting Fluid" contains this substance in the form of the chloride. As it is a strong irritant, and even corrosive, serious results have followed the taking of it. The "*first-aid*" treatment is to give large quantities of warm water

with *soda* dissolved in it. Common washing soda or ordinary baking soda will do, but they must be well diluted. After this, milk and raw eggs should be freely given, with tepid water.

NARCOTICS.

These are the substances that *induce sleep.* The following are the leading members of the group:—

1. *Alcohol.*—This may be taken only to the extent of causing Drunkenness, and if this is characterized by excitement and quarrelsomeness, the less the Ambulance pupil has to do with such a case the better.

It is different, however, when the Alcohol has been imbibed in large and poisonous doses, or in a concentrated form. Fortunately, these cases of Acute Poisoning from Alcohol are not common. They happen generally as the result of a wager to drink such and such an amount, or from mere bravado, or where persons unaccustomed to the use of Alcohol have had special facilities for obtaining it put in their way. Accidents, too, are not unknown in connection with the strong spirituous liquors, and cases, especially of children, have been recorded where Spirits of Wine, Methylated Spirits, and Camphorated Spirits, have been taken by mistake in dangerous amount. The Symptoms in these cases are at first those of ordinary intoxication, as shewn by confusion of thought, uncertain gait, flushed face, and dilated pupils. By degrees, however, or suddenly if the spirit taken was undiluted, or in large quantity, *stupor*, with deep snoring breathing comes on, passing sooner or later, into insensibility and death. Any one in this state is figuratively spoken of as "dead drunk." The "*first-aid*" treatment of conditions such as these is to get rid of the Poison by an emetic, or to encourage any vomiting that may be present. Steps should then be taken to rouse the nervous system, and prevent the occurrence of stupor. External stimuli in the form of pinching the patient, slapping the chest with a wet towel, cold affusion to the head, and the inhalation of ammonia as smelling salts, may all be tried, while internally hot and strong coffee may be given largely, if the patient can be got to swallow. Should the breathing seem shallow, Artificial Respiration must be carried on. The warmth too of the body must be kept up by flannels and hot water bottles, for, contrary to the general idea, persons under the influence of Alcohol lose their heat rapidly.

With these suggestions the subject might be dismissed, were it not that from time to time the condition of *Apoplexy* has been mistaken for *Poisoning by Alcohol*, with the result that persons suffering from a serious disease of the Brain have been treated for Drunkenness, and have ended their days in a police cell instead of in a hospital or their own homes. Further reference will be made to this matter under the head of Apoplexy; but a word of warning may not be out of place here as to the possibility of such a mistake. It should never be forgotten that a person may not only be drunk, but ill as well. In fact the condition of drunkenness predisposes to illness, for the congested state of the blood-vessels, as shewn by the flushed face, favours their rupture, and the falls to which a drunken person is liable may lead to fracture of the skull, concussion of the brain, or cerebral hæmorrhage. It is anything but an easy matter to distinguish between drunkenness and illness, and no Ambulance pupil should act hastily in so doing. He should always remember that there may be both drunkenness and illness, and should rather err on the safe side, and consider the case one of the latter. As regards the helpless and insensible wretches that one comes across from time to time lying huddled up in doorways and closes, or on the road-side, overcome with drink, one's first feeling is no doubt to pass, like the Levite of old, on the other side, and not mix one's self up with such cases. It must, however, be remembered, that persons so situated, even if only "dead drunk," lose heat so rapidly under the influence of alcohol that they are in a position of considerable peril, especially on cold frosty nights or in inclement weather, and that it is only an act of Christian charity to inform the police, or to obtain such assistance as will ensure their removal under cover, and thus obtain the necessary warmth.

2. *Belladonna.*—This is the plant more generally known as the *Deadly Nightshade.* It grows in our fields and hedgerows bearing flowers of a brownish-purple hue, and at seed-time beautiful shining black-berries, larger than cherries, which children are often tempted to eat, and with fatal results, as they contain a poisonous juice. Belladonna is very useful in medicine, and enters into many cough-mixtures, liniments, ointments, and plasters. Its active principle is *Atropine,* which forms the basis of most eye lotions.

The symptoms of Belladonna Poisoning are hot and dry throat, flushed face, dilated pupils, staggering gait, loss of hearing, and excited delirium, which in fatal cases passes into stupor or convulsions.

The "*first-aid*" treatment consists in the early administration of an emetic. When this has acted, means should be taken to keep the patient awake, as in opium poisoning. Stimulants and warmth should also be used, and, if the breathing fails, Artificial Respiration. It may be noted here that as a rule the stomach very slowly extracts the poisonous principles from leaves, roots, and berries, owing probably to their being eaten raw and being, in consequence, indigestible. Accordingly, where emetics are given early, the danger in these cases is slight.

3. *Camphor.*—This popular remedy for many complaints is not perhaps a very active Poison, but alarming symptoms are frequently produced by it, and deaths have occurred from the use of strong preparations of it, such as the Essence of Camphor and Rubini's Camphor, both of which should be employed with great caution. The same remark applies to some of the homœpathic tinctures. It is not a wise plan either to give children, as is sometimes

done, lumps of camphor to play with, as bits of it find their way into the mouth, are swallowed, and produce alarming symptoms. These consist of giddiness, faintness, coldness of skin, and general nervous depression, which may go on to delirium, convulsions, and stupor. A fatal result is not common, but death has occurred in a child from a piece the size of a nut. The "*first-aid*" treatment is to get rid of the Poison by an emetic, and then to treat the nervous depression by warmth, stimulants, and, if necessary, hot and cold douches.

4. *Chloral.*—This useful sleep-producing drug occurs in white crystals, like those of Epsom salts, and has a pear-like odour. It is unfortunately being very much abused, and a most dangerous practice has arisen of taking it as a "restorative," and for every little ache or pain. The unfavourable symptoms induced by an overdose are deep sleep, a livid congested face, heavy breathing, weak pulse, and cold extremities. This tendency of the body to lose heat indicates the chief danger in Chloral Poisoning,—namely, *failure of the heart's action.* "*First-aid*" treatment consists, accordingly, in keeping up the warmth of the body by the free use of stimulants, hot blankets, hot water-bottles, mustard over the heart and to the calves of the legs, and by drinks of hot, strong coffee. In addition everything should be done to prevent the patient sleeping, and he should be roused by speaking to him, slapping the face sharply with a wet towel, or even by pinching the cheeks. Should the breathing seem to fail, Artificial Respiration should be performed and continued until the doctor says it is useless. As Chloral depresses the heart, it is not always advisable to walk the patient about, as is done in Opium Poisoning, to keep him awake. Nothing has been said about giving an emetic in these cases, because it is only of service very early. After the unfavourable symptoms shew themselves, the Poison has been absorbed into the blood, and an emetic would only tend to further depress the heart.

5. *Chloroform* is sometimes swallowed in poisonous doses, as when the Liniment is taken accidentally. The "first-aid" treatment is the administration of large quantities of the Bi-carbonate of Soda dissolved in water. In addition all the means of resuscitation and rousing mentioned under Chloral Poisoning should be employed, if signs of stupor come on. Some people are foolish enough to indulge in the dangerous practice of inhaling Chloroform for the relief of pain. It is a most risky procedure. Should the Ambulance pupil have to deal with such a case, and alarming symptoms have come on, he should loosen all the clothing about the chest, admit fresh air by the open door or windows, and perform Artificial Respiration, care being taken that the tongue is drawn well forward. The head, too, is better placed at a lower level than the rest of the body.

6. *Ether.*—This is rarely taken internally, though in certain parts of Ireland "ether drinking" has become prevalent. Its early symptoms are those of intoxication, passing into insensibility, and the "*first-aid*" treatment is the same as for Chloroform Poisoning.

7. *Opium.*—Statistics shew that there is no form of Poisoning so common as that by Opium, and that it causes almost as many deaths as all the other Poisons together. This is not to be wondered at, when we remember that it is contained in variable quantity in a great many "patent medicines," and in most cough mixtures, and that it forms the basis of the majority of the "Mother's Friends," or "Soothing Syrups," that have lulled many an infant into its final sleep. "Black Drop," "Battley's Solution," "Dalby's Carminative," "Dover's Powder," "Godfrey's Cordial," "Nepenthe," "Paregoric Elixir," "English and Scotch Paregoric," are all preparations that contain Opium in varying proportion, and require very cautious administration. They should never be given to children, save under medical supervision. In connection, too, with the administration of Opium, it should always be remembered

that a certain period should elapse between each dose to give the medicine time to act. Harm has often followed the rapid administration of small doses of Opium.

Opium is not a simple substance, but contains a number of peculiar active principles, of which *Morphia* is the most powerful, and the best known. Another is *Codeia*, much employed now in cough lozenges. The most familiar preparations of Opium are the *Solution of Morphia* and *Laudanum*. This last is really a Solution of Opium in weak Alcohol, and a point to be remembered about it is that it should be kept very carefully in a well-stoppered bottle, otherwise the Alcohol evaporates, and the Laudanum is much stronger than is thought. On this account it is a safe rule never to use Laudanum that has been kept for months or years in a corked bottle. It is better to obtain a fresh supply. Another medicine, much used by all classes, that contains Opium, in the form of Morphia, is *Chlorodyne*. It is a very dangerous preparation, as it is really made up of a number of deadly poisons, of which Prussic Acid is one, and that in very variable quantity. One reason for the fatal cases from its use is that on standing Chlorodyne separates into two layers, the upper one of which is water, containing in it all of the Prussic Acid in the bottle. In this way a person may very easily get an overdose of this powerful Poison. The lesson taught by this is that a bottle of Chlorodyne should always be well shaken before pouring out a dose of it.

The symptoms of Opium Poisoning commence with giddiness, drowsiness, and an irresistible desire to go to sleep. This passes into a deep stupor, which is quickly followed by insensibility, and later on by slow stertorous breathing. The face, as a rule, is pale, the lips livid, and there is a profuse perspiration over the body. If the eyelids are raised, and the pupils examined, they will be found to be contracted to the size of a pin point. Death usually happens within twelve to forty-eight hours, though in children the symptoms come on more rapidly, and the fatal issue occurs more quickly

The "*first-aid*" treatment of a case of Opium Poisoning is to give an emetic, if that can be swallowed, and induce vomiting. The next point is to take steps to rouse the person, and keep him from falling into a deep sleep. This is best done by walking him about, flapping him with a wet towel, shouting at him, pinching him, slapping the soles of the bare feet with a slipper, and using any other means of a stimulating kind. In fact, one has to act in what seems rather a cruel manner, but it is the only chance of success. Douches of cold water poured over the head from a height are also beneficial, but they require to be frequently repeated, the patient being dried in the intervals. Children may be roused by putting them into a warm bath, and then exposing them to the air. Mustard plasters to the calves, and smelling-salts to the nostrils, are further useful aids, and the administration of strong black coffee must not be forgotten. The further advantage of this last is that it helps to keep up the patient's strength during all the forced exertion he has to go through. Never, however, give any wine or spirits with this object, as they are harmful. A cup of beef-tea from time to time is not objectionable, should any weakness or prostration shew itself, and should the breathing at any time seem to fail Artificial Respiration must be resorted to. All the above means must be carried out until a medical man arrives and takes charge of the case. When improvement shews itself, as the result of treatment, great care must still be taken, for a relapse is apt to ensue, and the patient should be carefully watched for some time after the dangerous symptoms have subsided.

8. *Prussic Acid.*—This is the popular name for Hydrocyanic Acid. It occurs as a colourless fluid, and is one of the deadliest poisons known. The fatal symptoms begin almost immediately, sometimes in the very act of swallowing, and certainly within a moment or two of taking the drug. Instant death from it is accordingly not uncommon. So volatile is it that even its vapour has proved fatal, as happened in the case of its discoverer, Scheele.

In poisonous doses not immediately fatal the symptoms commence with pain and weight in the head, giddiness, and a feeling of sickness. This is soon followed by great and sudden prostration with weak pulse, cold and clammy surface, and complete loss of muscular power, so that the limbs fail and the person falls down. Insensibility soon comes on, the pupils become dilated, the eyes fixed, the face blue, the jaws locked, and foam gathers at the mouth. Respiration is gasping, and at long intervals, during which the person seems dead. At length the breathing ceases, or convulsions terminate the scene.

In cases where death occurs so rapidly, there is no time for antidotes, or for emetics. In fact the power of swallowing is generally absent. The only "*first-aid*" treatment that can be of the slightest use is *cold affusion*. It should be carried out by pouring jugs of cold water from a height on to the head and spine. It is a valuable remedy, and it is asserted by some that it never fails if thoroughly applied in cases where the amount of Poison taken is moderate in amount. *Stimulants* also should be employed, such as smelling-salts to the nose, and internally sal volatile, as soon as the power of swallowing returns. *Artificial Respiration* should also be resorted to in these cases, as rabbits have been recovered by this means even after convulsions had ceased and they were apparently dead. The same measures should be adopted in cases of Poisoning by *Cyanide of Potassium*, a compound of Prussic Acid which is much used in photography, and in cleaning electro-plate ornaments.

The point of general interest about Prussic Acid is that it is found in many toilet articles, in confectionery, and in food. This is because it occurs in the impure *Oil of Bitter Almonds*, and the various oils and essences obtained from this fruit, as Ratafia, Peachnut Oil, &c., all of which are employed for flavouring purposes. Too much care cannot be taken with all these sweet smelling essences, such as

Laurel, Peach, and Passion flower water, and they should not be used too freely, as good results being got from small quantities as large ones. Another point of importance is that the articles of food into which they are put should be baked or boiled afterwards, for the heat expels the poison of the Prussic Acid, but not the flavouring oil. In fact, almond essences should not be used in dishes that do not need heating. This point receives further illustration from the Manioc root, which furnishes Tapioca. Readers of Stanley's book will remember that many members of the expedition died from eating this root unprepared by heat, the use of which drives off the Prussic Acid in it, and thus renders it wholesome as food. The practice, too, of eating apple-pips or the kernels of cherry, peach, and damson stones is not safe, as they all yield Prussic Acid, and in large numbers they are poisonous. Fatal cases have occurred among children from eating freely of these kernels. There is an "artificial oil of bitter almonds" got from tar, and called *Nitro-benzol*, which was for some time thought safe, but it requires the same careful handling as the ordinary impure Oil of Bitter Almonds, seventeen drops of which have proved fatal. Should alarming symptoms shew themselves from the use of any of the above essences, the cold affusion treatment with stimulants should be resorted to at once. The only wise course is to use in cookery nothing but the pure Oil of Bitter Almonds, which has been freed of all Prussic Acid.

IV.—NARCOTICO-IRRITANTS.

The Poisons in this class have, so to speak, a double action, their primary irritant effects being followed by a narcotic influence on the brain and spinal cord, which ends either in stupor or convulsions. The Narcotico-Irritants are chiefly derived from the vegetable kingdom, and though our fields are more free of violently poisonous plants than most countries, yet there are a great many which may prove fatal if partaken of. And this, unfortunately, very often happens. Scarcely a summer comes round that we do not read of cases of poisoning from eating, by mistake, the leaves, roots, or fruit of plants yielding deadly juices, and in the autumn the bright coloured berries of the different nightshades, of the yew, and of other plants, claim their victims, especially among children. No doubt nature has furnished a safeguard in the acrid bitter taste that most of these plants possess, but there would be fewer of these accidents if children were more instructed in matters botanical when at school, and were from time to time warned by their parents against the danger of tasting any leaves or berries with which they were not thoroughly acquainted. The following are the chief Narcotico-Irritant Poisons :—

1. *Aconite.*—This drug is derived from the plant called, sometimes, Monkshood, from the cowl-like shape of its blossoms, and sometimes Wolfsbane, from its powdered roots being used on Swiss mountain pastures mixed with food to destroy the wolves. In summer time its beautiful purplish blue flowers are a familiar feature of many of our gardens, and so powerful are they that their odour has been known to cause swooning fits and loss of sight. On this account they should be avoided by children and delicate persons. Accidents have happened from the leaves of the plant having been eaten for scurvy-grass, or having found their way into salads; while in the spring and autumn its roots are apt to be mistaken for those of the horse-radish, and cases of poisoning from this error have not been uncommon. At the same time there should be no difficulty in distinguishing the brownish, conical, tapering root of the aconite, from the white, cylindrical one of the horse-radish. A great safeguard would be not to grow the two roots near one another in the same garden.

Aconite is a very useful medicine for feverish colds and for relieving pain, and it is a very popular remedy in all cases of inflammation. This general use of it has led to several mishaps, and fatal results have followed from some of the various preparations of it, such as the tincture and the liniment. What is known as Flemming's Tincture of Aconite is a most powerful poison, and there is the well-known case of the excise officer, who lost his life by merely tasting it under the idea that it was flavoured spirit. A patent medicine for neuralgia called "Neuraline" has also caused death from the aconite it contains.

The symptoms of poisoning by aconite are burning and numbness of the lips, mouth, and throat, which soon extends to the stomach, and causes apparently violent and constant vomiting. The limbs get cold, and the head is covered with perspiration. Along with this, *great weakness of the heart* shews itself, the pulse and breathing becoming very slow. If the case ends fatally, the muscular prostration becomes more marked, sight, hearing, and feeling are lost, convulsions may or may not occur, and death seems to be the result of great feebleness of the heart.

The "*first-aid" treatment* is to induce vomiting by an emetic. As soon as this has acted, *free stimulation* should be employed by spirits or by sal volatile, while warmth should be applied to the limbs by rubbing and hot bottles. Mustard plasters should be used over the heart and down the spine, the patient being kept strictly in the lying down position. If the breathing becomes shallow, use artificial respiration, and continue it until medical aid arrives.

2. *Digitalis.*—This is the purple foxglove that grows so luxuriantly in rocky copses, neglected hedges, and by road sides. Its beautiful and attractive spike of bell-shaped purple or white flowers is so conspicuous an ornament of many of our waste sandy places that it is tolerably familiar to all. It is called digitalis from *digitabulum*, the Latin for a thimble, in allusion to the form of the flowers. Though a valuable plant in medicine, it is a violent poison. If taken in an overdose, it causes giddiness, indistinct vision, vomiting, purging, and intermittency of the pulse. Should a large amount of the recent herb have been inconsiderately swallowed, the above symptoms are followed by delirium

hiccough, cold sweats, convulsions, syncope, and death. The leaves are the active part of the plant, and accidents have happened from drinking an infusion of them under the idea that they had a purgative action. The "*first-aid*" *treatment* is to encourage the vomiting which the digitalis as a rule causes. If it has not done this, an emetic should be given. After this, frequent stimulants, such as hot brandy and water and sal volatile, should be administered, *the patient being kept carefully lying down flat on the back.* Mustard, especially over the heart and to the calves of the legs, should be applied; and none of these measures should be discontinued until all serious symptoms have ceased for some time.

3. *Laburnum.*—This tree, whose tassels of bright yellow flowers so adorn our gardens in the early summer, is possessed of poisonous properties in all its parts, and should be carefully shunned. Indeed, cases of poisoning by Laburnum are amongst the most common fatalities of country life. Children especially should be warned against eating its seeds, which are violently purgative and emetic, producing, when swallowed, vomiting, delirium, and stupor, with great pain in the abdomen, and diarrhœa. These symptoms often come on within half-an-hour or an hour. The best "*first-aid*" *treatment* in these cases is to get rid of the seeds as quickly as possible by an emetic, and then to counteract their depressing effect by brandy, sal volatile, or other stimulants, not omitting mustard over the heart and to the calves of the legs, if great weakness be present, and Artificial Respiration if the breathing seems to fail.

Did space allow, it would be easy to fill pages with a description of the symptoms and treatment of poisonous plants of wild or common growth, but it really is not necessary, as Aconite, Digitalis, and Laburnum are fair examples of how they manifest their hurtful properties, and the "*first-aid*" *treatment* recommended for them shews clearly the lines on which to work in these cases. At the same time the ambulance pupil should take every opportunity of learning the leading features not only of the above mentioned plants, but of others, such as the Hemlocks, the Thorn-apple, the Cuckoo-pint, the Meadow Saffron, and the Wild Parsley, so as to be able to recognise them, and perhaps give a word of timely warning in regard to them. This may be done by consulting any well-illustrated popular work on Botany, or by reading such articles as the one in *Cassells' Household Guide* on "Poisonous Plants of Wild or Common Growth." While on this subject, a word of advice may be given as to that universally used plant Tobacco. The extent to which it is employed has caused it to be rather regarded as innocuous, but it should always be remembered that it contains a most active poison, *Nicotia*, and that it is unsafe to use it as an external application, or as a cure for worms, as recommended in some popular works on medicine. It has been known under these circumstances to cause alarming weakness and faintness, with weak pulse and cold clammy skin. The proper treatment for such cases are stimulants, warmth, and the recumbent posture.

The subject of *Animal Poisons*, as received from snake-bites, stings of insects, &c., will be considered elsewhere, but the present chapter may be appropriately finished by a short reference to poisons taken into the system by eating tainted or decomposed meat, poisonous fungi, mussels, &c.

As regards *Tainted meat*, every one is aware that food undergoing decomposition is unwholesome; but cases of poisoning have been observed where the sense of smell gave no warning. Of recent years this subject has been a good deal investigated, and the chemistry of the poisons in decaying food is better understood. We know now that meat, fish, sausage, and cheese,—that is, food of animal origin,—all develop, especially in the presence of moisture, substances called by chemists "ptomaines." These are of a poisonous nature, and when they gain access to the system the symptoms set up are usually those of an irritant poison, as shewn by pain in the stomach, vomiting, and severe purging. The proper thing to do in these cases is to get rid of the offending material as quickly as possible, either by an emetic or a laxative, such as castor oil, should any time have passed since the food was taken. The remaining symptoms must be treated by stimulants, if there is weakness, and by external warmth, in the form of hot turpentine cloths or mustard poultices, if there is much pain. Looking to the insidious nature of these food poisons, many of them being quite odourless, too much care cannot be taken in the supervision of our markets, and the destruction of all diseased meat. Seeing, too, that they have a local action, those who have to handle food in its uncooked state should avoid doing so while suffering from any abrasions or cuts on the hand, as many of the "poisoned fingers" in cooks, and those engaged in washing up dishes, are due to this cause. In reference to those cases that from time to time occur of unfavourable symptoms following the use of tinned meats, it is not always easy to furnish an explanation. One fact about them is that they generally occur in the summer time, and the probability is that the contents, when opened, have been exposed to some unhealthy influence, as foul gases, and have quickly generated some fermentative poison. It is a safe rule to eat those tinned or canned meats directly they are opened.

Although in this country we do not make *Fungi* a prominent source of food supply, yet cases of poisoning from Mushrooms are not uncommon. Under this heading are not included those cases where, from some personal peculiarity, the most harmless varieties disagree, and cause disturbance of the stomach and bowels. The cases referred to are rather those where, shortly after Mushrooms have been eaten, alarming symptoms of great abdominal pain, vomiting, purging, dilated pupils, extreme muscular weakness, and mental excitement come on, followed, in fatal cases, by slow pulse, stertorous breathing, cold extremities, and death from failure of the heart's action. The "*first-aid*" *treatment* in these cases is an immediate emetic, followed by an ounce of castor oil to clear out the bowels. Stimulants will be required in most cases, with warmth to the extremities, and poultices to the abdomen. Although, perhaps, scarcely coming within the range of "*first-aid,*" it may be mentioned that Belladonna has been found to be an antidote to the Mushroom poison, and ten to twenty drops of the Tincture of Belladonna may be advantageously given in these cases, according to the age of the sufferer. In view of these poisonous properties of many fungi, too much caution cannot be exercised in collecting them. Avoid all fungi that have an unwholesome or sickly-looking colour, that leave a burning, bitter taste in the mouth, and that grow in deep, dark woods. Never, either, eat the most healthy kinds when they are beginning to decay, and never warm up a second time a dish containing Mushrooms (Murrell).

Cases of *Mussel poisoning* also occur with symptoms of uneasiness and weight in the stomach, numbness in limbs, dryness of the throat, cramps in the legs, swelling of the eyelids, and great exhaustion. In severe cases there is a nettle-rash eruption, failure of the heart's action, collapse, and death. The "*first-aid*" *treatment* must be conducted on the same lines as for Mushroom poisoning, and the remarks about Belladonna are equally applicable here. As to why sea-water Mussels should be so dangerous when eaten little or nothing is known. Various theories have been put forth to explain it, but while applicable to some cases, they do not clear up all, and there is still uncertainty in the matter. Some advocate for Mussels the rule which holds good for oysters, that they should be avoided in the months which have not the letter *r* in them.

As the accidental swallowing of noxious things, such as pieces of glass, coins, &c., has been already discussed, nothing more need be said on the subject here. No reference was, however, made to the swallowing of *leeches*, which may happen in drinking water from some impure source. They do not, of course, induce poisoning, but the occurrence is disagreeable, and may cause alarm. No apprehension need be felt, as they may almost invariably be dislodged and killed by taking copious draughts of salt and water.

From what has been said of the various classes of Poisons, it is quite evident that there are many occasions on which Ambulance aid may be of the greatest service. Exception may be taken to the length of this chapter, and the somewhat detailed manner in which the various poisons have been dealt with; but the subject is an important one, and cannot be fully mastered unless there is something more than a mere enumeration of the various poisons. There must be, also, some knowledge of how they act, so as to enable "*first-aid*" to be carried on in an intelligent manner.

CHAPTER XIII.

THE NERVOUS SYSTEM.

I care not, Fortune, what you me deny:
You cannot rob me of free Nature's grace;
You cannot shut the windows of the sky,
Through which Aurora shows her brightening face;
You cannot bar my constant feet to trace
The woods and lawns, by living stream, at eve!
Let health my nerves and finer fibres brace,
And I their toys to the great children leave;
Of fancy, reason, virtue, none can me bereave.

THOMSON—*Castle of Indolence*, Canto ii., Stanza 3.

IN the chapter describing the general build and anatomy of the body, it was pointed out that it was absolutely essential that there should be some guiding and regulating power over its various organs, so that their duties or *functions* might be carried on continuously and harmoniously, and it was briefly indicated that this was accomplished by the *Nervous System*. As this system is by far the most important in the human economy, it is proposed to consider it a little more in detail, taking up first that part of it which regulates and controls the action of all the other organs of the body, and has received the name of the Sympathetic Nervous System.

I.—THE SYMPATHETIC NERVOUS SYSTEM.

The term *Sympathetic* has been applied to this system from an idea that through its agency the different organs of the body, no matter how distant, have "sympathy" one with another. For instance, it is through it that death from stoppage of the heart has followed a blow over the stomach, and that mental anxiety or worry will derange the liver and digestive organs.

As we find it in the human body, the Sympathetic System

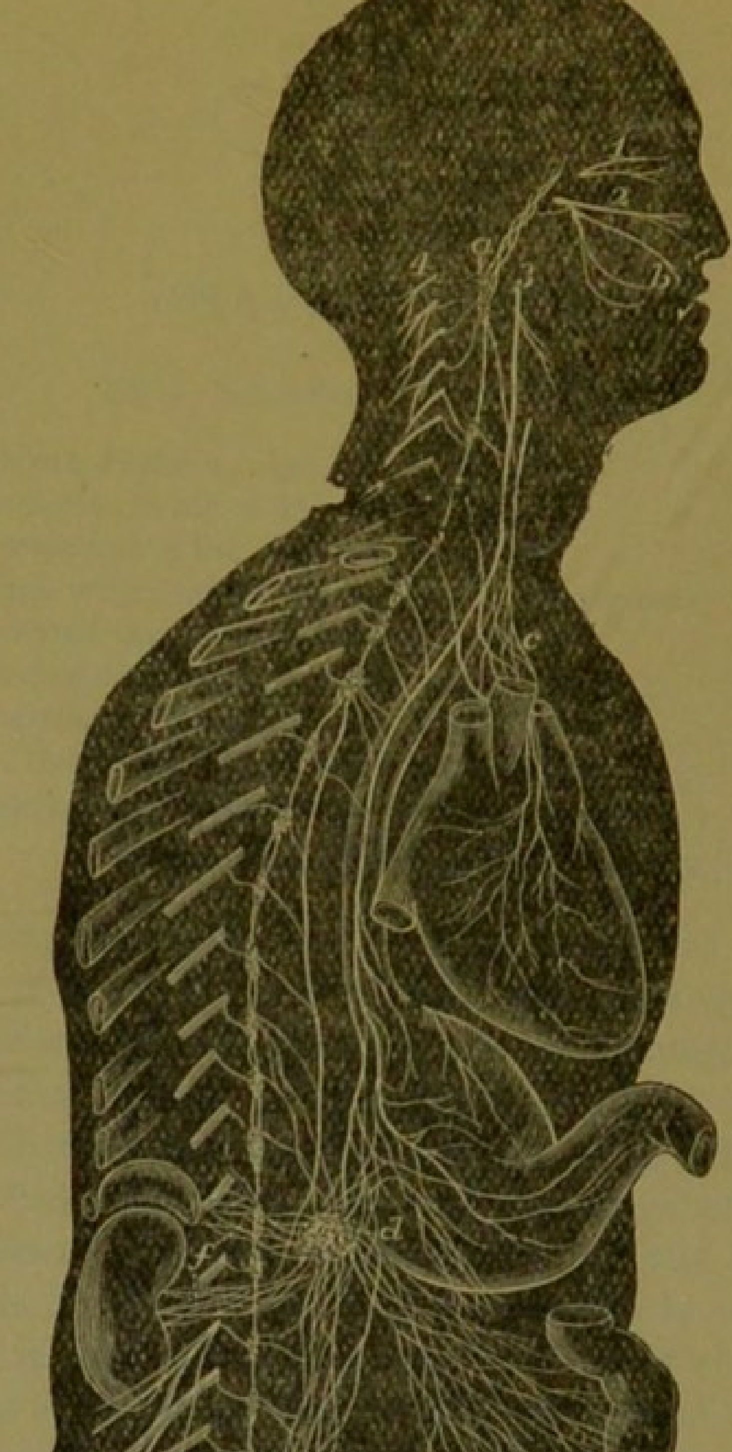


FIG. 71 A.

SYMPATHETIC SYSTEM OF NERVES.

a, Chain of sympathetic ganglia on each side of vertebral column; *b*, branches of communication between the chains of opposite sides behind the upper incisor teeth; *c*, cardiac plexus; *d*, solar plexus; *e*, hypogastric plexus; *f*, renal and supra-renal plexus. 1 and 2, first and second divisions of fifth cranial nerves; 3, vagus nerve; 4, first spinal nerve.

consists of a number of small, round, knot-like masses of *nerve tissue*, about the size of a pea. To these the term *Ganglia* is applied. About twenty-five of them are arranged in two parallel rows or chains, which are situated one on each side of the vertebral column, while others are somewhat irregularly disposed in various parts of the head and in the cavities of the trunk, the largest of them, perhaps, lying in the upper part of the abdominal cavity, behind the liver. (See Fig. 71 A.) Not only are these various *Ganglia* connected one with another, by means of cords of nerve tissue, called *Nerves*, but from them numerous Nerves branch out and form networks or *plexuses* round the great organs or viscera in the chest and the abdomen, such as the lungs, heart, stomach, liver, and intestines. In addition, a certain number of these nerves are spread round the walls of the minute blood-vessels of the body, so that they can control their size or calibre, permitting them to be either widely dilated or narrowly contracted. An arrangement such as this is able to exert a very powerful influence on the nutrition of every part of the body, and consequently these *Vaso-Motor Nerves*, as they are called, are an important factor in everyday life. Of the various plexuses of Sympathetic Nerves, the most important, perhaps, from its size and position, is that known as the *Great Solar or Epigastric Plexus*, (d, Fig. 71 A), situated in the abdomen, behind the stomach, and immediately in front of the Aorta.

As regards the *functions* of the Sympathetic System, or the work that it has to do, it may be said briefly to regulate and control the action of all the other organs of the body. It is it that presides over and influences all those processes in the body which, fortunately for our comfort and convenience, are carried on, waking or sleeping, involuntarily and independent of our will, of which the movements of the heart and lungs are familiar instances. In short, it may be said to correspond to the Nervous System in lower invertebrate animals, and to constitute in man a more or less distinct arrangement for the performance of those various functions associated with the nutrition of the body, which we cannot influence by means of our wills.

II.—The Cerebro-Spinal Nervous System.

Important, however, as are these *nutritive functions*, they rank lower than those higher attributes of man which distinguish him as a thinking and reasoning being. What makes him such is his *Mind*, which enables him to feel, learn, understand, know, and will, and thus brings him into conscious relationship with external nature. All this is accomplished by a specially-developed apparatus known as the *Cerebro-Spinal Nervous System*, consisting of Brain, Spinal Cord, and Nerves, each of which requires a few words of separate notice.

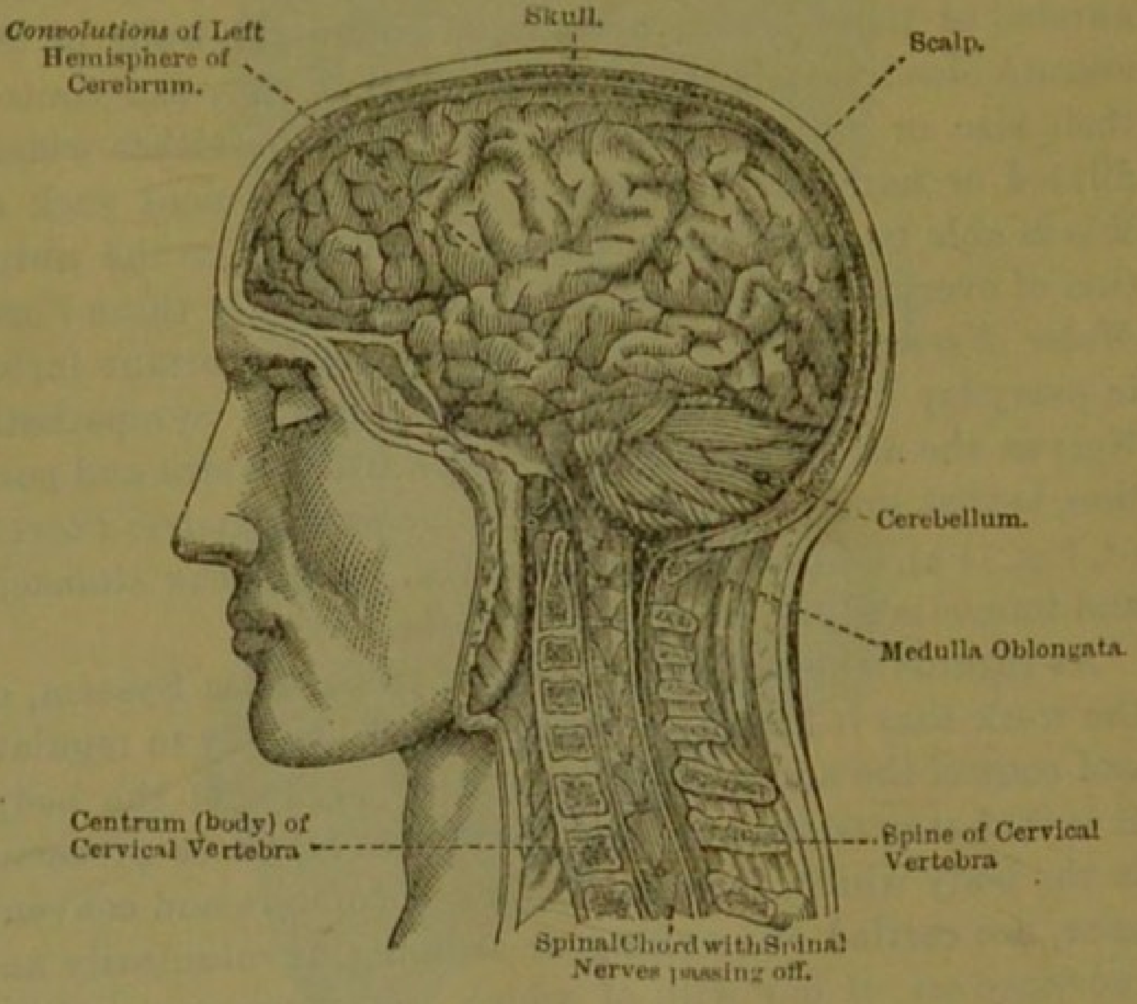


Fig. 72.—The Brain.

(*a*.) *The Brain.*—This is the portion of the cerebro-spinal axis contained in the skull, the bones of which carefully protect it. (See Fig. 72.) Three membranes of various consistency also surround it, and further add to its safety. for between two of them is a certain amount of fluid which furnishes a kind of water bed on which the Brain lies. The Brain is very freely supplied with blood-vessels, and its weight in a man is about 3 lbs., while in a female it is about 5 oz. less. The Brain really consists of a number of separate masses of nerve tissue blended together according to a definite plan. Thus we have the *Cerebrum*, or Brain proper, which forms the larger bulk of the organ, and occupies the upper part of the skull. It consists of two halves or hemispheres, which are separated from one another by a deep cleft, and have their surfaces arranged in folds or convolutions, so as to economize space. If each hemisphere is carefully examined, it will be found to be further subdivided by several fissures into three lobes, so that the Cerebrum is really made up of six distinct parts or lobes. Were a transverse section to be made through the hemispheres, as has been done diagramatically in Fig. 73

FIG. 73.—TRANSVERSE SECTION OF THE BRAIN.

it would be seen that the external ridge-like elevations of the convolutions were covered with a layer of *grey* matter, while the central parts were *white;* and further, it would be noticed that the two hemispheres are connected by a band of fibres, called the *Corpus Callosum*, which enables the two sides of the brain to communicate and act with each other. The next important mass of nerve tissue is the *Cerebellum*, or Lesser Brain, which is placed below the back part of the Cerebrum, and is overlapped by it. It only weighs some 5 oz., but it consists of two hemispheres, each of which is composed of an external layer of *grey* matter surrounding *white* nerve matter. A vertical section through the middle of the Cerebellum would shew the white matter spreading out inside the grey, so as to look just like the stem and branches of a tree, and this has led to the term *arbor vitæ* (tree of life) being applied to it. (Fig. 74.) Its two hemispheres are also brought into relation with one another, just as those of the Cerebrum are, and the band of fibres accomplishing this is termed the *Pons Varolii*, for they form a kind of bridge of nervous matter across the next and last mass of nerve tissue we have to notice—namely, the *Medulla Oblongata*. (Fig. 74.) This may almost be looked upon as the expanded portion of the upper part of the spinal cord. At any rate, it is into it that the spinal cord passes, and so becomes connected with the Brain. It is pyramidal in shape, being wider above than below, and measures one and a-half inches in length. An anterior and a posterior fissure divide it into two lateral halves, but a section of it shews that, compared with the Brain, the respective positions of the *grey* and *white* matter are reversed, the former being internal and the latter external. While, then, the Cerebrum, Cerebellum, and Medulla Oblongata make up the chief mass of the Brain, it is usual to include under that term certain masses of *grey* nervous matter which lie towards the base of the skull, and are called the *Basal Ganglia*. (Fig. 74.) They are quite concealed by the Cerebrum, but they play an important part in motion and sensation.

(*b*) *The Spinal Cord.*—This is a cylinder of nerve matter which lies in the *spinal cavity* formed by the vertebral column, and measures about 18 inches in length. (See Fig. 76.) It is about the size of the little finger above, but becomes smaller below. It is divided into two lateral halves

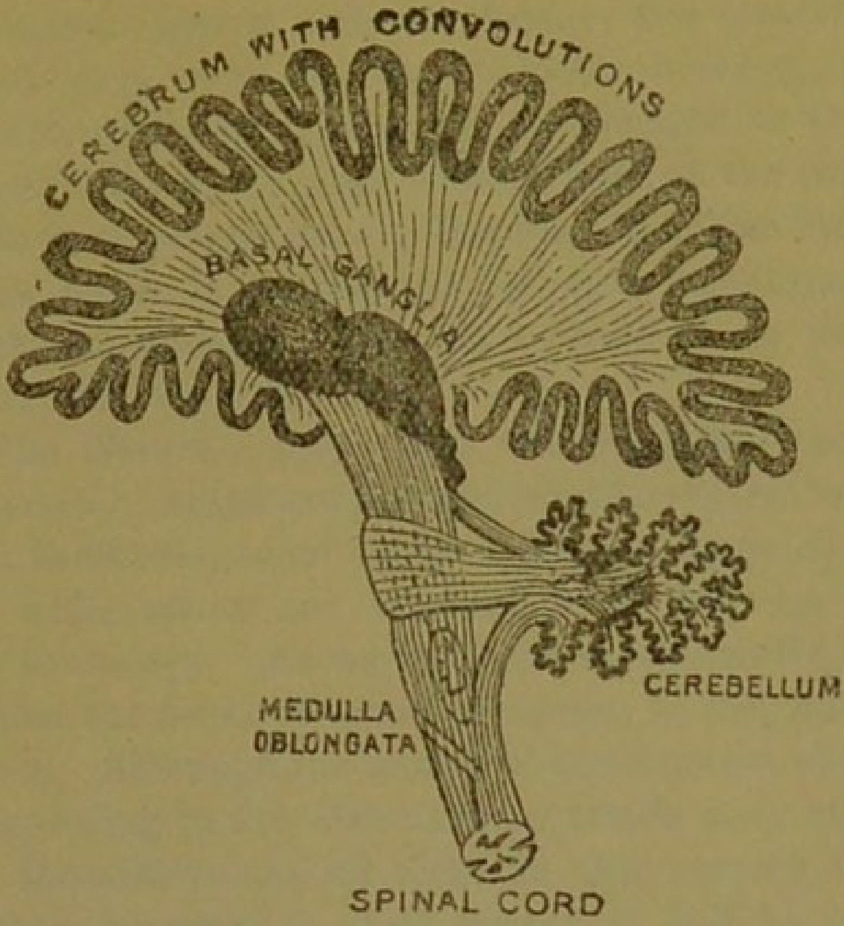


Fig. 74.—Vertical Section of the Brain.
Diagramatical mesial section through cerebrum, cerebellum, and medulla oblongata.

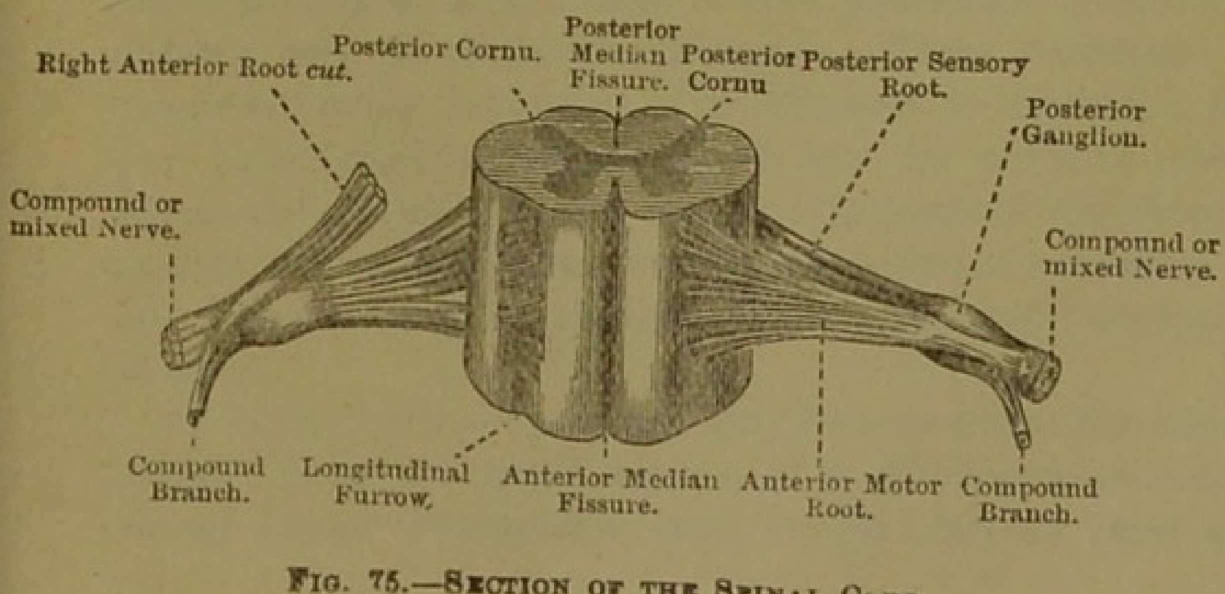


Fig. 75.—Section of the Spinal Cord.

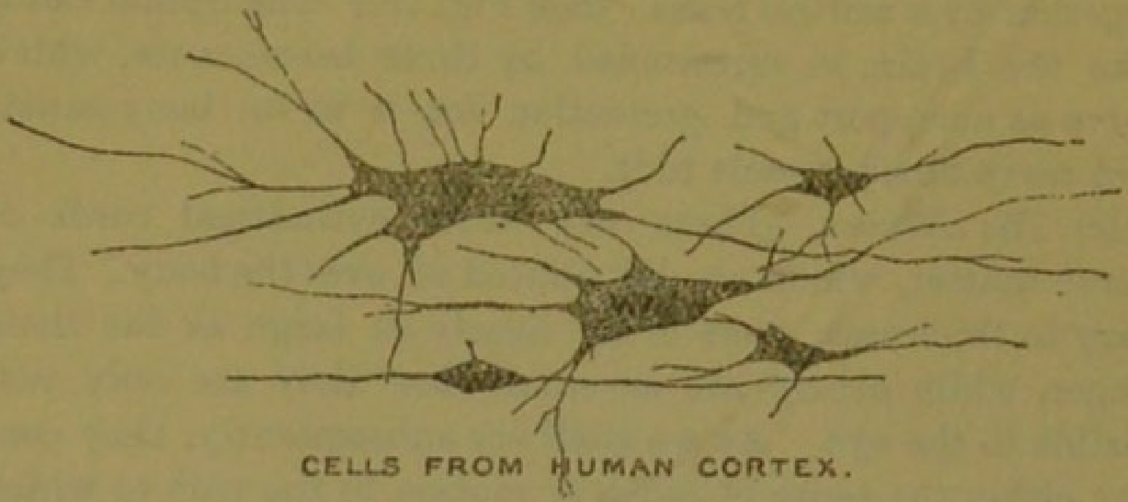
by an anterior and a posterior fissure, and consists of both *white* and *grey* nerve matter, the latter, however, occupying *the interior of the cord*, where it is arranged in the form of two crescents, one in each lateral half of the cord, united together by a central mass. (See Fig. 75.) The Spinal Cord, like the Brain, is surrounded by three membranes, which serve as a support and protection for it in its bony canal, and carry blood-vessels to it.

(c) *The Nerves.*—These are white cylindrical cords of nerve matter, which are distributed all over the body. They vary in thickness, some being nearly as large as the little finger, while others are so small that they are only just visible to the eye. As we shall see subsequently, they convey either the sense of touch or motion to the part to which they pass. Although the modes of termination of the nerves vary according to the structure in which they end, yet the nerves themselves are all alike in this respect, that if we trace them upwards to their source, it will be found that they spring either from the Brain or the Spinal Cord,—no less than 31 pairs of them issuing from the latter, and 12 from the former.

Before considering the functions of these various parts of the Cerebro-Spinal system, it will be as well to describe briefly their structure, and that of the Sympathetic System; in short, the structure of the nervous system generally.

Structure of the Nervous System.—To the naked eye nerve matter is a soft, marrow-like substance, presenting either a *grey* or *whitish* appearance. These variations in colour are really indicative of a difference in structure, the grey being composed of *nerve-cells* and the white of *nerve-fibres*, and as these two are the essential parts of the nervous system, not only in man, but in all animals possessed of one, it is necessary to obtain a thoroughly clear conception of them.

(*a*) *Nerve Cells.*—These can only be seen under the microscope. They are small masses of a finely-granular sub stance called *Protoplasm*, and are of various sizes and shapes in different parts of the nervous system. Some have quite a regular outline, but for the most part they have one or more processes, which terminate in fine transparent fibres. (See Fig. 76.) These nerve-cells are held to be the



CELLS FROM HUMAN CORTEX.

FIG. 76.

sources or generators of nerve-force, and all nervous impressions and impulses are considered to have their origin in them. Hence they are the essential constituent of all nerve-centres, where nerve-force is developed, or where nervous impressions are radiated, transferred, diffused, or reflected, and consequently the exterior of the Brain, the interior of the Spinal Cord, and the substance of all the various Ganglia in the body are made up of them, in the shape of grey matter.

(*b*) *Nerve Fibres.*—To see these, one of the white nerves scattered through the body must be teased out with needles and examined under the microscope, when it will be found that it is made up of a vast number of very fine threads, each of which consists of a central *core* or *axis cylinder*, surrounded by a layer of fat-like substance named the *medullary layer*, and enclosed in a very delicate sheath, *the neurilemma.* This last binds the whole fibre together, and probably to some extent protects it. The really important part in the nerve fibre is the *core.* It is along it that nerve-force travels, just as the electricity does along the copper wire which serves as the "core" of the Atlantic telegraph cables, and it is not unlikely that the gutta-percha covering used in the latter for insulation purposes is represented by the medullary layer and sheath of the nerve. All the white nerve substance which forms so large a part of the Brain and Spinal Cord is composed of these Nerve Fibres, as are also the numerous nerves distributed through the body. As regards the Nerve Fibres found in the *Sympathetic System*, it is necessary to mention that they closely resemble the white ones, but differ from them in having rather a *greyish* tinge, and in having no white sheath enclosing the axis cylinder.

Very little requires to be said about the *chemical composition* of the nerve-centres and nerves. Speaking generally, nerve-tissue may be said to be composed chiefly of albumen and water, with a small proportion of phosphorus and salts.

The Working of the Nervous System.—The above outline of the Nervous System, and of its microscopic structure, should render clearer its *mode of action*, of which it is necessary now to give a short account. Taken collectively, the functions of the Nervous System are spoken of as *Innervation*, and they consist *of the power of generating and transmitting motor impulses, of perceiving sensations, of forming ideas, of exercising intelligence, and of originating the wish or will to do anything*. In short, the Nervous System is the means by which the individual receives impressions from the external world, imparts communication to certain instruments of motion, and governs the body by a conscious, intelligent will. As long as it is working properly, the person feels, moves, and thinks; but if it is in any way injured or diseased, loss of feeling and inability to move (paralysis), and unconsciousness, or even death, may come on.

With duties such as these, the Nervous System must have the power, first, of generating within itself *nerve-force*, and secondly, of transmitting it in various directions. This is exactly what it does possess, and for these apparently separate acts distinct portions of nerve-tissue are called into play, the *Nerve-cells*, or grey matter, generating the nerve-force, and the *Nerve-fibres*, or white matter, conveying it in the necessary directions. This has led to the nerve-cells and the nerves being arranged in a special way. As regards the *Nerve-cells*, they are grouped together in masses, either of moderate size, when they are called "ganglia," or of considerable extent, when they are spoken of as "nerve-centres," while the *Nerves*, which serve as channels for the nerve-force, as soon as they leave the nerve-centres of the Brain and Spinal Cord, spread out like the branches of a tree (see Fig. 77), dividing and subdividing, until eventually they end in very minute twigs, which are distributed to the muscles, the skin, or some special sense organ, such as the eye or ear, according as the case may be. To allow, however, of the nerve-force passing along them, the nerves must be connected with the nerve-cells of the nerve-centres. And they are so. Were the ultimate fibrils of which the nerves are composed traced upwards, they would be found to become connected with the various processes springing from the nerve-cells of some nerve-centre in the Brain or Spinal Cord. In this way the continuity is established, and every part of the body is brought into contact with the various ganglia and nerve-centres of the Nervous System. It is this that has led to the Nervous System of the body being compared, and not inaptly, to a complete telegraphic system, in which the *Nerve-centres* of grey matter represent the different head offices, and the *Nerves*, branching from them to all parts of the body, the telegraph wires. It must not, however, be implied from this that nerve-force and electricity are the same. They may resemble each other in their mode of action, but this is all; and if proof of their dissimilarity were wanting, it is shewn by the fact that while nerve-force passes along a nerve at the rate of about 120 feet per second, electricity passes along a telegraph wire at thousands of miles per second.

It will be as well to briefly indicate now the special functions of the various parts of the Nervous System, taking

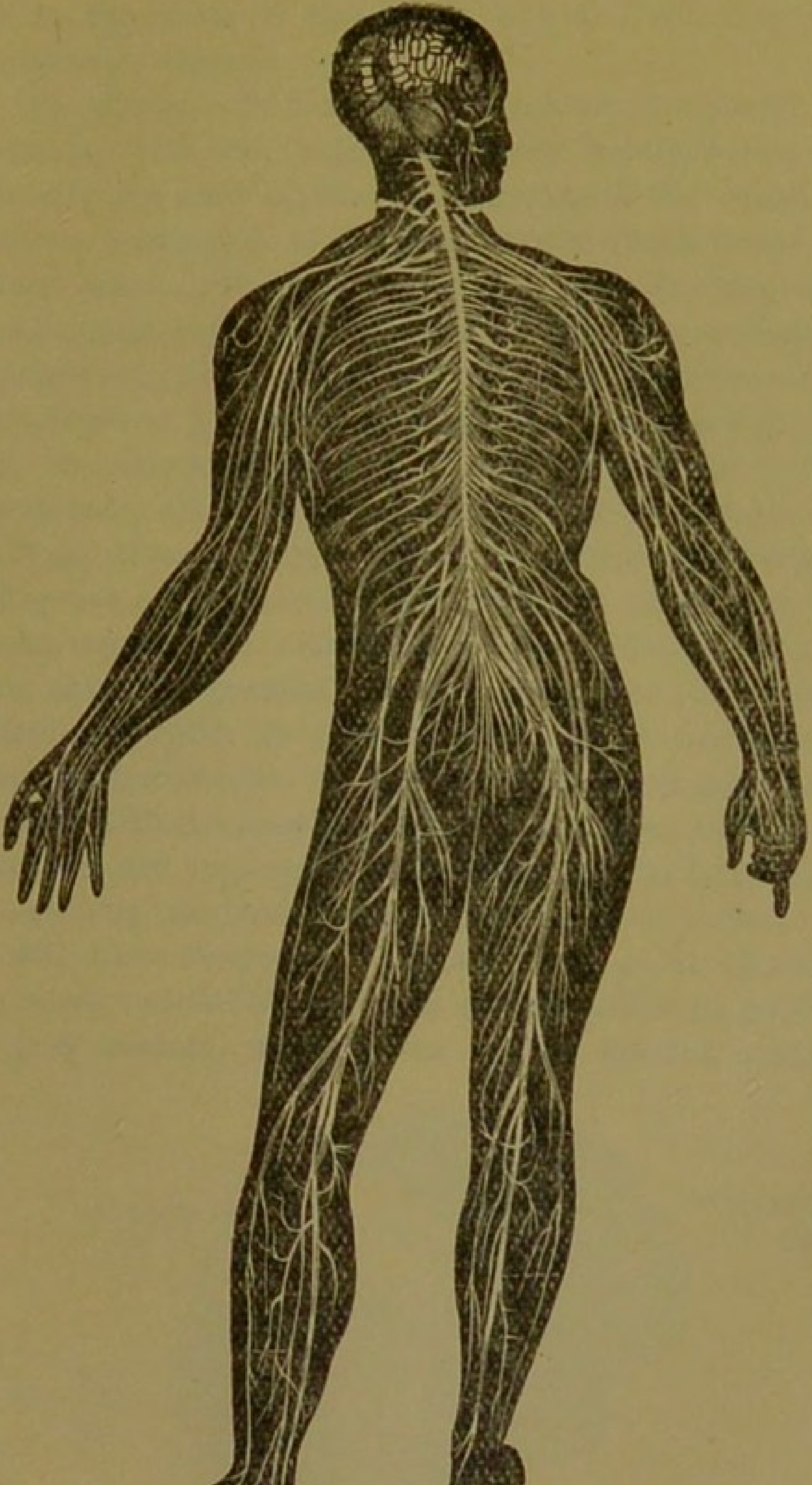


Fig. 77.—The Nerves.

them in the order of the Brain, Spinal Cord, Nerves, and Sympathetic system.

1. *The Brain.*—Of the principal masses composing it, the Cerebrum, with its large convoluted hemispheres, is undoubtedly the seat of the phenomena of the Mind. The numerous nerve-cells of the grey matter which forms such a distinct layer over all the cerebral convolutions, are the nerve-centres where Intelligence resides, where Sensations are perceived, where Ideas are formed, and where the Will or the Wish to do anything originates. Comparative anatomy, the effects of disease or injury, and the results of experiments, all go to prove this. Thus, the removal of the Cerebrum from a pigeon produces complete abolition of intelligence, and destroys the power of performing spontaneous movements, although life still goes on. It may be taken, then, for granted that the grey layer of the cerebral hemispheres, with its rich supply of blood-vessels and its numerous nerve-cells, all interlocking by means of their processes with one another, contains the nerve-centres where sensations and impressions are registered, to be reproduced subsequently as ideas, and in which intelligence, reason, and will, have their seat. Of late years great efforts have been made to localize and map out the different portions of this grey matter, which serve as the special centres for

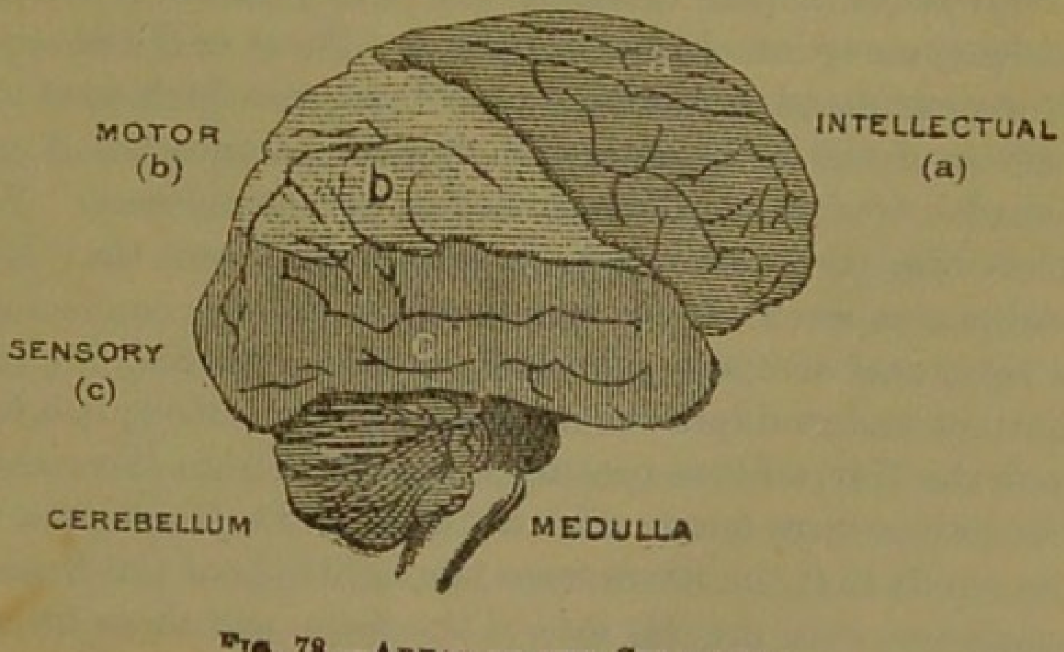


Fig. 78.—Areas of the Cerebrum.

these distinct functions of the Brain. Considerable progress has been made in this direction, and without going into any detail, it may be mentioned here that the Cerebrum may be divided into three areas, as seen in Fig. 78. In front, we have what may be termed the *Intellectual* area (*a*); over the top, in the direction of a line running from ear to ear, we have the *Motor* area (*b*); and behind, we have the *Sensory* area (*c*), lying underneath and to the back. Distinct fissures or clefts in the brain substance more or less mark off these areas, so that there is not so much difficulty in recognising them. Within these areas it has been shewn that in the Motor one there are separate portions of grey matter or "centres" for moving the muscles of the face, the arm, and the leg, while in the Sensory area, the front part of which is in contact, it will be noticed, with the Intellectual area, is the seat of such special centres as those for sight, hearing, taste, and smell. The remaining hinder portion of the Sensory area probably contains the centres for general sensation, as for the skin and internal organs. In reality, then, the Brain is not a single organ, but is made up of a great number of distinct and separate centres, each with its own work to do. To keep it in touch with the whole of the body, it is necessary that it should be brought into contact with all the various parts. This is done by means of the *Nerve-fibres* which compose the white mass revealed on making a section of the Cerebrum. These nerve-fibres pass downwards and enter the Spinal Cord, to which most of the nerves of the body pass, and thus the connection is established. One point must, however, be noticed here. When describing the Cerebrum, it was pointed out that it was really composed of two symmetrical halves, connected, it is true, one with the other by transverse fibres, but really distinct and re-duplications of each other. Now, it is found that the Nerve-fibres passing downwards from these respective halves *cross one another* at the Medulla Oblongata, with the result that the fibres from the right side of the Brain are connected with the left side of the body, and those from the left side of the Brain with the right side of the body. This is a very important fact, and explains why it is that an injury to the right side of the Brain may render powerless the nerves on the left side of the body, and prevent the arm and leg being used.

2. *The Cerebellum.*—It is probable that its chief function is to regulate all muscular movement. When we perform such complicated actions as walking and running, it is necesary that there should be harmonious action between all the muscles, and this is brought about by the Cerebellum, so that it is probable if it were removed, as by disease, the person, though capable of *voluntary* motion, would not be able to walk or balance the body properly.

3. *The Medulla Oblongata.*—This connecting and conducting medium between the Brain and Spinal Cord is a most important portion of the Nervous System. Through it we saw there pass the nerve-fibres leading *down* from the grey matter or the Brain, but in addition it contains nerve-fibres going *upwards* to that organ from the Cord. Over and above this, several nerves of the face and head arise from its grey matter, as also do those that preside over the *movements of the heart and lungs.* It is these latter that give it its vital importance. Without the Cerebrum life might go on, but not without the Medulla. Hence it is into it that cooks pass a pin when they wish to kill poultry, and it is it that is injured when the gamekeeper kills a rabbit by striking it a blow close behind the ear. In the same way, criminals are executed in Burmah by blows on the nape of the neck. Certain narcotics, too, act specially on the Medulla, and it is when Opium and Chloral are exercising their deadly effect on this part of the Nervous System, as shewn by the shallow breathing, and weak fluttering pulse, that fatal results are apt to ensue, and artificial Respiration is needed. As to the other Ganglia of grey matter that are placed at the base of the Brain, their precise functions are not known, but they are in some way probably connected with *motion* and *sensation*

4. *The Spinal Cord.*—This, it will be remembered, consists of both grey and white matter, the former being in the centre, and the latter outside. Continuous with the Brain, or more correctly, perhaps, a mere prolongation of it, it is the great channel of nervous communication with the rest of the body through the numerous nerves which issue from it. Like the Brain, it is composed of two symmetrical halves, and from each of these the nerves for the two sides of the body issue by two separate and distinct roots, with an interval between them (see Fig. 75). By this arrangement each half of the cord is divided into three portions called respectively the Anterior, Lateral, and Posterior columns. These are composed of white fibres, and down them *motor* impulses travel to the parts below, either from the Brain or from one part of the Spinal Cord to another. The grey matter in the middle of the cord conveys *sensations* to the Brain, so that the main work or function of the Spinal Cord may be said to be that *of conducting sensations to and impulses from the Brain.* Besides this, however, its grey matter serves as an *independent reflex centre* for many movements which are quite devoid of any feeling or will on the part of the individual, and are termed "*reflex*," because they are more or less automatic, and seem not to require the brain for their performance, but are "reflected" outwards from the cord as the result of certain impressions received by it. Breathing and swallowing are illustrations of this important class of movements, but there are many others which might be adduced.

5. *The Nerves.*—These are the strings or cords distributed all through the body, along which the nerve-influence or current finds its way, just as the electricity does along the telegraph wires. If traced to their origin, all these nerves will be found to spring either from the Brain or the Spinal Cord, those from the latter being the more numerous. Of the 12 pairs coming off from the Brain, and known as the *Cerebral Nerves*, some are specially modified in their endings, so as to allow of our receiving impressions from the outer world,

(See Fig. 79, Nos. 1-12.) Thus, one is devoted to the sense of *smell*, and, spread over the upper cavities of the nose, makes us aware of the proximity of odours and perfumes. Another, arranged in a special manner in the ear, confers the power of *hearing*, and thus allows of objects being detected at a distance; while a third one, spread out as the retina over the interior of that highly developed organ, the eye, gives us the inestimable boon of *sight*, the most precious

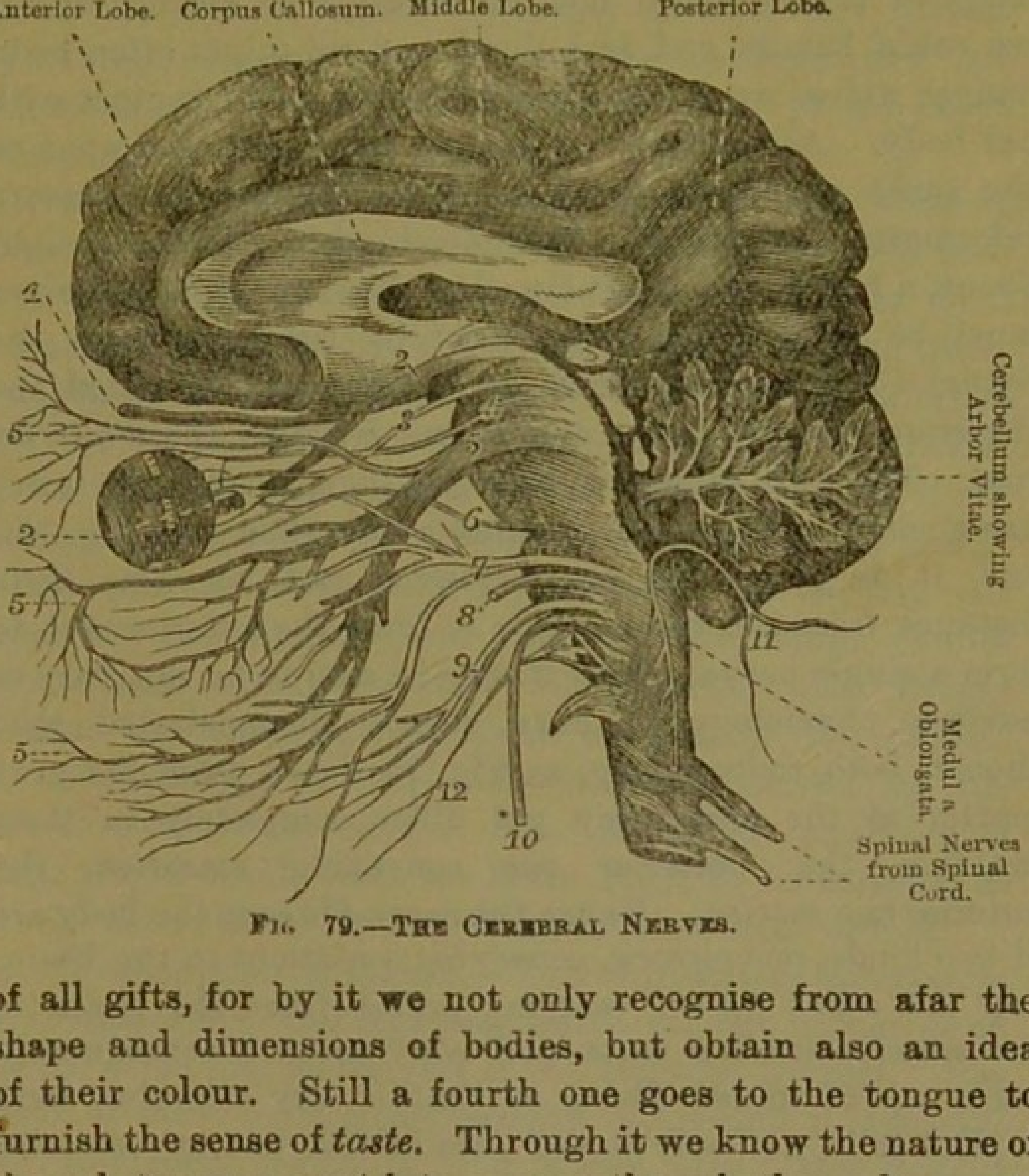


FIG. 79.—THE CEREBRAL NERVES.

of all gifts, for by it we not only recognise from afar the shape and dimensions of bodies, but obtain also an idea of their colour. Still a fourth one goes to the tongue to furnish the sense of *taste*. Through it we know the nature of the substances we put into our mouths, whether salt, sweet, or bitter, and thus we are furnished with a means of protection against injurious and harmful things, while at the same time the necessary and important process of taking food, is made a source of enjoyment, to be indulged within reasonable limits, and not made, as it too often is, the sole aim and object of life. Through these four *Gateways of Knowledge*, as they have been called, we gain an accurate and correct idea of all that lies around us, and in conjunction with the *reasoning* power of the Brain, to which these nerves pass, can recognise much that is good for us, and avoid much that is harmful. At the same time our knowledge of things would not be accurate or correct unless we could handle and feel them, and we might often be in danger unless we knew when objects were in contact with our body. Accordingly we find we have bestowed upon us the sense of *Touch*, through which the above necessary information is attained. To understand how this is brought about, a few words of explanation about the Spinal Nerves must be given here. They arise by *two* roots from the Spinal Cord, one of which is in front and is called the *Anterior root*, while the one behind is called the *Posterior root*. The only difference between them is that the latter has a small swelling on it called a Ganglion (see Fig. 75), and it is placed on the posterior root, at some little distance from the front, where it joins the anterior root to form a single nerve. Now it may be said to be the glory of modern physiology to have clearly demonstrated that though both roots spring, as Fig. 75 shews, from the grey matter of the cord, they yet differ completely in their function, the *posterior* one conveying *sensation*, the anterior one *motion*. Hence the nerve-fibres in the body are of two kinds, one *sensory*, conveying sensations to the Brain, and the other *motor*, carrying orders from the Brain to the muscles or other parts, and every nerve is consequently made up of mixed fibres, so that if any stimulus were applied to it, not only would pain be felt, but any muscles to which it was distributed would be moved. Of course, although both these kinds of fibres are bound up together for a greater part of the nerve trunk in the same sheath, yet in their ultimate distribution they separate, the *sensory* ones going to the skin, and the *motor* ones to the muscles. It is in this way that the sense of *Touch* is located in the skin all over the body, some parts, however, having it more highly developed than the others, as at the ends of the fingers. These ramifications of the *Sensory Nerves* warn us when anything has touched us, and they also convey other sensations, telling us whether it is colder or warmer than the body. As to how these *sensory* nerves end in the skin it is not necessary to offer any further explanation, beyond stating that the arrangements are such as to enable the delicate terminal fibrils of the nerve to respond to very slight vibrations.

Of course it must be understood that the term *Sensory Nerves* does not imply that the nerves themselves feel. It is the Brain that feels. All that the Nerves do is to transmit the *sensations*, and the Brain interprets them. If anything were to come in the way that would interfere with the transmission of the nerve-current to the Brain, as, for instance, any disease of the Spinal Cord, or if the sensory nerves were cut across, then no sensation would be felt. In the same way, if the *motor* nerves are cut across or the Spinal Cord injured, the Brain cannot execute any orders it may wish carried out, simply because the nerve-current does not reach the nerves, and the message consequently is not received by the muscles that would carry it out. A similar condition of things would result were the Brain itself to be injured, as it could then neither receive sensations nor issue orders.

6. *The Sympathetic System.*—To a large extent this system works separately, and regulates nutrition, but it does so in just the same way as the rest of the Nervous System. The masses of nerve-cells in the ganglia composing it generate nerve-influence, which is transmitted along the various plexuses of nerves to the intestines, heart, and other organs. Besides, however, acting as centres for nerve-force, it is probable that the ganglia possess a power of obstructing the passage of impressions through them that might reach the Brain,

for though the Sympathetic System may be looked upon as practically independent, yet it is to some extent connected by nerves with the rest of the Nervous System. It adds so materially to everyone's comfort and convenience that the working of the various organs connected with nutrition is carried on without the will, and quite imperceptibly, that it is likely this object has been kept in view, and that one of the functions of the ganglia is the task of to some extent isolating the organs they control. This holds good, probably, only in health, for when these organs are out of order or diseased, we are soon made conscious of the fact.

In conclusion, it may be asked, What causes nervous influence to shew itself? The nerve-cells, of course, generate and store it up, but what makes them part with it? They certainly would not do so spontaneously, any more than gunpowder would go off without a light. It may be accepted as a fact that some excitation must be applied to the nerve-cells before they will liberate their stored-up energy or nervous influence. The excitation, whatever it may be, is always spoken of as a "*stimulus.*" These stimuli vary. They may be *objective*—that is, arising from some external agency, and thus travelling up the nerves, or *subjective*—that is, produced by the intrinsic action of the Brain itself. Consequently, they may be of all gradations of intensity, from the coarse vibrations of outward mechanical violence to the more delicate ones of light and sound, or the still more subtle changes involved in the working of the Mind. Be it, however, what it may, some stimulus is necessary to rouse the nerve-cells to activity, and induce them either to liberate the energy they have stored up or to generate a fresh supply.

CHAPTER XIV.

THE DISEASES OF THE NERVOUS SYSTEM.

King: "I should rejoice now at this happy news, and now my sight fails and my brain is giddy.—O me! come near me; now I am much ill." (He falls back.)

Prince Humphrey: "Comfort, your Majesty!'

Clarence: "O my royal father!"

Westmoreland: "My sovereign Lord, cheer up yourself; look up!"

Warwick: "Be patient, Princes; you do know these fits are with His Royal Highness very ordinary. Stand from him; give him air. He'll straight be well."

—*Henry IV.* Act IV., Scene IV.

THE outline of the Nervous System given in the previous chapter should enable the ambulance pupil to understand better the symptoms and "*first-aid*" treatment of the diseases and injuries to which it is liable, for though it is largely protected by a strong bony covering, its sensitiveness and delicacy allow of the nerve-centres being easily deranged and upset. When this is the case, the different functions of the body, dependent as they are upon a proper supply of nerve-force for their working, become depressed, and should the Brain itself, which is the organ through which the mind manifests itself, be in any way damaged or thrown out of gear, we have indications of this in the shape of confusion of thought, partial unconsciousness of varying duration, complete insensibility, or convulsive movements.

Shock or Collapse.—When the impression made on the nervous system has been severe, a certain train of symptoms is generally set up, to which the term "*Shock*" or "*Collapse*" has been applied. The leading symptoms of this state are *diminished energy of the heart and circulation, and a general lowering of the vital powers.* In some cases it is slight in amount, being due largely to the fright and pain of the accident causing it, and shows itself merely by paleness of the face and slight tremor of the body. These symptoms, however, pass off readily, and the person seems as if he had been temporarily frightened. In bad cases, however, the condition is a very alarming one and closely resembles death. The face is pale, the lips blanched, the eyes lustreless, the skin cold and clammy, the breathing feeble and sighing, and the pulse scarcely perceptible. All this while the person lies in a dazed or semi-unconscious state, though occasionally he is very restless and tosses about. These effects may be temporary, passing off in a short time, or they may be lasting, death occurring in a few hours from pure failure of the heart's action owing to a want of proper nerve-supply. The most rapid cases of death from Shock are those following lightning-stroke, where the fatal result may be said to be instantaneous. In cases that terminate favourably, a condition known as "*Reaction*" comes on. This is characterized by a marked improvement in the force of the heart and the circulation. The pulse gets stronger, the body warmer. The face loses its ghastly pallor, resuming either its natural colour or presenting a flushed appearance. Another symptom that very often indicates that reaction is about to set in is the occurrence of vomiting.

As to the *causes* of Shock, in the majority of cases it is the result of some severe bodily injury. Thus, it is commonly met with after railway and machinery accidents, especially if there has been any laceration or crushing of the tissues, after gunshot wounds, after lightning-stroke, and after extensive burns or scalds. In fact, anything that makes a deep impression on the nerve-centres may give rise to Shock. Hence, it has been known to follow any sudden fright, severe grief, and even excessive joy, and in persons of a nervous temperament, or who are suffering from illness or any disease, such occurrences have even proved fatal. Another point to remember is, that a very slight blow on a sensitive part, or over a sensitive organ, may give rise to fatal Shock. This has been observed in connection with comparatively trivial injuries about the heart, at the pit of the stomach, or in the neck, in all of which localities there is a considerable collection of nerves closely interlaced.

The "*first-aid*" treatment of Shock is in many ways similar to that for fainting. The person should be kept quiet in the lying-down posture, any tight clothing about the neck should be removed, and all injudicious movements should be prevented. Of course, if the Shock is the result of any injury accompanied by bleeding, the hæmorrhage should be at once arrested, and if the accident has happened in the open, the person should be properly conveyed to shelter, where the further appropriate treatment may be carried out. As any one in a state of Shock is both cold and faint, treatment consists mainly in applying warmth and in internal stimulation. The former is best attained by the use of warm blankets and hot bottles placed at the feet, about the legs and arms, and on each side of the chest, but care should be taken that they do not burn the patient, whose power of feeling is often lessened. Hot flannels, or a hot plate wrapped in flannel, over the heart, favours its action. Friction, too, of the surface of the body and of the arms and legs is useful in promoting the circulation. As regards internal stimulation, in many of the milder cases of Shock a cup of warm tea, coffee, or beef-tea will suffice, but where the patient's condition is low, and it is evident the Shock is severe, if the power of swallowing is not lost, a tea-spoonful of whisky or brandy might be given to an adult in a small amount of hot water, hot milk, or hot beef-tea, and repeated every quarter of an hour up to six doses, if reaction does not shew itself. As soon as this latter does appear the stimulants should be lessened, for an injudicious use of them might induce too great reaction, and lead to inflammatory fever. If the person cannot swallow, nothing should be given by the mouth, as the fluid might get into the windpipe and cause choking; all that can be done is to apply smelling salts to the nostrils. Should the breathing at any time get shallow and threaten to stop, Artificial respiration might be undertaken, but the prospects of its doing good are not great. In the case of children, the amount of stimulants must be correspondingly lessened, and the warmth may be often very conveniently applied by placing them in a hot bath and wrapping them in a warm blanket on their removal from it. When reaction has set in, the point to attend to is to lessen the stimulants, giving instead small quantities of easily assimilated food, as beef-tea or milk, and keeping the person quite quiet for some time.

Concussion of the Brain.—This expression implies that there has been a shaking up or jarring of the Brain, usually the result of blows or falls on the head. When these have been slight and the Brain has not suffered much, the effects are only transitory, amounting to mere dizziness and confusion of thought, or it may be loss of consciousness for a moment or two. This condition is not uncommonly seen after falls on the back of the head, as in skating, and, in popular language, the person is said to be "*stunned.*" As a rule, the stupid confused feeling passes off very quickly, and in a few minutes the person is quite himself again. On the other hand, should the blow or fall have been severe, causing a good deal of commotion in the Brain tissue, matters assume a more serious aspect, and the person is very much in the state described under the head of Shock, lying on the ground quite motionless and insensible, with the surface of the body pale and cold, the pulse feeble, and the respiration slow. Though there are no outward injuries, yet it is clear the Brain has been much shaken, and is carrying on its work with difficulty. Indeed, death sometimes results, just as a watch that has fallen on the floor, will occasionally come to a complete stop, even when it is apparently uninjured.

The "*first-aid*" treatment of those stunned or suffering from Concussion of the Brain is to keep them lying down on the back, with the head slightly raised, to unloosen any tight articles of dress, especially about the neck, and to make a cooling application to the head, as a folded handkerchief steeped in water. In mild cases this is all that is required. Should the symptoms not pass off readily and the insensibility remain, then the "*first-aid*" treatment advised for Shock should be adopted, with the exception that stimulants should not be given internally, as the *Reaction* that ensues is apt to be extreme. Some warm tea, or beef-tea, may be given as soon as the person can swallow; and this must be combined with perfect rest and quietness for a little time until a medical man has been seen, as too early removal or lifting might bring on a return of unconsciousness.

Head Injuries.—Besides Concussion, blows and falls on the head may cause other injuries, such as Laceration of the Brain, Compression of the Brain from hæmorrhage, Wounds of the soft parts covering the skull, and Fractures of the skull itself, either of the vault or base. Wounds of the soft parts or scalp should be treated in the manner already described in a previous chapter, but no Ambulance pupil can be expected to say exactly what has happened when any one meets with a severe injury to the head, so exact rules cannot be laid down. It may be that the insensibility, the stertorous breathing, the unequal size of the pupils, the loss of power in the limbs, and the bleeding from the eyes, ears, or nose, may lead him to think that there is a *fracture of the base of the skull;* but it will be more prudent for him not to spend time in considering too minutely what is wrong. Let him carry out the "*first-aid*" treatment, which is the same in all these cases,—viz., to keep the patient quiet in the lying down posture, to loosen all tight clothing from the neck and body, to raise the head slightly, to apply cold in some form to the head, and warmth to the feet, to prevent the administration of stimulants, and to secure medical aid as soon as possible. If there is a wound, it must be dressed, and if the patient has to be moved, it must be done with great caution. It is a safe rule never to regard any head injury as trivial.

Convulsions.—These are involuntary contractions of the muscles of the whole or part of the body. Sometimes the muscles remain perfectly tense and rigid, as is seen in lockjaw, at other times they relax and contract alternately, as in an epileptic seizure. This latter is an illustration of convulsions affecting all the muscles of the body, while the irregular movements of St. Vitus' Dance are instances of certain muscles only being involved. It is in children that we most commonly meet with Convulsions, and fortunately they have not the same gravity as when they occur in adults. They may arise from very slight causes, as teething, worms, or indigestible food, although they may indicate something wrong with the brain, or the approach of one of the numerous children's diseases, such as scarlet fever, thus corresponding to the shivering fit that grown-up people often have at the commencement of an illness. It is not necessary to describe minutely the convulsive attack as usually seen in children. The fixed and upturned eyes, the thumbs carried across the palms of the hands, the rigidity of the body, the twitching of the muscles of the face, and the dusky livid countenance, are familiar to most people, and have caused many a mother anxious hours.

If the Convulsion has come on suddenly, and no medical assistance is at hand, it is advisable to place the child in a hot bath of about 100° Fahrenheit, to which a table-spoonful of mustard may be added, enveloping the head at the same time in a cloth wet with cold water. Should there not be sufficient hot water available for a bath, apply cloths dipped in hot mustard and water to the feet and legs, using also the cold to the head. The child should remain from three to five minutes in the bath, and should be wrapped in a warm blanket on removal from it. Should the fit cease and then return, or should it continue, the child should be immersed again in the bath. If it is known that any indigestible food has been eaten, then an early opportunity should be taken to make the child vomit by giving it some Ipecacuanha wine, or other emetic, as soon as it can be swallowed. Later on, too, some castor oil may be administered, but in these cases it is better to act under the advice of the medical attendant, for the convulsion may be a symptom of brain disease, and it is wiser not to take upon oneself any unnecessary responsibility. Besides, it is better to know exactly what has been the cause of the attack, and a doctor is the best person to find out that.

Epilepsy.—This is a convulsive disease due to some affection of the Brain, and comes under the popular term of "fits." It is known also as the "Falling Sickness." The attack occurs at irregular intervals, without any warning usually, and is characterized by *convulsive movements and unconsciousness.* The patient is suddenly seized with the fit and falls just where he is, so that he may be severely hurt, should he tumble, for instance, into the fire or from a height. Unconsciousness at once comes on, though it may be preceded by a loud piercing shriek, and then the convulsive movements commence, the hands being clenched, the legs and arms jerked violently towards the body, and the features horribly distorted. The face gets livid, and the jaws are brought together with such force that the tongue, moved as it is in all directions, is frequently bitten through, with the result that the froth issuing from the mouth is stained with blood. The convulsions last, as a rule, but a short time, when the person passes into a deep sleep, awakening eventually with a dull and confused look, and altogether ignorant of what has passed. A scene, such as the above, is most unpleasant to witness and naturally creates great consternation amongst the bystanders. Fortunately, in the majority of cases, there is no cause for immediate alarm, death in an epileptic fit being uncommon.

As nothing can be done to shorten the attack once it has begun, the aim of "*first-aid*" treatment is to prevent the person in any way receiving further injury. Attention should be directed to the position in which he has fallen. So sudden often is the attack, that it may be one of danger. Place him then in a safe and comfortable place, lying on his back, with the head slightly raised, so that he can breathe freely. Loosen all tight clothing, especially about the neck, so as to favour the circulation in every way, and satisfy yourself that there is nothing in the mouth which can obstruct the breathing, such as morsels of food, loose false teeth, &c. This necessitates the opening of the mouth, and this is best done by a paper knife, handle of a latch key, thin piece of wood, or any other resisting substance that can force open the jaws. This has the further advantage that it may be kept in position and serves as a gag to prevent the tongue being bitten. Next guard against the convulsive movements causing any hurt to the patient, in the first place, by removing any hard objects around that might do harm if the limbs came against them, and in the second place, by gently controlling the arms and legs. Rather guide the limbs than try by main force to keep them quiet, and never allow a person in an epileptic fit to be tied down, or in any way violently restrained, as serious harm has often been done by such attempts. Never either try to give anything by the mouth. When the convulsions have ceased, should the patient seem drowsy and inclined to sleep, let him do so. This stupor that follows an attack requires no treatment, unless the patient seems weak, and then he should be roused and some beef-tea, or other moderate stimulant, given him. No reference should afterwards be made to the sufferer as to what has happened, and if the attack has taken place in the public street, some one should accompany him home, conveying him in a cab if he seems drowsy and weak. From what has been said, such a disease as Epilepsy exposes those who suffer from it to many dangers, so that, with a view of prevention, they should have explained to them the necessity of avoiding many things, like bathing, riding, fishing, &c., that carry with them special risks.

Hysteria.—This is a nervous disease caused by excitement, weakness, and nervousness. It presents itself under many aspects, one of the most common of which is "*a fit of Hysterics.*" Females are the usual sufferers from it, but it is not unknown amongst men. In fact it may shew itself in any one who is debilitated by illness or overwork. As a "fit of Hysterics" is apt to occur without any warning, it comes under the heading of sudden illness, and the Ambulance pupil should know its leading features, so as to recognise it, and be able to render suitable "*first-aid.*" This is really important, for there is nothing causes such unnecessary alarm, and creates so much commotion in private life as an incident of this kind. Sir James Paget has very well described Hysteria as "the mimicry of disease," and a "fit of hysterics" is made to resemble an epileptic attack as much as anything. In fact it has been described as "sham epilepsy." Accordingly we find that the patient falls down, is at once seized with jerky movements of the head and body, rolls the eyes about under the half-closed blinking eyelids, and sooner or later ends the performance by commencing to laugh, cry, scream, or sing excitedly. Compared with the description given of the true epileptic seizure, it will not be difficult to recognise very essential points of difference. Sudden though the hysterical attack be, it often comes on after something has happened to upset the patient, as some disappointing news, some fancied insult, or some domestic tiff. Then, not only is it arranged to occur before a numerous and sympathetic audience, but the patient always falls very carefully, so as not to receive any hurt, sinking often into a comfortable chair, or the arms of one of the bystanders. One writer states, "that out of 612 young ladies who had hysterical fits last year, more than one-half fell into the arms of gentlemen. Only three had the misfortune to fall on the floor." Again, the movements indulged in are of an extravagant nature, and their irregularity alone distinguishes them from true convulsions. In fact the whole performance is overdone, and the kicking, screaming, howling, and wild tossing of the arms that goes on is not followed by the drowsiness and stupor of Epilepsy, but generally ends in a laugh or loud guffaw. Never at any time is there complete unconsciousness. Thus, if an effort is made to open the eyelids, it is accomplished with difficulty, and the eyes themselves are found to be sensitive to touch. Another very characteristic symptom of Hysteria is the blinking or opening and closing of the eyelids that was alluded to above. It has not the terrible import that many would assign to it, for it is really the efforts of the patient to see what is going on, and to gather how the exhibition is taking with the audience, to say nothing of the anxiety to know whether any active measures of an unpleasant kind are being contemplated in the way of treatment, for if so it is time to bring the attack to an end. What then is the proper thing to do under these circumstances? Probably the less done the better. Check at once any sympathetic attention on the part of those around, and get them to leave the room. Deal gently but firmly with the patient, and let it be clearly seen that the nature of the attack is thoroughly understood, and has created no alarm. Perfect indifference to the whole proceeding has often a wonderful effect, and many an hysterical fit has come to a speedy termination when the patient has been plainly spoken to, and left entirely alone. A very general recommendation in the way of treatment is to administer a douche of cold water, but this should not be resorted to indiscriminately. It must be remembered that Hysteria is merely a symptom of ill-health, and that it is questionable whether it is a prudent thing to drench with water the weak and debilitated women in whom it so often occurs. A dash of cold water in the face, so as to make the person uncomfortable, with the threat that there may be repetitions of it, will generally suffice, provided no unwholesome sympathy is expended on the patient. It is this latter that so frequently causes the undue prolongation of an hysterical attack, and does so much harm in the way of encouraging the patient to repeat the performance. It is a much greater kindness to these cases to exhibit a complete want of sympathy towards them, rather than to let them monopolize the whole attention of the household, as is too frequently permitted. At the same time it should never be forgotten *that Hysteria is a sign of ill-health*, and the sooner the sufferer is put under medical care the better for every one concerned. It must, too, be remembered that while Hysteria most frequently shews itself in the shape of the paroxysms of emotional display described above, it may assume other forms, as of "fainting fits," and that the hysterical person soon finds out which kind of attack takes best in the way of causing most alarm and terror to those around. Consequently, nothing is neglected to get up the part perfectly, and this adds materially to the difficulties of deciding upon the case. Indeed, medical men of considerable experience cannot always give a definite opinion. The majority of cases, however, are easily recognised, and the rule for the Ambulance pupil to act on is never to *shew* outwardly the sympathy that may be felt inwardly, yet never while appearing to be unfeeling to do anything that savours of either cruelty or harshness.

The Feigned "Fits" of Impostors.—While dealing with this subject of "fits," it is only right to mention that the charity and kindness of heart of the public is from time to time taken advantage of by unprincipled and designing impostors, who pretend to be seized with sudden illness, generally of the nature of a "fit," the foaming at the mouth being produced by soap or other agents held in the mouth. A crowded thoroughfare is always selected as the scene of operations, with a confederate to go round among the many onlookers who speedily gather round their convulsed and writhing fellow-creature, and solicit some assistance for "the poor sufferer." Such an appeal always meets with a ready response, and the whole affair is a very paying business for all those in the secret. The possibility of such imposture should always be borne in mind by the Ambulance pupil, and he should call to mind the distinctive features that were pointed out as belonging to hysteria, for they are equally well-marked in these cases. A very good test, too, is to make pressure under the nail upon the "quick" of it. The impostor cannot tolerate it, whereas a person in a genuine "fit" does not feel it at all.

Insensible Persons.—People are often picked up insensible by the road-side, or fall down suddenly in the street and are found to be so. From what has been already said in the present chapter and elsewhere, the Ambulance pupil will have gathered that this condition may be due to several causes. With a view of making the matter clearer, the following table of the different varieties of Insensibility has been drawn up:—

1. Injuries of any kind in any part of the body.	Shock or Collapse.
2. Injuries to the Head.	Stunning or Concussion. Fracture of Skull. Compression of Brain.
3. Diseases of Brain.	Apoplexy. Epilepsy.
4. Fatigue, fright, bleeding, debility, &c., causing failure of the heart's action.	Fainting.
5. Poisoning.	Intoxication. Opium. Kidney Disease.

To most of the above causes reference has been made, but the term *Apoplexy* requires a few words of explanation, as also does Poisoning from Kidney Disease. The word *Apoplexy* implies that the person has been struck down by an unexpected blow, and is used to express the sudden loss of consciousness associated with paralysis that follows disease of certain parts of the Brain. It may arise from one of the vessels of the Brain getting blocked with a clot, or from some blood-vessel rupturing in the Brain, and is consequently most frequent in persons advanced in years. Be the cause, however, what it may, the characteristics of a "*fit of Apoplexy*," as it is called, are sudden or gradual insensibility, face flushed and drawn sometimes to one side, slow puffing and snoring breathing, unequally dilated pupils, loss of power in one or more limbs, and sometimes convulsive twitchings of the muscles. As a rule the patient is quite unconscious, and cannot be roused. The symptoms are in every way very similar to what we find in a case of fractured base of the skull. To some extent, too, they resemble those seen in Intoxication, and this fact has led to many distressing mistakes. "*Dying, not Drunk,*" has formed the heading of many a newspaper paragraph, telling of some one locked up as intoxicated, whom the morning has found in the police-cell cold, pulseless, and moribund. An occurrence such as this is a great sorrow to all concerned, and it teaches the important lesson that Insensibility may be due to disease as well as drink, and that when any one is found, even though smelling of drink, so deeply unconscious that he cannot be roused, the case is one for the hospital, and not for the police-cell. If taken to the latter, a doctor should be summoned at once, and until he arrives the warmth of the body should be in every way maintained. The distinguishing signs of Intoxication are the absence of any paralysis, the occurrence of vomiting, the smell of drink in the breath, and the ability to more or less rouse the person by pinching, douching with cold water, or other means. The Ambulance pupil in dealing with such a case, should make it a rule to give the unfortunate person the benefit of any doubt, and rather to treat every case of Insensibility as one of Apoplexy than to make any mistake. The police, too, should in these cases invariably call in medical skill, for the question of Drunk or Dying is not one for any police-officer to decide, no matter how intelligent he may be.

The *Poisoning from Kidney disease* that was mentioned above as a cause of Insensibility occurs when the Kidneys are unable, owing to alterations in them, to perform their functions and remove the waste products from the Blood.

These accumulate and act as Poisons, consequently this unhealthy blood circulating in the Brain affects it, and often renders the person drowsy and insensible. It is a condition of considerable peril, and requires prompt medical treatment, as it may end in convulsions and death.

Looking to the varied conditions that may give rise to *Insensibility*, the "*first-aid*" treatment of such cases should be conducted on the following lines:—

1. Send for medical assistance.

2. Loosen all tight clothing.

3. Place the body flat upon the back, with the head slightly raised, so as to favour the breathing.

4. Apply cold to the head, with warmth to the feet and legs.

5. Ensure a plentiful supply of fresh air, with rest and quietness.

6. Give nothing by the mouth to drink, and avoid stimulants internally.

7. Observe and note the position of the body, especially as to the state of the clothing, whether torn or disarranged, also the immediate surroundings.

8. Examine cautiously for wounds, fractures, bleeding, &c.

9. Observe the state of the pupils and the character of the breathing.

10. If the person has to be removed, let it be done with the greatest caution, and carry him rather to the hospital than the police station, if there is any suspicion of illness.

Sunstroke.—This occurs in hot climates, and in summer weather, and is due either to the direct rays of the sun or to any high temperature, even from artificial heat. Hence it happens in the vitiated air of hot and close apartments, in mines, and in the stoke-holes of steamers, and is now generally spoken of as *Heat-stroke*. The excessive use of spirits in hot climates seems to predispose to it. It may shew itself by mere dizziness and faintness, with nausea and weakness, just as is seen in ordinary cases of heat exhaustion during a warm summer in our own country, or the symptoms may be more severe and the person falls suddenly to the ground, generally insensible, and with a flushed face. Other unfavourable indications, such as convulsions and a weak pulse may shew themselves, and death may occur very rapidly from exhaustion due to the effect of the high temperature on the nerve-centres. The "*first-aid*" treatment of such cases is to remove the person to a cooler atmosphere, and if it is in the open to a shady spot. Raise the head and upper part of the body, remove the outer clothing, and take steps to reduce the temperature of the body by douching the head, neck, chest, and spine with cold water, by means of a sponge or a watering-can, or by pouring jug after jug of cold water from a height of three or four feet. Holding the patient's head under a pump, or ice-bags to the head and spine are other ways of obtaining that reduction of body heat which should be the first aim of treatment. In severe cases it may be necessary to envelop the body in sheets, wet with cold water, and apply mustard to the nape of the neck. If consciousness returns, keep the patient in a darkened room with cool air around him, and free from all disturbance; but if there is any tendency to a relapse, repeat the cold applications. Some say that on no account should stimulants be given in Heat-stroke, but there are cases where the depression is so great that they must be administered, and in the ordinary heat-exhaustion of our own country a little weak stimulant is often needed. As a precaution against heat-stroke in hot summers, a suitable head-dress should be worn, and the nape of the neck well covered, while all unnecessary exposure to the sun should be avoided.

CHAPTER XV.

BURNS, SCALDS, BITES.

Fatal Burning Accident.—On Monday forenoon, the wife of a moulder residing in Orchard Street, on the South Side, had occasion to go out a message, and left her boy, two years old, alone in the house for a few minutes. When she returned, the child was standing in front of the grate with his clothes on fire. His mother promptly rolled him in a rug, extinguished the flames, and got medical assistance; but the little sufferer died in the Royal Infirmary the same night.—*Glasgow Herald, September, 1890.*

THE above paragraph, which serves as a heading for this chapter, summarizes briefly a class of accident too common in our midst, both amongst rich and poor. Hundreds of children are annually burnt to death in Great Britain in consequence of their clothes taking fire, or they fall victims to the upsetting over themselves of the hot liquids that are too easily, and sometimes even carelessly placed in their way. Looking to the painful and serious nature of these occurrences, they are an important group of injuries for the Ambulance pupil to consider, as the "*first-aid*" treatment rendered, if of a suitable nature, may often prove of great service in relieving suffering, and may occasionally save life.

In speaking of the local effects of severe heat it is customary to classify them as *Burns* and *Scalds.* The former result from the application of *fire* or *dry heat*, as from a flame, and the latter from *hot fluids* or *moist heat.* With the advances made of late years in the arts and sciences, leading to the introduction of fresh substances of a combustible and explosive nature, Burns and Scalds are more common than they used to be; but of the two, Scalds are probably more frequent, owing to the greater increase in the use of steam machinery. Burns are very alarming at the time they occur, and they are generally looked upon as more serious than Scalds, as the hot liquids that cause the latter cool quickly, and run off the parts. With either of these injuries the actual danger to life is in proportion to their extent or depth, and to the region of the body they may be situated on. As regards extent, if one-half or even one-third of the surface of the body is involved, death always results, and, as to situation, of all parts the surfaces of the chest and the abdomen are attended by the most danger, and those of the extremities by the least. Age, too, influences the result in Burns or Scalds, infants and children very readily succumbing to them if at all extensive.

Of the *causes* of Burns and Scalds very little need be said. These are recounted every day in the pages of our newspapers with their never-ending tale of clothes catching fire, of lamp explosions from cheap inflammable oils, of children drinking hot fluids, or tumbling into tubs of hot water, of boilers bursting, of mine disasters from the rashness of some fool-hardy miner, and of many other equally appalling casualties too well known to need repetition here.

The *effects* produced by Burns and Scalds vary with the intensity and duration of the heat. Only a passing reference need be made to that form of Burn known as *Sunburn*, which follows exposure to the sun's influence in a hot summer, and is characterized by great redness of the skin, with severe smarting pain. The face, neck, fore-arm and hands are the parts usually involved, but this depends on the amount of clothing worn or removed, when taking any violent exercise. In the case of persons with delicate skin, blistering and even inflammation of what has seemed an erysipelatous kind, have been known to follow, so that there should be an avoidance of all strong or irritating remedies. Any applications should be of the most soothing nature, and if bathing the part affected with simple hot water, and, after drying, dusting it with zinc or violet powder does not give relief, then medical advice should be sought.

As regards ordinary Burns, it is customary to arrange them in various classes, according to their severity; but practically it is better to look upon them as coming under one of three groups, the *first* being characterized by mere scorching or redness of the skin, the *second* by the formation of blisters, and the *third* by more or less destruction or disorganization of the soft parts. All of these conditions, if the Burn or Scald is a limited one, are accompanied by severe pain, as a symptom, but if the injury has been at all extensive then it is invariably followed by all the symptoms of *Shock*, the temperature falling, the pulse becoming imperceptible, and the mouth dry. In this condition of prostration and collapse many cases, especially children, die, and, as a rule, they do so without any pain. The usual stereotyped newspaper phrase that the poor victim passed away after hours of agony and suffering, is purely an imaginative one on the part of the writer. The fact is the Nervous System has received such a shock, that for the time its power of feeling is more or less in abeyance, and though, in the case of children, convulsions may occasionally precede death, yet, as a rule, the end comes peacefully. In Hospital work it is not unusual to see a child brought in wrapped in the shawl or plaid that has been used to extinguish its burning clothes. Examination reveals extensive burns over the body, and yet it shews no signs of suffering. Placed in bed, it lies perfectly still, utters no complaint, heaves from time to time a deep sigh, asks occasionally for water to quench its thirst, and in the course of a few hours slips quietly away, killed really by the Shock that the accident has entailed. To relatives this fact ought to be an element of consolation, but it is sometimes regarded by them as a favourable sign, and they cannot always understand how the absence of pain is really an indication of intense shock, and very often of approaching death.

Before speaking of the "*first-aid*" treatment of Burns and Scalds, a few words must be said on *What to do when* *dress catches fire.* In the *Times* of January 7th, 1886, Mr. John Marshall has written a letter embodying full directions as to how to act in such an emergency. The letter is rather long for insertion here, but its teaching is that a girl or woman who meets with this accident should immediately lie down on the floor, and that any one going to her assistance, if she be still erect, should make her lie down, or, if needful, throw her down into a horizontal position and keep her in it. This argument is the very sensible one that flames ascend, and that if the person is in a horizontal position the flames have very little to feed on, and do not encircle the victim. Rolling or moving on the floor also helps to extinguish them; while, if alone, the person might crawl to a bell-pull or a door, to ring or cry for help. When the person is prostrate, the task of completely stifling the flames is best accomplished by enveloping the sufferer in a coat, shawl, rug, bit of carpet, table-cover, or anything that is handy, the head only being left exposed, and then rolling him or her from side to side. The Illustrated Triangular Bandage in Fig. 35 furnishes an illustration of how to extinguish flames by wrapping the person in the hearth-rug. Subsequently, obtain water as quickly as possible, and have everything thoroughly saturated, for though the flames are out, the partially consumed clothing retains heat and does further damage. Appalling and terrifying as these accidents from the dress catching fire are, if the above directions are borne in mind, and the victim is placed in the horizontal posture, rolled in some covering, and then water applied, the injuries inflicted will be minimized, and the person rendering assistance will do so at the least peril. Certain it is that matters are made a thousand times worse by the person on fire rushing about and creating a current of air, which simply increases the intensity of the flames. While on this subject of Burns, it may not be out of place to refer to the subject of rescuing persons from a house on fire. Occasionally it happens that the escape of the inmates is rendered impossible, owing to the wooden stairs being on fire or destroyed, and to there being no sky-light by which they can get on the roof and reach the next house. Under these circumstances the windows are the only means of exit, and if there are no ropes available, or no time for extemporizing any by tying together the corners of sheets or blankets, and the only alternative left is to jump from the window into the street, those below should remember that the best thing to do is to hold out a large sheet or plaid, so that the persons may throw themselves into it. By following this plan, more than one hundred lives were saved at the burning of the Ring Theatre, Vienna, in 1882. Again, in entering a room full of smoke, it should be remembered that covering the mouth with a handkerchief wet with water, or vinegar and water, is an excellent protection, and that in such a room the smoke is less dense close to the floor; so that any one lying recumbent, with the face downwards, would probably breathe better than in the upright posture.

Before indicating the "*first-aid*" treatment of Burns and Scalds, it is necessary to offer a word of caution as to *the removal of the clothes*, especially in cases that have been badly burnt. Here gentleness must be the guiding principle. There must be no dragging or pulling off of things, lest portions of skin and flesh be taken at the same time. Rather let the clothes be cut off with a sharp pair of scissors bit by bit, raising each portion gently and separately. Should any piece adhere very closely, if it will not separate easily after it has been soaked with water, allow it to remain. Where the upper or lower extremities are the parts involved, it is a good plan to immerse them in warm water before uncovering them, and if there is any difficulty with the stockings they should be well soaked with olive oil before removal. By attention to these points, just as in the case of Fractures, a great deal of suffering and damage may be averted, and the subsequent course of the case rendered less tedious.

Passing next to the "*first-aid*" management of Burns and Scalds, what are the chief points to attend to? They are two in number,—first, the relief of pain; and secondly, the treatment of shock. If this last is very marked, owing to the severity of the injuries, the pain, as already pointed out, is not a leading symptom, so that the proper thing to do is to aim at restoring warmth and vitality by wrapping the victim in a warm blanket, attending to the temperature of the room, and adopting those other measures that have been already detailed when speaking of Shock. No attempt should be made to undress the patient under these circumstances until Reaction has set in, and there should also be as little moving as possible. If there are facilities for it, and especially in the case of a child, a very good plan is immersion in a warm bath, as it not only soothes and also loosens the charred clothing, but it helps in establishing the Reaction aimed at. If used, it should not be hastily discontinued, and the temperature of the water should be kept at the same level, the patient's strength being maintained by the internal administration of some warm stimulant. In the majority of cases, however, the local symptoms are the most prominent and the alleviation of the suffering the leading indication. The remedies that have been used for this object are legion, and include some of the greatest abominations conceivable. In choosing an application, the Ambulance pupil should take into consideration both the depth of the Burn and also what can be most readily got to exclude the air from it. Both dry and greasy substances have been employed as protective coverings, and the following have perhaps been found the most beneficial:—flour, starch, oxide of zinc, cotton wadding, olive oil, carbolized oil, Carron oil, vaseline, glycerine, fresh lard, dry carbonate of soda, and powdered boracic acid. To this list many other popular remedies might be added, but those have been enumerated that are generally at hand in every household. In Burns of the first degree, where there is chiefly a superficial scorch, the air is best excluded by dusting the part with flour, soda, or zinc, and then enveloping it in layers of cotton-wool. Should the burn be of the second degree, and blisters have formed, these latter should be pricked with a needle to evacuate their contents, after which some greasy dressing, such as vaseline, lard, olive oil, carbolized oil, or Carron oil, should be applied on strips of lint, or linen, layers of cotton-wool being placed above them. A similar line of treatment should be followed in Burns of the third degree, involving loss of skin and soft parts. The *Carron oil* mentioned above is made by mixing equal parts of linseed oil and lime-water together. It is so called from having been adopted as a first-dressing for burns at the Carron Ironworks at Falkirk, and at present it is a very general favourite with the public, not only in Scotland, but all over the world. Undoubtedly it is very soothing and grateful, but it has the disadvantages of giving out rather an offensive odour, and of staining with a greasy look all the bedding and clothes of the patient. In some places it is the custom to add a little oil of turpentine to it, and this seems to add to its power of allaying pain. Another very excellent first dressing for Burns is *Carbolized Oil*, of a strength of about one to fifty. It may not be always at hand, but, if available, it is probably preferable to the Carron oil on antiseptic grounds ; and further, the carbolic acid lessens in a very striking manner the pain of burnt or scalded surfaces. When the application of the dressings is complete, the patient should be lifted into bed and the warmth of the body kept up by suitable coverings, with the addition, if necessary, of hot bottles. Nothing more need be done until the doctor comes. If any length of time elapses before his arrival, and the patient is in great distress and very restless, a dose of laudanum might be given, *but not to a child under two years of age.* Above that, a drop for every year may be administered. That is to say, a child of three years may get three drops, five years five drops, and so on, up to 25 years of age. More than the latter amount should, however, never be given by a non-professional person, and it is understood that recourse will be had to laudanum only where there is urgent need for it, and not as a matter of routine. Here, too, let a word of caution be given to the Ambulance pupil never to attempt to manage a case of Burn or Scald beyond the period of "*first-aid.*" If at that time he acts up to the three principles inculcated above, of removing the clothes carefully, of excluding the air by a suitable dressing, and of treating the shock that is invariably present in a less or greater degree, he will have done excellent service; but if he tries more than this he is undertaking a grave responsibility, for the subsequent complications and deformities that follow this class of injuries demand all the skill and knowledge of a medical man.

In the "*first-aid*" suggestions given above it is supposed that the Burn or Scald is of some severity and extent, and no mention has been made of many of the simple remedies that have received the sanction of use and custom, such as iced water, spirits and water, Eau-de-Cologne and water, hot milk and water, white paint, vinegar, whiting, ink, &c. There is no reason why they should not be employed, especially if the injury is very superficial and of small extent; but probably under ordinary circumstances and conditions, the most satisfactory results are obtained by the dry or oily applications mentioned above.

The "*first-aid*" treatment of Burns from Corrosive Acids, Caustic, Alkalies, &c., requires a few words of notice. These accidents happen in chemical works and in places where these substances are employed. The point to aim at is that mentioned in the treatment of Poisons, and consists in neutralizing the Acid, Alkali, or Caustic, whatever it may be. In the case of *Acids*, the best immediate treatment is to dust on whiting or powdered chalk, which causes effervescence, and effects neutralization. Water may then be used to wash the compound off, but the experience of workmen seems to be that it should not be employed at first, as in union with the acids it increases heat. The same thing should be done for burns from such caustics as Chloride of

Zinc or Tin, and when any of these substances are splashed into the eyes, bathe them well with lime-water, and drop in afterwards some castor or olive oil. The local antidote for the *Caustic Alkalies* of Potash, Soda, Ammonia, and Quick-lime is Vinegar; but when applied to the eye it must be diluted with seven parts of water. If vinegar is not obtainable, any of the fixed oils or fats is the next best thing, and failing these, then a thorough and free use of water is all that can be done. Burns from *Phosphorus* are very unmanageable, and very deep, as there is really nothing will arrest its action, and it only goes out when it is completely consumed. The caustic effects of *Carbolic Acid* sometimes cause alarm from the whitening of the skin that follows, but it is such a local anæsthetic that the burns soon lose their painfulness, especially if a little glycerine or oil is rubbed over them.

In connection with *Scalds*, mention must be made of that very serious and distressing one which is so common among children as the results of trying to drink out of the spout of a kettle containing boiling water. The hot steam and fluid drawn into the mouth by the attempt to "smoke the kettle," as children call it, scalds the larynx, or upper part of the windpipe, and severe spasms and swelling ensue, so that there is great danger of suffocation. In these cases a medical man should be sent for immediately, and pending his arrival the best "*first-aid*" is to wrap the child in a warm blanket, administer some stimulant if the shock is great, and endeavour to allay irritation and swelling by applying hot sponges or flannels externally to the throat, the atmosphere breathed being warmed by diffusing steam through it. Little bits of ice or small quantities of water may be given if the thirst is severe, and the use of equal parts of cod liver oil and lime-water in tea-spoonful doses every hour has been recommended as a soothing and healing application to the scalded internal parts. It would be quite justifiable to use this latter remedy before the doctor comes, but subsequently it should only be administered with his knowledge and approval. Never delay in obtaining medical aid at once in these cases, for death from suffocation may ensue at any moment very rapidly, and never oppose the opening of the child's windpipe (tracheotomy) if the medical opinion is given that that operation is necessary for its safety. Cases such as these impress on us the necessity of keeping hot liquids out of the way of children, who, by the way, seem possessed with an innate love of playing with fire, and everything that is dangerous to them.

Burns from Exploded Gunpowder.—They have no doubt some special peculiarities arising from the momentary intensity and suddenness of the flash, while the force of the explosion gives rise to severe shock, but they call for the same "*first-aid*" treatment as ordinary burns. The injured surface, is, moreover, generally blackened with smoke, and penetrated with unignited grains of powder, and as this may lead to subsequent disfigurement, medical aid should be summoned in all these cases, and the care of them committed from the first to professional skill.

Gun-shot Injuries.—In civil life these are generally caused by fowling-pieces, and often they are the result of the insane folly of pointing a gun in jest at some other person. They are sometimes serious accidents, and require the best surgical advice, but their "*first-aid*" treatment is that of ordinary wounds,—namely, the arrest of bleeding, and the application of a suitable "first-dressing." Should any bone be fractured, splints will require to be used in addition, and if *Shock* is present it should be dealt with in the manner already described.

Injuries from Lightning.—When any one receives the direct stroke of the electric fluid of a so-called "flash of lightning," death is, as a rule, instantaneous, and even in Great Britain a number of deaths are annually recorded from this cause. But many of the persons said to be "struck by lightning" have really only received a severe electrical shock from being in close proximity to a strong snow-house, at a temperature of 20° below zero (Fahrenheit). The parts were bathed in ice-cold water for about two hours, and then enveloped in furs for three or four hours. Then frictions were used, first with the feathery side of a bird-skin, then with snow, alternately wrapping the limb in furs and rubbing it for nearly twenty-four hours. It was next carefully wrapped up, and the temperature of the snow-house raised by lamps above zero. On the third day the patient was taken to his house, and in seventy hours was walking about with only a slight frost-bite on one of his toes." Nothing could be more instructive than the above narrative, and it should serve to impress strongly on the Ambulance pupil the proper "*first-aid*" treatment of Frost-bite. It also teaches that in dealing with *Chilblains* friction with some gently stimulating liniment is the proper thing, provided the skin is not broken, and that any sudden transition from great cold to heat, as by warming the hands or feet when icy cold before the fire, or putting them into hot water, is to be avoided.

Besides acting locally, severe cold has depressing constitutional effects, especially on those sitting still and exposed to it, so that in a hard winter even in Great Britain not a few persons are frozen to death. Shepherds and watchmen are among the chief sufferers, but in the old coaching days many a guard was found at the end of the stage cold, stiff, and insensible in his seat. The "*first-aid*" treatment of a *frozen person* must be conducted on the same lines as that of Frost-bite. There must be no sudden application of heat. To bring any one in a frozen and benumbed condition into a hot room, or to place them in a warm bath, is simply to cause their death. The proper thing to do is to place the person in a cold room, such as a barn or shed, remove the clothes, especially if wet, wrap the body in a blanket, and with gentle frictions of ice-cold water, snow, or tincture of camphor, endeavour to re-establish the circulation. This treatment should be carried on for some time, and then the patient may be enveloped for a while in blankets, and some internal nourishment and stimulant—as cold beef-tea, milk, ordinary tea, or weak wine and water—given, if consciousness and the power of swallowing have returned. After an interval the frictions should be repeated if necessary; but when the limbs lose their stiffness, and there are signs of returning life and vitality, the body should be carefully dried and put into a cold bed in a cold room. If respiration does not become satisfactorily established, Silvester's artificial method should be employed. As improvement shews itself, the room may be made warmer and the internal stimulants may be repeated, so as to bring on gentle perspiration. Close proximity to a fire should not, however, be allowed for some time. In this way, by avoiding sudden changes of temperature, lives may be saved which at first seemed hopeless, and persons that have been buried for hours in the snow have been revived. As to the best thing to be done in the emergency of being overtaken by a snow-storm and being unable to reach a place of shelter, the chief thing to remember is to fight strenuously against the overpowering desire to sleep that so often comes on, but if it is compulsory to lie down, from sheer exhaustion, not to do so until the precaution has been taken of seeking protection from the wind under the lee of a snow-drift, or in a hollow filled with snow, or in a hole scraped out in the snow large enough for the body. Snow is a bad conductor of heat, and so serves as a protection, provided the wind is not too strong, or is kept away, for it is it that removes so rapidly the warm air next to the body, and thus increases the intensity of the cold. The protective influence of snow has often been illustrated by human beings and sheep having lain in it for days, and yet been rescued alive. At the same time, it should be remembered that every effort should be made not to yield, under the influence of cold, to the irresistible desire to go to sleep that is sometimes so overpowering and so fatal, as the records of many Arctic expeditions shew.

Bites by Animals, possibly Rabid.—When we speak of an animal being *Rabid,* we mean that it is suffering from *Rabies,* a disease characterized by a train of nervous symptoms of a very distressing nature, and accompanied by an inclination to attack other animals. As far as our present knowledge goes, it is due to a special and fixed poison, which, if introduced into man, sets up in him the disease known as *Hydrophobia ;* but it is important to remember that the two are separate and distinct diseases. The one, no doubt, induces the other, but they are not identical. "There would be no Hydrophobia were there no Rabies; there can be no Rabies unless it be communicated by a rabid animal" (*Watson*). It is not, accordingly, correct to speak of a *hydrophobic* animal, for Hydrophobia derives its name from the dread of water which makes its presence in the human subject, whereas a dog suffering from Rabies will seek water greedily, and, though nervous spasms may prevent him drinking it, the creature has no aversion or fear of it. Hydrophobia, then, is a specific disease, occurring in man as the result of an *Animal Poison* introduced into his system. In the great majority of cases, it is the result of the bite of a *rabid* dog, but as Rabies may occur in cats, wolves, foxes, hyænas, jackals, horses, pigs, goats, sheep, deer, and other horned cattle, it may result from injuries caused by bites or tears from any of these animals. It is in the saliva of the mouth that the poison is contained, hence there is less fear of inoculation when the part bitten is covered with clothing, as this wipes the poison off the teeth. This may explain partly why every person who is bitten does not take Hydrophobia, but the fact is that the hydrophobic poison is a very uncertain one, only one, perhaps, of several persons bitten being attacked, and that *rabid dogs* are far less common than is generally supposed. The popular notion is that the phrenzy and temper that any dog will display if hunted through the streets by an excited mob, who have raised the cry of "Mad Dog!" clearly indicate *Rabies;* but this is a complete delusion. The dog foams at the mouth from excitement, and bites simply in self-defence. When a dog becomes *rabid* it is because he has been bitten by another rabid dog or by some wild animal, as a fox or wolf, in that condition, and this fact that Rabies cannot originate spontaneously should serve to allay apprehension, especially at a time like the present, when Hydrophobia is regarded as alarmingly prevalent, and when even a growl from an angry and perhaps irritated terrier is thought to require a trip to Paris with a visit to Pasteur's laboratory. The truth is, that "dog-bites are extremely common—hydrophobia one of the rarest of maladies" (*Holmes*), and that the majority of medical men have never seen a case of it. This statement is not made with the object of throwing doubt on the existence of such a disease as Hydrophobia, but merely to allay anxiety; for, terrible as Hydrophobia is, the mental dread of having it is almost worse than the disease. It is certainly a more prolonged agony.

What, then, is the best "*first-aid*" treatment in cases of bites or tears from animals? Where the injury has been inflicted by a healthy animal in self-defence or in a moment of irritation, no special measures are required beyond those needed for any torn wound—namely, to apply a warm water dressing and to keep the part quiet until a medical man sees it. And here it may be mentioned that no one should ever be foolish enough to yield to the notion that any dog who has bitten a person should be destroyed at once to prevent its ever going mad. From what has been said about Rabies, it will be readily understood that any subsequent illness of the dog can have no effect on what has happened before, and that it is only if the animal is rabid at the time it inflicts the bite that any harm can accrue to the person bitten. When this is the case, or where any doubt exists as to the condition of the dog, act at once. The two things to aim at are,—first, to prevent the poison being carried into the circulation; and, secondly, to get rid of it locally. The former is not so impossible as it might appear, for a certain period must elapse before it takes place, and the latter, too, can be carried out without delay by sucking the wound When the bite is on any of the limbs, grasp the parts above, and tie a ligature between the wound and the heart. Next, let the bitten person suck the wound, if possible, provided the mouth is free from any abrasion and the lips not cracked, and encourage any bleeding by washing it with warm water. This alternate sucking and washing should be repeated two or three times, and then the part should be freely cut out, burnt, or cauterized. Mr. Youatt had great faith in nitrate of silver for cauterizing the wound, and he gives statistics of 400 cases of bites from rabid dogs treated successfully in this way. Others use a red-hot wire or knitting-needle, while some are not content unless the part is cut out. Probably the best thing for the Ambulance pupil to do is to employ a ligature for arresting the circulation, to bathe the part with warm water, and to suck the wound, leaving the cauterizing, burning, or excision of it for the medical man; but if a considerable interval is likely to elapse before medical assistance can be got, then it would be prudent to use such caustics as Nitrate of Silver or Carbolic Acid, and failing these, to burn the wound with a red-hot wire, steel (for sharpening knives), knitting-needle, carving-fork, cinder, or lighted fusee, or by the ignition of some gunpowder placed in it, after the plan followed by sportsmen in India, when bitten by a poisonous snake.

Before leaving this subject, it may be observed that, with the view of *prevention*, any dog bitten by another strange or ailing dog should have his wound properly attended to, and should be kept under observation, and when any case of Rabies has unmistakeably declared itself, the authorities should be communicated with, so that any rabid animal may be at once secured, and steps taken to ensure the necessary disinfection of any kennel, collar, or chain with which the creature has been in contact.

Snake-Bites.—If it is the case, as Shakespeare tells us, that it is "the bright day that brings forth the adder," we have probably our variable climate to thank for our freedom from these reptiles, for in Great Britain we have only one poisonous snake—the Viper, or common black Adder—known by the chain of dark, lozenge-shaped marks down its spine. It is smaller than the common grass snake, which has a bright yellow collar below its head, and is quite harmless, as it never bites, though it makes a hissing sound. Serious constitutional symptoms—such as fainting, giddiness, loss of speech, nausea, vomiting, and great weakness, with rapid feeble pulse, follow the bite of an adder, especially if the poison has entered a vein; but, as a rule, fatal consequences do not ensue. Sometimes the indications of the poison take the form of severe local irritation in the shape of heat, pain, and swelling at the seat of the bite, which is marked by two small, minute wounds, from which a drop or two of blood may issue. The most prudent "*first-aid*" treatment in these cases is undoubtedly to apply a ligature, or improvised tourniquet, above the bite, for the person bitten to suck the wound, if possible, and to wash it freely with warm water, to which some Condy's fluid has been added. Besides these *local* measures, however, *constitutional* treatment in the way of supporting the strength is of the utmost importance, and with this view, if alarming symptoms come on, stimulants should be given rather freely, such as Ammonia (sal volatile), brandy, or whisky. Under these circumstances intoxication is not so easily induced, and in India a favourite remedy for snake-bite used to be to drink a bottle of Madeira wine in two draughts, with an interval of about three minutes between them!

Nothing has been said about cauterizing or cutting out the wounds in these cases, because the general opinion is that this is not necessary in the case of adder-bites. In dealing with bites from the deadly hooded snakes of India, or the rattle-snake of America, where the poison secreted is much more active and greater in quantity, more energetic measures may be required, in addition to the use of the ligature and the suction of the wound already recommended. Various substances have been much vaunted as direct antidotes to the snake-venom, of which the injection of *Ammonia* into the veins (*Halford*), the use of *Potash* (*Shorrt*), and the local injection of *Permanganate of Potash*, in the shape of twenty drops of *Condy's Fluid* (*De Lacerda*), are best known. Others place their reliance on *Olive Oil*, and assert that, if used freely both internally and externally, it is an absolute specific in case of rattle-snake bite. Thus, Dr. Earley, in an experience of thirty-eight years in America, treated by olive oil twenty-five severe cases of snake-bite without a single death, and he states that "the inhabitants of locations where poisonous snakes are found always keep a good supply of olive oil in their houses, and when bitten, never call in a doctor, but use olive oil freely, which in every case gives full and complete relief." There may be some association between this method of treatment and the popular notion that the adder carries its own antidote in the fat contained in its belly, for in some parts it is customary to kill the animal and smear its grease upon the part bitten. As regards snake-bites, it should be mentioned that probably snakes use their poison-apparatus against man in self-defence only, and that they are not, as a rule, aggressive, their hiss or puff being more of the nature of a warning to any one they see approaching.

Insect-Stings.—A great many of the injuries inflicted by insects on man are with the object of extracting nourishment, but in the act of suction they sometimes inject an irritating fluid, which sets up very various effects, yet is not poisonous, and only causes inconvenience. Some insects, as Hornets, Wasps, or Bees, are provided with poison-glands and stings as weapons of offence and defence, and they use them occasionally in anger. Beyond the intensity of the pain that it produces, a solitary sting is in no way dangerous; but when the stings are numerous, as from a swarm of bees, serious, and even fatal, results may follow. So, too, a sting on the tongue or throat, caused by swallowing a bee or wasp concealed in honey or fruit, may prove dangerous from suffocation, owing to the severe swelling that comes on.

The "*first-aid*" treatment of all these cases is the same —namely, the soothing of local irritation, and the combating of any constitutional symptoms that may shew themselves. Should the sting have been left, as is usually the case with bees, but not with wasps (so that Bees can defend or offend only once, for some mysterious reason), it should be extracted by the pressure of a watch-key over it, and then some alkali, such as dilute ammonia, in the form of sal volatile and water, or solution of soda, should be applied, as it seems to neutralize the poison. By many carbolized oil is thought to give the best relief. Other popular remedies are the scraped pulp of a raw onion, cut in half, and a clay poultice, but the "Wasp-Sting" question is one on which every one thinks himself an authority, as is shewn by its frequent discussion in the daily papers. If any local irritation follows a sting, then ordinary poultices of bread or linseed are called for, while in the case of a sting on the tongue or in the throat, hot mouth washes and gargles of glycerine and water, or salt and water, should be used until the doctor arrives, any signs of weakness or faintness being met by suitable stimulants. In these cases, also, the popular idea is that if a piece of raw onion is chewed and slowly swallowed, relief will be obtained.

Foreign bodies in the Eye.—It is not unusual for small insects, particles of sand, scales of seeds, pieces of straw, soot, stone, or cinder, to make their way into the eye, either under the influence of the wind or driven by mechanical forces. The expression, "into the eye," does not imply that they gain access to the interior of the eye, but that they make their way between the eyelids, and may either lodge on the surface of the eye or under the lids. If the body is at all hard, and has been forced in with anything like violence, it may be embedded in front of the eyeball, but probably the larger number of the foreign bodies lie loosely on the inner surface of the upper lid. It is exceptional to find them between the lower lid and the ball. No matter, however, where they fix themselves, they create a great deal of discomfort, with redness, watering, and irritation of the eye.

As regards the "*first-aid*" treatment of these cases, if a person is alone, the proper thing to do is to shut the eye, and keep it shut, avoiding all rude rubbing with fingers or knuckles, which only serves to fix or embed the cinder or other foreign body. Some have advocated rubbing the other eye, and there can be no harm in this, but complete closure of the injured eye should be observed. The effect of this is that the excessive flow of tears set up by the foreign body accumulates between the lids, and often carries the particle to the inner corner of the eye, whence it escapes with the gush of fluid that takes place on opening the eye, or where it is easily seen and got rid of. If the Ambulance pupil happens to be in the company of any one who has met with this misfortune, he should first inculcate the above line of treatment, and only when it has failed should he attempt to interfere. In doing so, the first point to attend to is to place the person in a good light for inspecting the eye thoroughly. Then the spasmodic closure of the lids present in all such cases should be overcome by gently separating and holding apart the lids, and the person should be asked to turn the eye in various directions, so as to see the whole globe. If any substance is seen firmly embedded in the eye, or the organ is in any way cut, no attempt should be made to deal with the case, but a few folds of wet lint or linen should be placed over the closed lids, with a triangular bandage to hold them in position, and medical assistance obtained without delay. It should be a fixed rule never to interfere with a foreign body in the front of the eye that the point of a pocket-handkerchief or a camel's hair brush will not remove. Fruitless efforts to drag out or pick out such a particle may lead to irretrievable damage. If, however, the irritating substance is merely lodging on the eye, then it may be taken away. First evert the lower lid by drawing it down towards the cheek, as shewn in Fig 26 of Triangular Bandage; and ask the patient to look up. If the foreign body is there it is very easily got out, but it is more commonly located under the upper lid, and then various devices have to be resorted to to remove it. One plan is to draw the upper eyelid well down over the lower, so that the latter, with its eyelashes, serves as a brush to sweep the inside of the upper lid. Another way is to lift up the upper lid and then insert a piece of blotting-paper between it and the globe. By moving it gently about, the foreign body is often caught by it and removed with it. In America the railroad conductors carry with them a supply of horse-hair for the extraction of the particles of dirt or cinder that so frequently enter the eyes of passengers and cause so much distress. Their experience makes them experts in doubling the hair and drawing it over the eye while the lid is closed. Often, however, these manœuvres fail; and then there is nothing left but to evert the upper lid, as shewn in Fig. 27 of Triangular Bandage. Many think this a difficult procedure, but if the Ambulance pupil is gentle and steady, this simple step is easily carried out as follows:—Seat the patient in a chair, and direct him to look steadily downwards; then take the upper lid firmly but lightly between the the forefinger and thumb (not by the lashes), and draw it gently out from the globe. It is then readily turned on itself inside out, or, if this is difficult, the end of a pencil or a knitting-needle or a bodkin, as in the illustration, may be used to turn it over on. The inner surface of the lid must now be thoroughly explored until the particle is found and removed, when the severe pain at once disappears. Any subsequent irritation is best alleviated by a drop of castor oil or by bathing the eye with warm water or tea. One of the most dangerous accidents that can befall the eye is the entrance of lime or mortar between the lids, and no time should be lost in everting the lids and washing the eye with vinegar and warm water (one part to seven). If vinegar is not at hand, use warm water alone, and subsequently introduce a drop or two of castor oil. In reference to this accident it is good advice, while walking through streets in which new buildings are being erected, to avoid the dust heaps and the collections of lime, and never to look up at these buildings, as foreign bodies are apt to be blown into the eye in so doing. In the case of a burn of the eye, drop in a little olive oil or insert some vaseline, and let a medical man see the case as soon as possible. In fact, this should be the invariable rule in all cases of injury involving so delicate and important an organ.

Foreign bodies in the Ear.—The majority of these are found in the ears of children, who introduce them while playing, or while trying to imitate conjuring tricks they may have witnessed in which objects are made to pass from ear to ear. A list of the foreign bodies that have been found in the ear passages would include a great variety of articles, but for practical purposes it is as well to classify them, and the best division, probably, is as follows:—

(*a*) Those that are liable to swell and enlarge, and becoming impacted are the source of serious irritation Peas, beans, and coffee berries are illustrations of this class.

(*b*) Those likely to irritate, but with no tendency to enlarge, as insects and putrescent pieces of cotton wool.

c) Those which do not enlarge and are not in themselves irritating, as pebbles, beads, shells, shoe-buttons, bits of chalk, slate pencil, or wood.

As regards the "*first-aid*" treatment of these cases, there are very few of them that will not admit of the delay necessary to procure the services of the doctor. The only exception I would make is in the case of insects in the ear. They sometimes cause intense agony, to say nothing of alarm. Fortunately, the pouring of a little oil or water into the ear kills them and they generally float out. If they do not, they are quickly got rid of by syringing, which is really the only active means of treatment that an Ambulance pupil should undertake in dealing with the ear. In fact, if there is a doctor within reasonable distance he ought to be seen at once in these cases. Nothing should induce an unprofessional person to use bodkins, hooks, hair-pins, or other instruments of extraction, for owing to the narrowness of the passage greater danger, probably, results from unskilful manipulations than from the presence of the foreign body itself. Under these circumstances, parents and friends would be wise to allow none but the gentlest efforts at extraction on the part of amateur operators, and as syringing, if properly done, and without delay, will remove a foreign body in ninety-nine cases out of a hundred, no other steps should be taken until this has been fairly tried. Objection perhaps should not be made to the plan of using some cobbler's wax, glue, or cement on the point of a fine piece of wire or stick to withdraw the foreign body, but it should be laid down as a rule that mechanical attempts at extraction should only be carried out by a medical man.

Foreign bodies in the Nose.—These are often inserted by children or insane people, but sometimes find their way in by accident. An endless list of the foreign bodies found in the nostrils might be given, and would include buttons, glass beads, pebbles, nuts, carpet tacks, bits of wood, pieces of coal, beans, pins, and many other things. The amount of irritation set up will depend on the nature of the article introduced, but very often no symptoms arise. An effort may be made to dislodge the foreign body by syringing or preferably by pressing on the nostril which is clear and then getting the patient to blow his nose hard, or sneezing may be induced by tickling the opposite nostril with a feather or the administration of a little snuff. Very often either of these plans is successful, especially if adopted soon after the insertion of the foreign body, but in the event of their failure medical skill should be obtained.

The "*first-aid*" treatment of foreign bodies in the air and food passages has been already discussed, so that the only cases left for notice are those where *Needles and Splinters of wood* run into such parts of the body as the palm of the hand or sole of the foot. If any part of them is projecting.

they should be at once extracted, but if they have broken off, then medical advice should be sought, as they may give rise to a great deal of trouble.

Rings Fixed on Fingers.—A tight ring may get fixed on the finger of children or grown up persons, and if it is not removed severe inflammation, leading even to the loss of the finger, may result. The first thing to try is putting the finger in cold water and soaping it. Should this fail, a piece of strong pack thread or twine should be wound evenly and gradually round the finger from the top downwards until the ring is reached, when the end of the thread should be passed under it, if necessary by the aid of the eye end of a needle. When through it should then be pulled tight, and the thread unwound towards the point, the ring generally coming off with it. It is a somewhat painful operation, but is usually successful. In cases where it does not succeed, the ring should be cut or filed through, the skin underneath being carefully protected. In these cases there should not be any delay, as the finger swells rapidly.

Tears from Machinery.—In the chapter on Hæmorrhage, reference was made to the different *varieties* of wounds, as Incised, Lacerated, Contused, and Punctured. As a rule, tears from machinery result in injuries that are both Contused and Lacerated, for not only are portions of the body often torn away, but the surrounding parts are generally severely bruised. Such accidents cause a good deal of Shock, but owing to the twisting that the blood-vessels undergo there is not much loss of blood. The "*first-aid*" treatment is to deal with any Collapse that may be present, while *locally* all hæmorrhage should be arrested, any torn portions of the body, such as the scalp, cleansed and replaced, and a suitable "*first-dressing*" applied. If the general condition of the patient allows of it, steps should then be taken for the removal of the injured person by proper means to the nearest hospital or their own home. The treatment of Crushed and Bruised parts has been already fully given when dealing with Bruises. Cases of

Abrasions, where the skin has become ingrained with dirt, require special care at the doctor's hands, otherwise great disfiguration may follow.

Stabs.—These are punctured wounds, and, as such, have special dangers of their own, to which reference has been already made. They are inflicted by knives, daggers, and other sharp-pointed bodies, and from their depth may cause serious bleeding. Sometimes they open into large cavities, such as the abdomen, and some internal organs, such as the bowels, may protrude through the wound. Under conditions such as these, the "*first-aid*" treatment is to repress any bleeding by direct pressure, or by pressure between the wound and the heart; while, if the wound is in the abdomen, and the bowels have protruded, they should be washed with warm water and covered with hot cloths or flannels until the arrival of the medical man. If Shock be present, it should be met by the usual remedies.

Supposed Death.—The question, *When is Life extinct?* is not so easily answered as might be supposed. Every now and again remarkable statements find their way into the public papers, and indicate that a great deal of difficulty is involved in deciding whether death is real or apparent. It is, of course, a matter for a medical man to settle, and he does so on certain signs and indications, but the Ambulance pupil may sometimes be so placed that he may have to take the responsibility upon himself. The practical points that would guide him are the entire cessation of the heart's action, a motionless condition of the chest—all rising and falling of the ribs being absent—while a mirror held before the mouth would be in no way dimmed by moisture. Upon such evidence it would be fair to conclude that death has occurred, but if the case is one of drowning or hanging, and there is the remotest chance of the slightest spark of vitality being left, it would be wise to put in force for a time the restorative measures advised in the preceding pages, and to carry them out until a doctor arrived or a reasonable period had elapsed.

CHAPTER XVI.

THE REMOVAL OF THE INJURED.

"All that day, and for five or six hours more on the following morning, the seamen of the Albion and the Vesuvius, being well provided with stretchers, laboured hard, and with cheerful alacrity, at the business of carrying the sufferers on board ship."—Kinglake's *Invasion of the Crimea*, vol. iii., p. 334.

BESIDES rendering such "first-aid" as has been described in the previous chapters of this handbook, it may often fall to the lot of the Ambulance pupil to have to undertake the removal of a sick or injured person to a place of safety. The Good Samaritan, it will be remembered, not only applied the necessary "first dressing" of wine and oil to the wounded man, but "he set him on his own beast, and brought him to an inn." Sometimes this removal is not an easy matter and may require a great deal of tact and ingenuity to accomplish it satisfactorily, so that it is important for the Ambulance pupil to make himself acquainted with the various details of the different methods of transport. The present chapter is meant to offer some hints and suggestions upon this subject, in addition to the further valuable information given in the "Stretcher Exercises," published by the St. Andrew's Ambulance Association.

The nature of the assistance to be rendered to a disabled person will vary with the nature of the case, the severity of the accident, and as to whether the Ambulance pupil has to effect the removal alone or with one or more helpers.

When the Ambulance pupil is the *only one at hand to help*, not so much difficulty presents itself in that class of cases where the person, though weak and faint from shock, or it may be hæmorrhage, has escaped injury in the lower limbs, and can walk. Here the great point is to render assistance in the proper way, and the matter should not be beneath notice because of its apparent simplicity. The usual plan of the disabled person supporting himself on the arm of his attendant, and leaning his weight on it, is not nearly so efficient as that represented in Fig. 80, which is

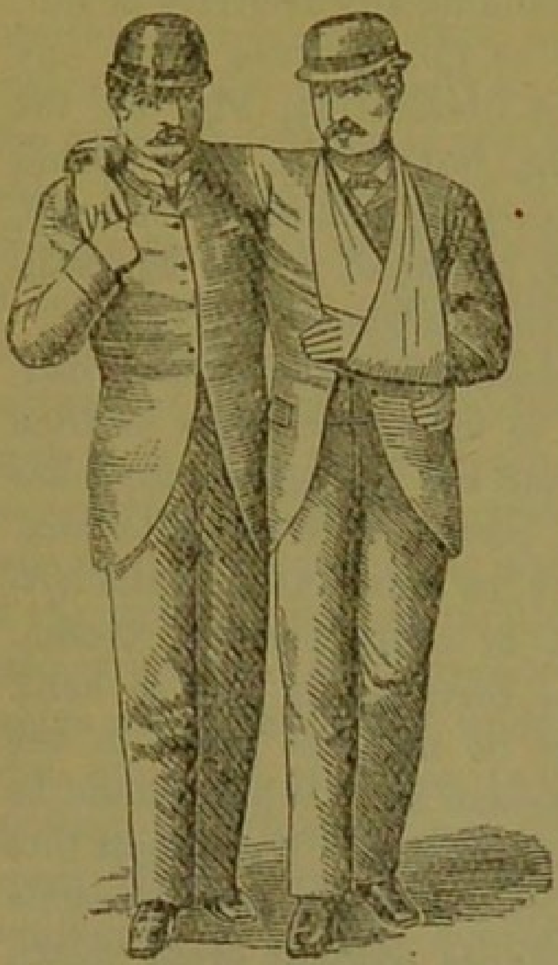


FIG. 80.—ATTENDANT SUPPORTING INJURED PERSON.

copied by permission from the Manchester Health Lectures of 1880-1881, and is thus explained by Dr. Cullingworth in his lecture on Sick Nursing amongst the Poor: "Under such circumstances the problem is how you can render the greatest help, and still leave yourself, as well as the person requiring assistance, free to walk. To secure this it is evident that your faces must be turned in the same direction. We will suppose that a man has a broken arm which has been put into a sling, and he wishes now to walk to the hospital, or to the nearest doctor. You must stand at his uninjured side, with your face in the same direction, and, passing your arm behind his back, place one hand firmly on the man's hip farthest away from you. He must then pass his sound arm behind your neck, letting his hand fall well in front of your shoulder; which hand you must now grasp very firmly with the hand you have still disengaged. This is an arrangement worth a little practice, for it is a good way of assisting weak persons to go upstairs, and might usefully take the place of some of the more clumsy methods now in vogue." A trial of the above plan will at once convince any one that it is the most effectual way of supporting a partially disabled person, and that if the helper is strong enough, and it is deemed necessary, by placing the hip behind the near hip of the patient, the latter can be easily raised from the ground and carried bodily along. When patients are being assisted in this manner, Professor Longmore has drawn attention to the need of extra caution while descending any declivity or hill, lest they should suddenly slip or fall forward from any accession of weakness. In the illustration, Fig. 80, the patient has his arm in a sling, but if that limb should happen to be unhurt and the injury be located in the head, neck, or upper part of the trunk, the hand would be available for holding a stick as a further means of support.

The most arduous cases are those where the sufferer cannot walk, either from damage to his lower limbs or from being in any way unconscious, and the ambulance pupil has *to lift and carry the disabled person without assistance.* The chief difficulty, undoubtedly, in these cases, is the *lifting* the person into the arms or other position chosen. Once this is accomplished, the *carrying* is not so hard. Accordingly, no attempt should be made to stoop to the ground and pick an insensible person up. What should be done is rather by indirect methods to coax "the weight into such a relation to the centre of gravity as to make it possible to carry it to a considerable distance without great weariness" (*Pilcher*).

For short distances, in the case of a child, a woman, or a light and slim adult, the carrying is best managed *by taking the sufferer in a sitting posture in the arms,* the right arm being placed under the thighs, and the left thrown round the trunk under the shoulders, the disabled person, if conscious, placing his arms round the neck of the person carrying him. This method requires that the patient should be first got into the upright posture, in the way to be presently alluded to, as otherwise it is not easy to lift the sufferer off the ground.

A somewhat better and easier plan, perhaps, is for the Ambulance pupil *to take the disabled person on his back, and carry him in the position known as "pick-a-back."* This is best accomplished in the following way: Having spread out the patient's legs and placed him in the sitting posture, kneel, or what is better, crouch down between his legs with your back to him. Then draw his arms as far forward as possible over each of your shoulders, and by stooping forwards lift him gradually up until you stand upright. If the patient's position is now found not to be very comfortable, it may be improved by giving a hoist or two while holding on firmly to his hands. Subsequently, the patient, if conscious, may cling with one or both hands to the bearer's neck, and this frees the hands of the latter. This method of mounting the disabled person on the bearer's back is one that was very much in vogue in the days when transport material was very scanty, and Professor Longmore tells us that it was in this way Baron Percy, the originator of the stretcher-bearers (brancardiers) in the French army, gallantly carried off a wounded fellow-officer over a pontoon bridge across the Rhine under a heavy fire from the Austrian guns. A visit, too, to that record of modern deeds of heroism, the Victoria Cross Gallery, will show that in more recent times both this method, and the one previously mentioned, have been successfully resorted to by British soldiers when succouring wounded comrades.

With the view of rendering both these methods of transport less fatiguing and more suitable for longer distances, the use of slings, cross-belts, and straps has been suggested by Heyfelder, Harbers, and others; but it is not easy to arrange these appliances single-handed, and when another helper is available there are other plans of removing the disabled person that are to be preferred.

Before speaking of these latter, some reference must be made as to the best way of carrying an *unconscious* person without assistance. This is no easy task at any time, but under certain circumstances it is one of great difficulty. As was said before, no attempt should be made to lift the insensible person directly from the ground. This would tax the strength of the strongest man. The better plan to follow is to coax the weight into such a relation to the centre of gravity, that the carrying of it is rendered easier.

Going on this principle, it will be found that *three* different positions are assumed in raising a wounded man to a bearer's back. First of all, the ambulance pupil

FIG. 81.—ATTENDANT CARRYING INJURED PERSON.

turns the patient on his face, and, standing astride of him, lifts him to his knees, and then to his feet (Fig. 81).

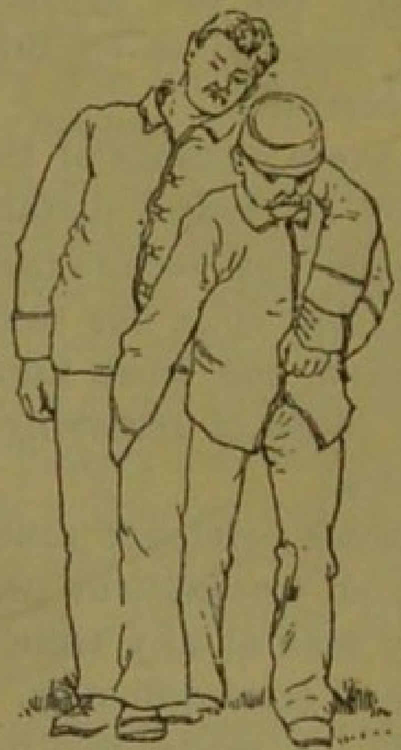


FIG. 82.—THE SAME.

FIG. 83.—THE SAME.

Secondly, he draws the patient's left arm around the back of his neck, grasping the wrist in front with his own left hand, and stooping down he passes his right arm around in front of the patient's left thigh (Fig. 82). Lastly, he assumes the upright posture, and, on rising, the patient falls across his back (Fig. 83).

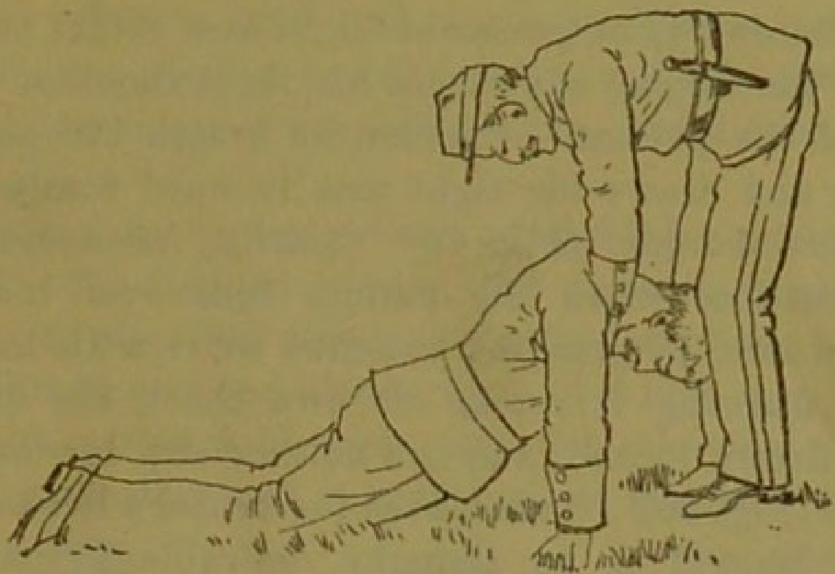


FIG. 84.—THE SAME.

Should circumstances render it necessary that the bearer should have one arm free, as in the case of a soldier or policeman for carrying a weapon, or of a fireman for climbing up or down a ladder, a modification of the above plan is called for, so that the disabled person is carried rather on

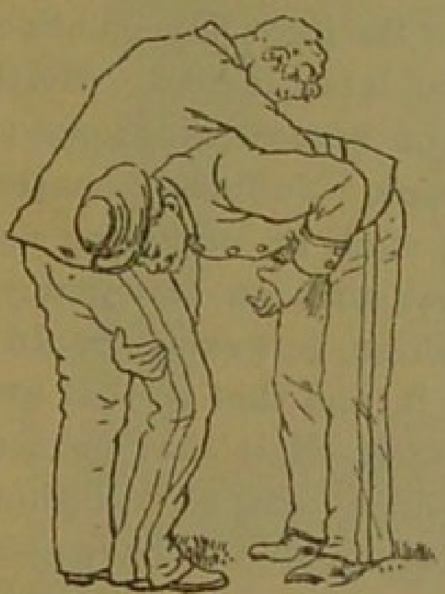


FIG. 85.—THE SAME.

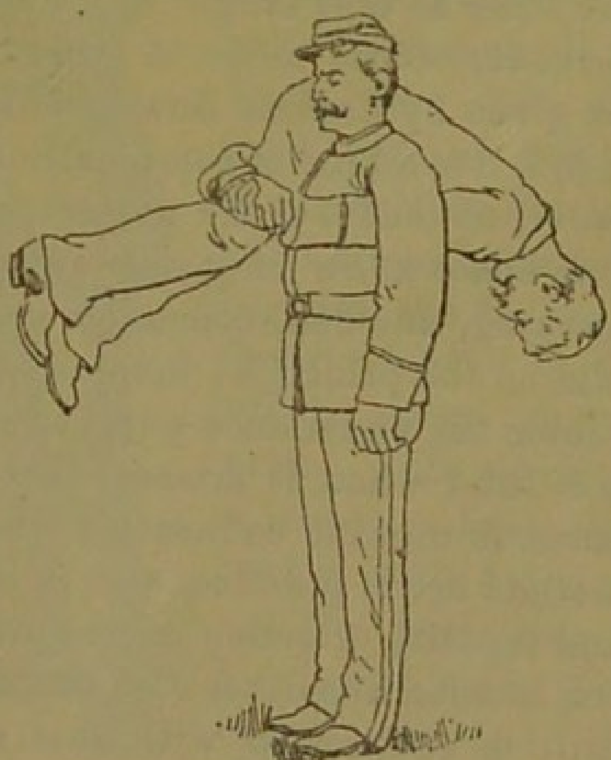


FIG. 86.—THE SAME.

the bearer's shoulder than his back. Here, again, three positions are assumed, but in the *first* one the Ambulance pupil, after placing the patient on his face, stands at his head (Fig. 84) and raises him successively to his knees and his feet. Secondly, he passes his right arm either between or around the thighs, and places his right shoulder at the stomach of the patient. Further, he grasps the patient's right wrist and draws his right arm forward firmly under his own left shoulder (Fig. 85). Lastly, he assumes the upright position, when the patient falls over his right shoulder, where, by grasping patient's wrist with the right hand and drawing it across his own chest, the disabled person is firmly locked, and can neither slip forwards nor backwards (Fig. 86). This leaves the bearer's left arm disengaged. Should it be thought desirable to have the right one free, then the operation is reversed, the patient being carried on the left shoulder, the bearer's left arm being passed behind patient's left thigh, and his right arm grasped from behind.

By some the term "*Fireman's Lift*" has been given to this method of carrying a disabled person, but it is not quite the same as that taught to the members of the London Fire Brigade, whose mode of procedure is somewhat different. As given by Captain Shaw in his book on Fire Protection, p. 271, it is a kind of combination of the two plans mentioned above, so that it is not necessary to detail it here. Neither does space allow of my dwelling on several other ways of carrying, unaided, insensible persons. Sufficient has been said on the principles involved in such an operation as to enable the ambulance pupil to deal with an emergency of this kind when it arises. One thing, however, should be borne in mind in connection with it, and that is, that every method needs practice, and it is only by it that dexterity and rapidity of action can be attained. Hence it is that in the London and other Fire Brigades the firemen have special drill in connection with this matter. A small platform, some forty or fifty feet high, is erected on the roof of one of the buildings of the drill-yard. One-half of the men who are drilling go up to this platform and prostrate themselves in all kinds of peculiar attitudes. The other half have to go up and fetch them down single-handed. In this way there is gained a skill and dexterity in manipulation that could be acquired in no other way, and has already borne fruit in the shape of numberless lives saved from an agonizing death.

Should there be *two persons* available for rendering assistance to the injured person, the task is rendered much easier, for standing side-by-side they can form no less than *three* kinds of *hand-chairs*, each of which is applicable to different varieties of cases, and the selection of which depends on the amount of back support needed. Thus, if the person is too much injured, or is too ill to sit upright, what is known as *the two-handed seat* may be employed. This is made as follows:—The two bearers stand side-by-side, half-facing each other. They then join the front pair of hands, the fingers of the left hand of one interlocking with the fingers of the right hand of the other, palms uppermost. This serves as a seat. A back support is made by crossing the back pair of hands and arms, each bearer grasping the other bearer's shoulder

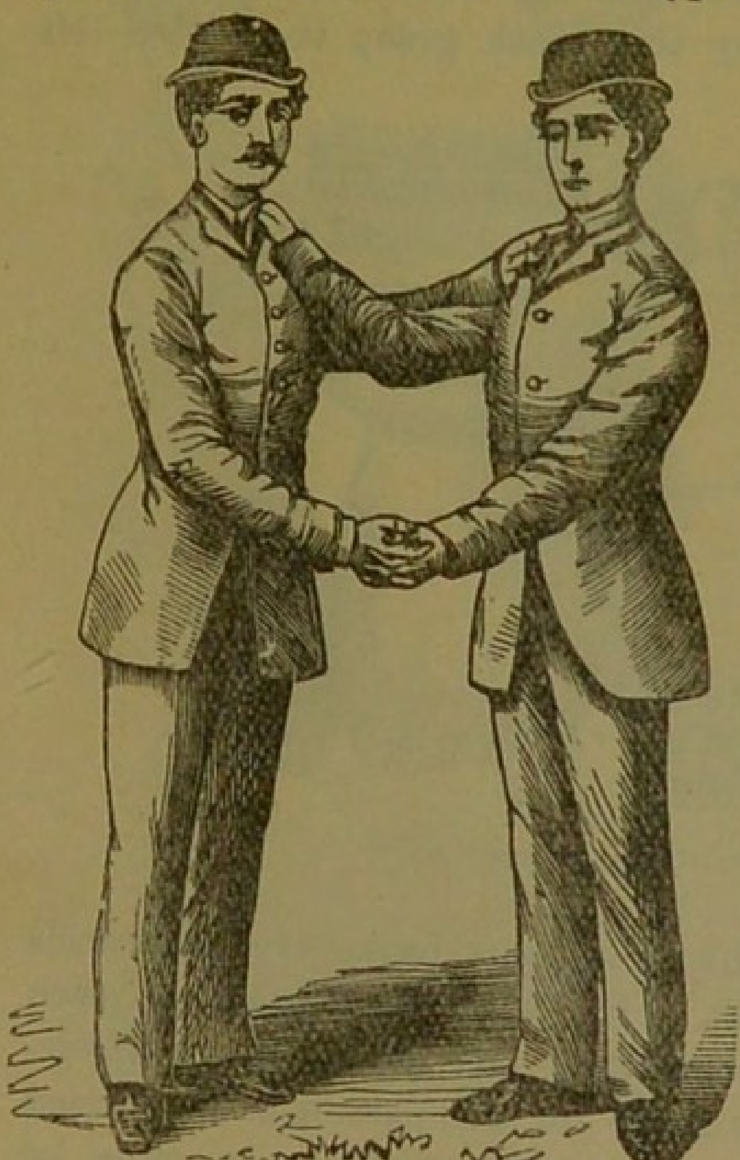


Fig. 37.—Two-Handed Seat.

with his disengaged hand. (See Fig. 87.) The person is then carried lying back, his weight falling chiefly on the two arms behind, which encircle his loins, as it were, and on the chests of the bearers. By raising the hands in front, the patient can, when necessary, be placed almost in the recumbent posture. If the disabled person can bear to be carried in the sitting posture, there is no plan that answers so well as *the four-handed seat*, better known, perhaps, by its popular names of "lady's chair," "sedan-chair," and "dandy-chair." It is, perhaps, the most comfortable of these improvised hand-chairs, and puts least strain on the bearers, while its security is very much added to by the patient, when able, placing his arms round the shoulders of the bearers. To make this seat the bearers half-face each other as before. They then both grasp their own left

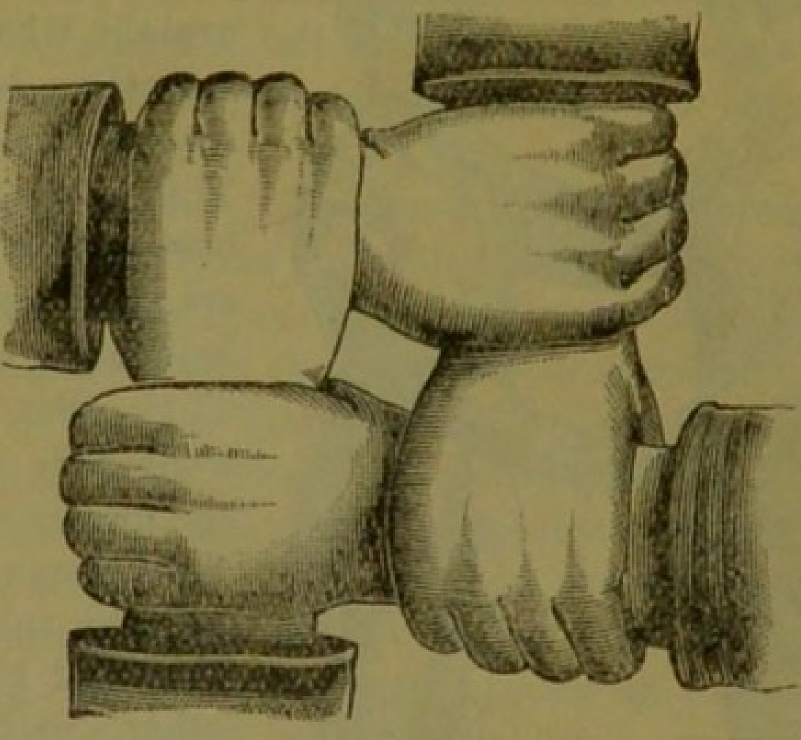


FIG. 88.—FOUR-HANDED SEAT.

wrists with their right hands, the backs of both hands being held uppermost. By both next grasping each other's right wrists with their left hands, backs uppermost, a square seat is made for the person to be carried (see Fig. 88), and a considerable weight can thus be borne with very little inconvenience, for the bearer's arms mutually support each other, and are mutually supported.

A very useful modification of the "sedan-chair" is that known as *the three-handed seat*, in which one of the bearers has but one hand in the seat, and with the other grasps his comrade's shoulder, thus forming a back support against which the patient leans. In this variety of hand-chair the seat is three-cornered, as it were, but it is a very easy way of transport for the bearers, and, like *the two-handed* seat, is very suitable for a weak, though not collapsed patient. It is made as follows:—The two bearers half-face each other as in the other methods. The bearer on the right grasps the middle of his left fore-arm with his right hand, while the bearer on the left grasps the middle of the right fore-arm of the other bearer. To complete the seat, the latter with his left hand grasps the middle of the left fore-arm of the bearer on the left, whose right hand is placed on the left shoulder of the other bearer. Fig. 89 should help to make clear what seems rather an intricate method, but in practice is really very simple.

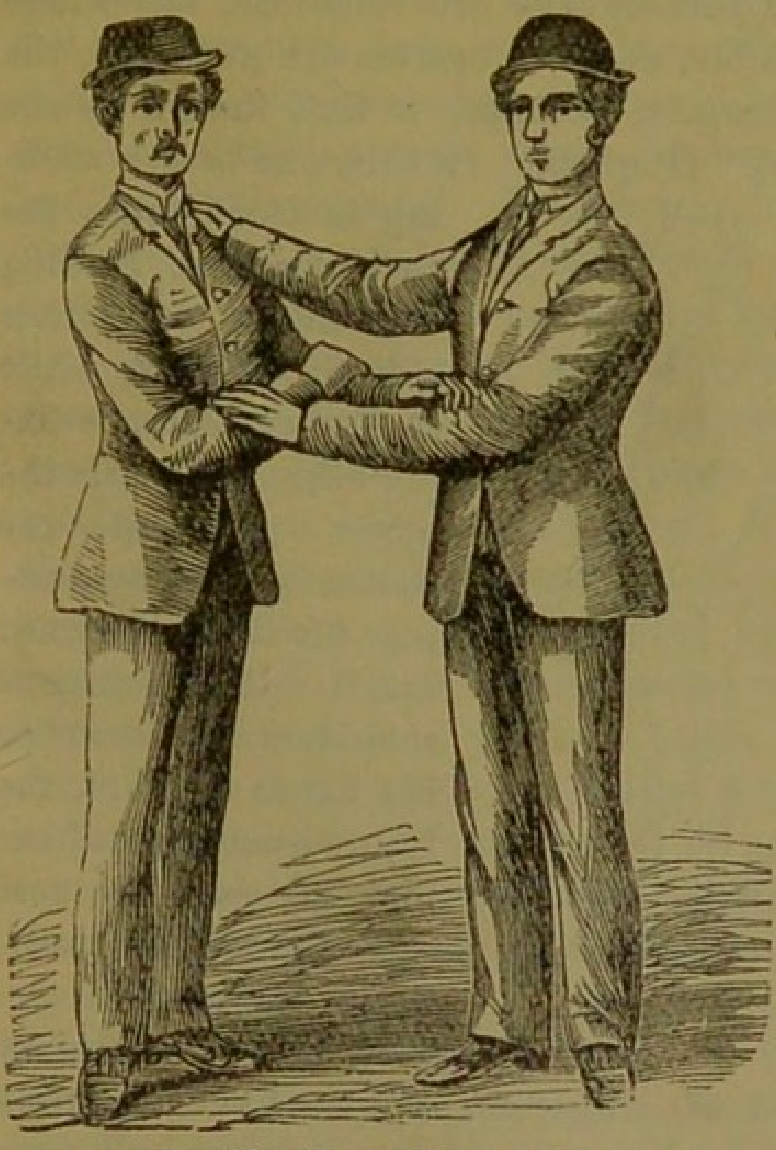
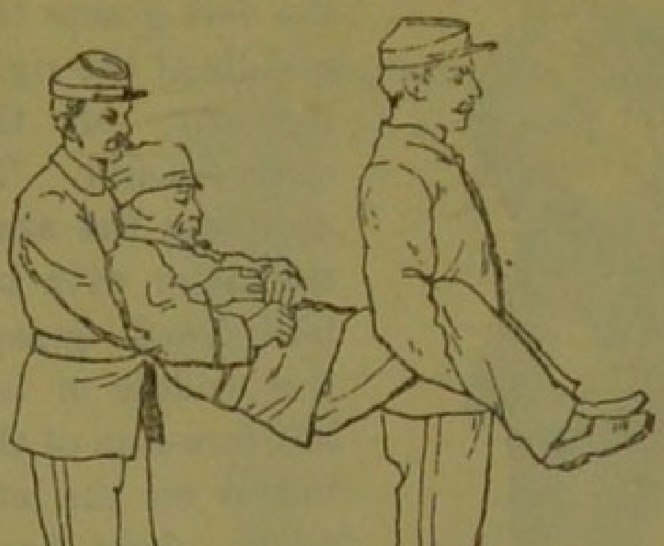


Fig. 89.—Three-Handed Seat.

Convenient as these improvised seats are, there is sometimes a difficulty in getting patients on to them. To accomplish this the bearers kneel on the knee next the patient's feet, and having raised him on to their knees, and having explained to him that he must pass his arms round their necks, they at once form one of the varieties of hand-chairs underneath him. It is then not a difficult matter to rise steadily together, and lift the patient off the ground. To gain dexterity in forming these seats and in carrying patients on them there is nothing like practice, so that the Ambulance pupil should avail himself of every opportunity of perfecting himself in them.

The above described improvised hand-chairs are very suitable for disabled persons who are conscious, but where the patient is insensible, and two bearers are available, the better mode of transport, perhaps, is that known as the "Fore-and-aft Carry" (Fig. 90). In this, one bearer walking in front takes the patient's legs, holding the thighs on either side of his hips, while the other bearer walking behind supports the upper part of the patient's body by passing his arms forward under the patient's shoulders and clasping his hands in front, the injured man's head being allowed to rest upon the bearer's chest. Some authorities regard this as a clumsy and unsafe method of transport, but it has Esmarch's sanction, and there can be no doubt that it is the only plan available in certain situations, as, for instance, in the narrow workings of a mine, or the passages between



Fore-and-aft Carry. FIG. 90.

machinery. In fact, wherever there is no space to get at the side of the patient this plan of supporting him by the extremities should be resorted to. The only plan of carrying a patient to which, perhaps, the term "unsafe" should be applied, is that known as the "Frog's March," where the person is placed with the face downwards. Sudden death has been known to occur under these circumstances, so that it should never be employed, even in the case of unruly drunkards.

Up to this point it will be observed that nothing has been said about *Ambulance material*, such as litters or stretchers, because the supposition has been that circumstances did not allow of their use, or that they were not available. All that has been done, so far, is to offer suggestions to the Ambulance pupil as to how he should best meet the difficulties of particular cases where his assistance was limited and his appliances nil. In this way, when such emergencies arise, he is rendered better able to cope with them, and there is developed in him, or further strengthened, that inventive faculty, or the ability to make the best of circumstances, that Ambulance instruction always aims at encouraging. But, in a very large number of cases of accident and sudden illness, apart from the question of distance, the disabled persons are too weak and too much injured to allow of their removal by any of the means mentioned, and it becomes necessary to call into use some form of conveyance. Of these there are a great variety, some being carried by men, others wheeled by men, some borne by animals, others drawn by animals, and, lastly, some moved by steam-power on railways. Upon each of these different classes of conveyance it will be necessary to say something.

1. *Conveyances carried by men.*—Of these "*hand-litters,*" as they are occasionally called, the form known as a *stretcher* is the most familiar to people in this country. The word "*litter*" is connected with the Latin word *lectica*, a sort of couch with a bed in it, in which the wealthier

Romans were carried about by servants called *lecticarii*, or litter bearers; and its name implies the idea of recumbency, the position, as we know, most suitable for anybody sick or hurt. The word *stretcher*, again, is probably derived from the fact that the material forming it is *stretched* within a frame, thus furnishing a firm and reliable support for the person carried. I have said that this is the form of hand conveyance best known in this country, simply because Europeans are accustomed to support heavy burdens by their arms, while Oriental races are more in the habit of bearing burdens upon the shoulders instead of bringing hands and arms into play. Hence, among them we find the hammock and dhooly more in vogue. It would be impossible, in a chapter like this, to give any account of the great variety of stretchers that have been devised from time to time. Their designers have all claimed for them that lightness, strength, and simplicity of construction which should be the essential qualities of every stretcher; but, in very few instances, have the expectations formed of them been realized in practice. Of manufactured stretchers, the ones that have met with the most approval have their supporting material of canvas. This canvas is about six feet long and two feet wide, and is furnished, in addition, with a self-adjusting or detachable pillow. On either side of the canvas run two long poles of seasoned ash, some eight feet in length. Projecting, as they do, beyond the canvas, their ends, which are rounded off, serve as handles. Two iron rods or "*traverses*," as they are technically called, keep these poles apart, and stretch the canvas between them. Instead of legs there are four wheels of hardened wood, which keep the stretcher off the ground, and on which it can be rolled into the ambulance waggon. Leather slings are also provided, which are attached to the handles, one at each end, and are long enough to pass over the shoulders of the bearers, thus assisting them materially in supporting their burden. Lastly, to allow of them folding into very small compass when not in use, most modern stretchers are constructed with jointed traverses, which permit of the poles being approximated laterally, and the canvas rolled tightly round them. These are the leading features of such stretchers as the military one designed by Surgeon-Major Faris, the one brought out by Mr. Maclure, and the folding one devised by Mr. Furley, of the St. John's Ambulance Association. All of these patterns are good and admirably adapted for the work they have to discharge; but none of them surpass in utility and compactness the one issued by the St. Andrew's Ambulance Association. It is shewn, unfolded, in Fig. 91. It is made of canvas, and is fitted with four india-rubber wheels instead of the ordinary wooden ones. Its length is only a little over seven feet, and it has two small straps, fastened to one side of it, for securing it when folded up. With the view of sheltering the patient, it can be fitted with an awning, as seen in Fig. 92. For conveying patients by train the same pattern of stretcher is used, but the handles, instead of being immovable, are telescopic. This admits of the stretcher being placed upon the seat of any ordinary railway carriage and causes the minimum of discomfort to the patient. A comfortable pillow is also provided, fitted with cords for passing through eyelet holes in the canvas of the stretcher. There are four eyelet holes at each end of the stretcher, enabling the pillow to be fixed at either end. Web slings can also be fitted, for use where the loaded stretcher may have to be carried some distance, but these are not ordinarily necessary.

There are, however, occasions when it is not possible to remove injured persons in the recumbent horizontal position, as there is not room for the stretcher, and the only way of overcoming the difficulty is by drawing the stretcher up the narrow shaft or sewer *vertically*. To allow of this being done, various contrivances have been suggested, of which, perhaps, *Mr. Furley's Lowmoor Jacket*, designed for use in the small pits at Lowmoor, near Bradford, is the best known. What is called the "*Hinged Pit Stretcher*,"

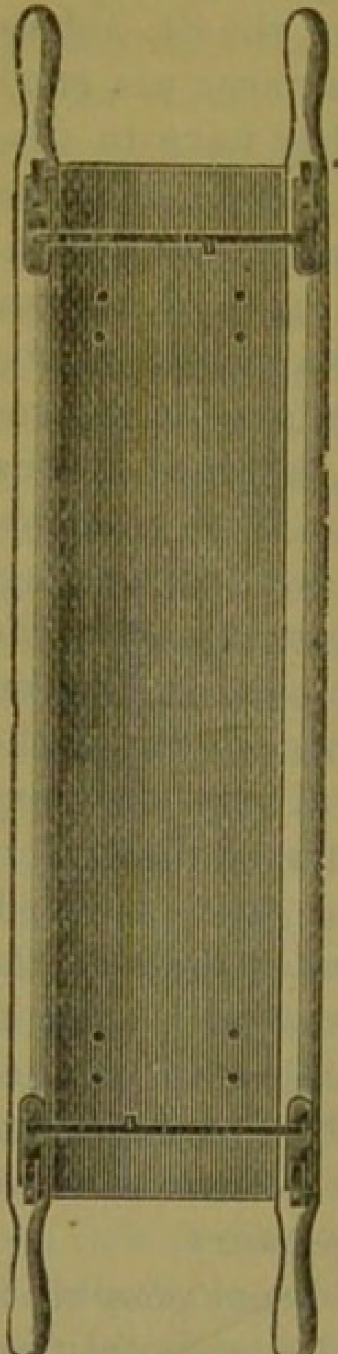


FIG. 91.—STRETCHER.

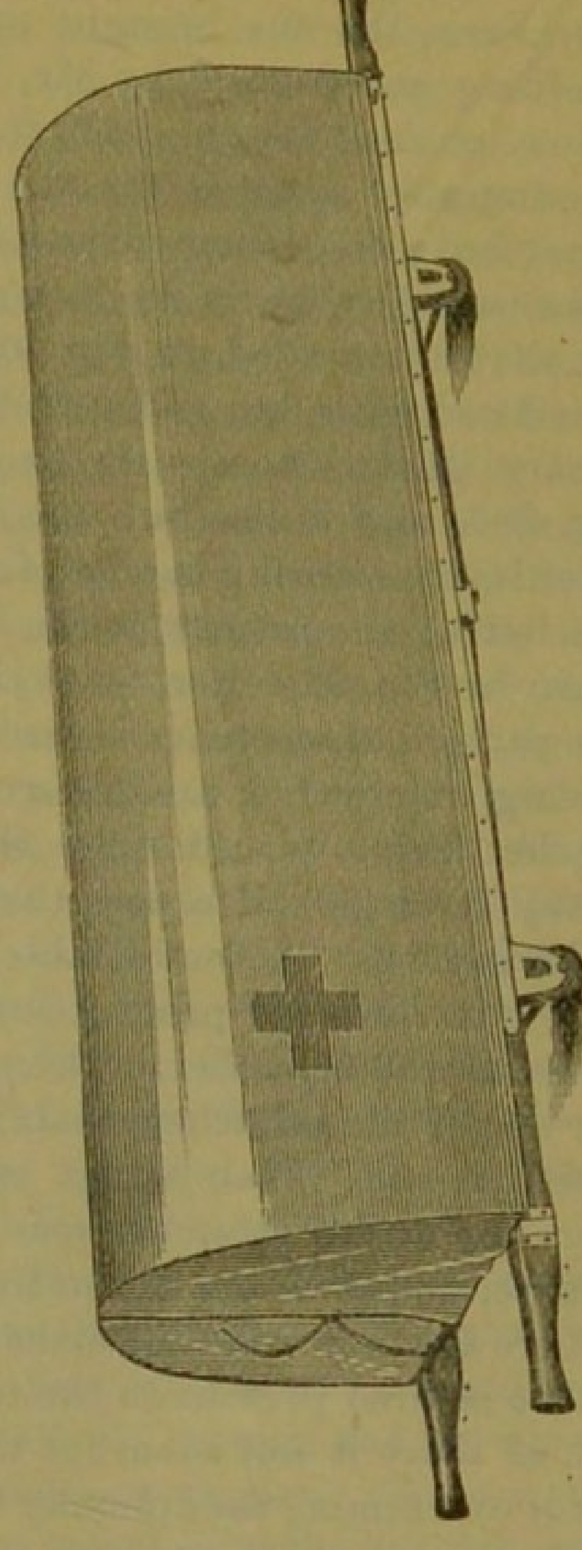


FIG. 92.—STRETCHER WITH AWNING.

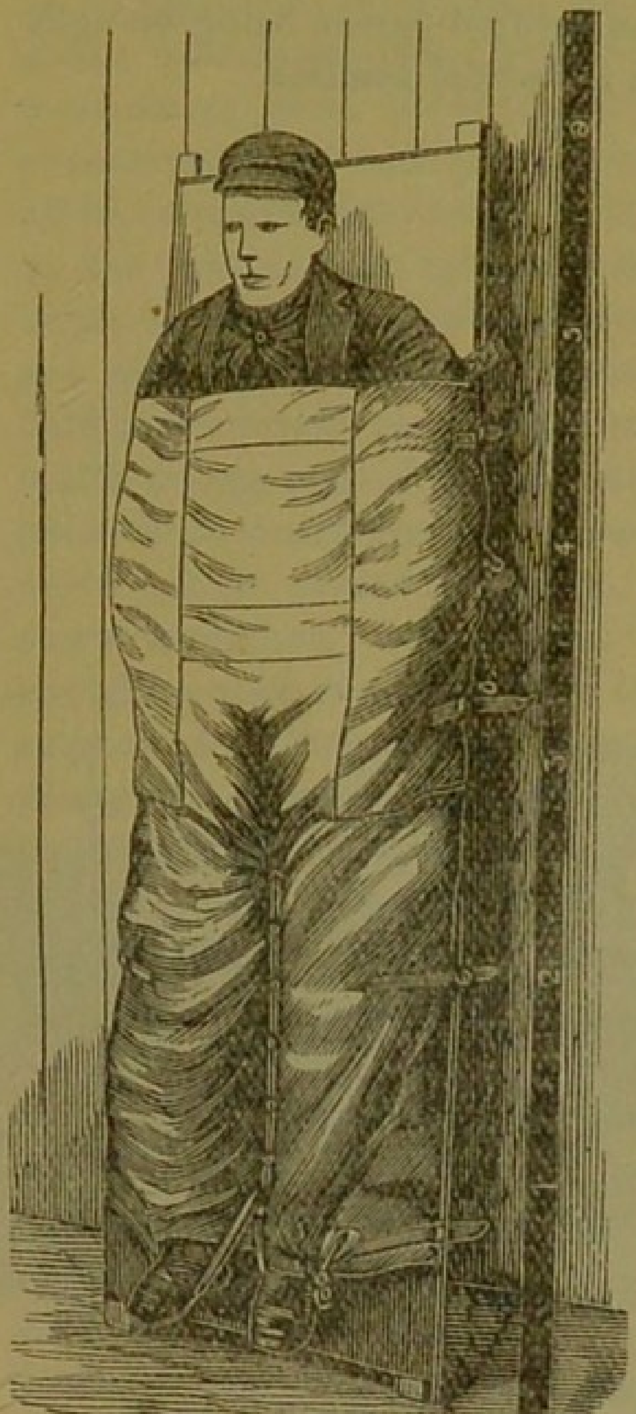


FIG. 93.—HINGED PIT STRETCHER. STRAIGHT.

with cover, of the St. Andrew's Ambulance Association, is meant to meet similar contingencies. It is shewn in Figs. 93 and 94. It was originally suggested by Mr. Macdonald of Coatbridge, but has received since some modifications. As at present constructed, it is fitted with forked feet, so that it can be placed on ordinary hutch axles and wheeled along the underground rails to the pit bottom. A cover is then strapped to the stretcher poles, and binds down the patient's trunk, legs, and arms independently, allowing of him being brought up from the bottom of the pit either in a horizontal or a vertical position. There is also a hinge which admits of its being placed on the cage, with the patient in a sitting posture (Fig. 94), where the shaft or cage is too narrow to admit of its being brought up at full length. Such a contrivance as this is only needed for very narrow spaces, the ordinary plan of having the stretchers with telescopic handles, which slide in, being usually all that is required in roomy and well-constructed mines. It should, perhaps, be mentioned that the St. Andrew's Ambulance Association furnishes a cover similar to that attached to the Pit Stretcher for fitting on to C pattern, to permit of an injured person being brought up from the hold of a ship in a vertical position.

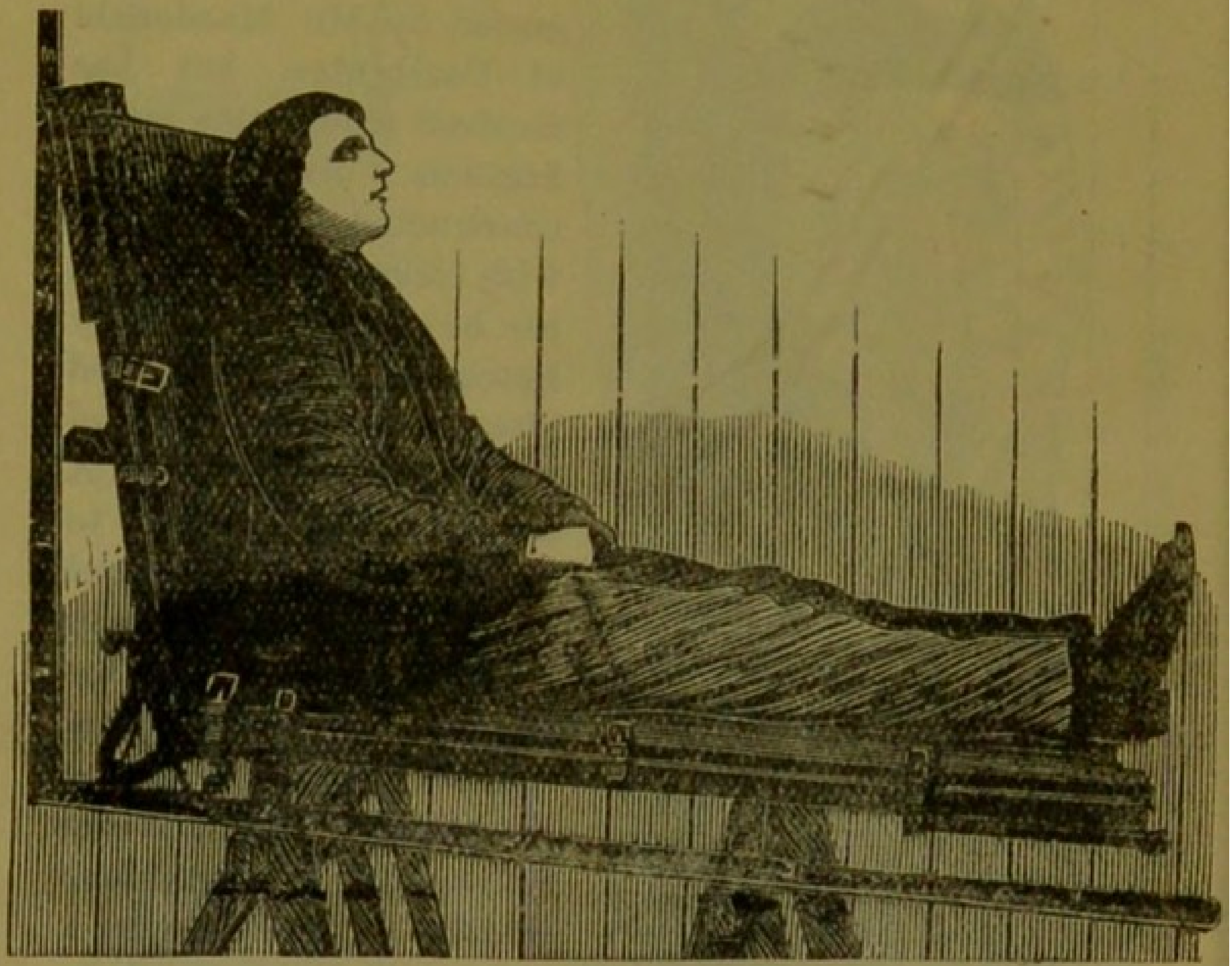


FIG. 94.
HINGED PIT STRETCHER.—FOLDED

Sometimes it happens that no stretcher is procurable. Under these circumstances one must be improvised, and this renders it necessary to say a few words on the second and important class of stretchers known as "*Extemporary*" ones. Here the inventive faculty of the Ambulance pupil will come into play, and as he will have to utilize the materials at hand, the nature of the stretcher will depend, just as in the case of splints, on the *locality* where the accident has happened. The variety of articles that may be so employed is endless. In *towns and inhabited houses*, doors, window-shutters, bed frames, boards, benches, tables, mattresses, short ladders, etc., are all available; while counterpanes, blankets, rugs, coats, empty sacks, etc., may all be converted into very serviceable litters by being carried by the four corners by four bearers, or by having rings or loops, made with straps attached to their four corners, and poles inserted through these. In the *country*, hurdles, field gates, bits of fencing and paling, are generally at hand, while a long rope of plaited straw, "laid zig-zag over two poles kept apart by two cross pieces of wood, having a straw pillow placed on them, forms a very comfortable straw stretcher."—(Esmarch.) The excellent temporary stretchers with supports, after the design of the Norwegian surgeon, Dr. Christen Smith, made by taking branches and young spruce stems from woods and gardens, and binding them together with birch twigs, should be borne in mind, as they are very easily constructed. At *sea*, where hammocks are at hand, no difficulty is experienced in making an extemporized litter by hanging one of these at either end upon a single pole, while oars, boat-hooks, jackets and jerseys, are available for the same purpose. On *military service*, the soldier's arms and accoutrements furnish ample material for constructing improvised stretchers, and the sight of wounded soldiers conveyed on litters formed of knapsacks, or of rugs with rifles and fixed bayonets (improvised rifle stretcher), is suggestive of that millennium when "to ploughshares men shall beat their swords and pruning-hooks their spears." From what has been said, the Ambulance pupil should have no difficulty in constructing, should circumstances demand it, a strong and comfortable extemporized stretcher, not liable to change its shape under the patient's weight, and with its upper surface rendered soft by mattresses, straw, great-coats, rugs, or clothes, obtained, if necessary, from the bystanders. A very interesting demonstration of such work was given at the first annual gathering of the members and associates of the St. Andrew's Ambulance Association. An Ambulance detachment that was present from the Middleton Shipbuilding Yard were supposed to be away enjoying themselves in the country, when one of their number fell, fracturing his thigh-bone. A piece of rough stick (found in the vicinity) and a walking-stick served as splints, while handkerchiefs were used for binding up the limb. The next point was to get a stretcher, and on the suggestion of one of their number the four men took off their vests, when, with the aid of their walking-sticks, a very comfortable stretcher was improvised, on which the supposed injured man was carried off. This is only one of several equally ingenious and useful demonstrations that have been given at Ambulance lectures delivered under the auspices of the St. Andrew's Ambulance Association. In connection with this subject of extemporized litters, I would impress on the Ambulance pupil the necessity of practising their formation whenever he can, and I would further suggest, that in cases of real accident, it is a good plan to test the strength of any improvised stretcher before using it, by placing some one on it and lifting him up. It is a great satisfaction to the person who has to be carried to know that this has been done, and it obviates the risk of any further damage to one already crippled.

Perfect though a stretcher be, and furnished though it be with every modern improvement, it will be of little service to an injured person unless the Ambulance pupil knows how to use it. And this is not the simple matter that is generally supposed. The proper way to open out and fold up a stretcher, and how to lift and lower it, is very easily mastered by a short course of instruction, but the raising and placing an injured person on it, the carrying of it when so "loaded," the laying down of it with a patient on it, and the removal of the disabled person off it, are operations that involve certain principles that it is absolutely essential to master. Thus, the lifting and placing an injured man on a stretcher involves three separate manipulations,—viz., The lifting the patient off the ground; the laying of the stretcher immediately under him; and the lowering of him on to it. Of these different movements, the lifting and the lowering must be done in unison by those engaged in it, for, as the weight of the disabled person's body is distributed, as it were, among them, one taking the chest, another the pelvis and buttocks, and the third the lower extremities, unless this point is attended to, the patient's injuries and sufferings may be much increased. Then the carriage of a "loaded" stretcher, that is, one with a sick or injured person on it, necessitates attention to several very important points. If as little as possible of the movements of the bearers are to be communicated to the stretchers, the bearers should *not* march in step, and the pace taken should only be about 20 inches, all springing from the fore-part of the foot being avoided, and the knees being kept well bent while the advance is being made. Further, to allow of the stretcher being maintained on all occasions in the horizontal position, and as near the ground as is consistent with the ease and comfort of the men carrying it, it should always be carried in the hands or suspended by straps over the shoulders of the bearers, these latter being selected, as much as possible, of the same height. Nothing ever justifies a stretcher being placed on the shoulders of the bearers, for if one of them falls, the stretcher is apt to careen over and throw the occupant out of it. It was in this way, at Chancellorsville, that General Stonewall Jackson had his already serious injuries further intensified, so that ultimately a fatal result ensued. Again, the crossing of ditches, dykes, and hollows, etc., with a stretcher, are conditions which call for special manipulations, while the position of the patient on a stretcher when going uphill, and in descending, or when suffering from a fractured leg, has also to be especially considered. As a general rule, the patient's head is in front in going uphill, and in descending, behind; but the reverse position is assumed in cases of fracture of the thigh or leg. Lastly, the part injured, and the nature of the injury, will determine, in a great measure, the position of a patient on a stretcher, so that attention must be paid to the general condition of the patient, and to the particular injury he has met with, before placing him on the stretcher. Space does not allow of my going further into this matter of the hand transport of injured persons. Nor, indeed, is it necessary, for the St. Andrew's Ambulance Association has issued a separate pamphlet on "Stretcher Exercises," where directions are given for dealing with injured persons under the varying conditions met with in civil life. In these exercises no definite *drill* is, very properly, laid down; but as, at the present time, four persons are regarded as necessary for the proper loading and carrying of a stretcher, a plan of procedure is detailed which embodies certain principles, and which should enable these three or four persons, strangers it may be to one another, yet suddenly called upon, in the face of an accident, to work together, to act with more speed, steadiness, and combined action than they otherwise would.

Of the other *Conveyances borne by men*, such as Hammocks, Dhoolies, and Swinging Litters, nothing special requires to be said. The hammock, in its simplest form of the soldier's blanket, or the officer's or sergeant's broad sash, has proved serviceable in emergencies on the battle-field; but, suspended from a pole, and borne, like the dhooly, on the shoulders, is the form in which it is almost exclusively used in the East. Swinging litters or stretchers, as first suggested by Colonel Crichton, and at one time in use at some of our Scotch hospitals, have quite gone out of use, and have been wholly displaced by more approved and better constructed stretchers.

2. *Conveyances wheeled by men.*—These, as a rule, consist of an ordinary stretcher placed upon a wheeled support, and their use has been advocated on the ground that they save a great deal of valuable time, to say nothing of fatigue and labour. Mr. Furley of the St. John's Ambulance

Association is strongly in favour of their use, and he has brought out what is known as the "Ashford Litter." In it there is no lifting of the stretcher over the wheels when it is desired to move it off the wheeled support. This is accomplished by the bearers passing between the wheels and over a crank-axle. The wheeled litter supplied by the St. Andrew's Ambulance Association is shewn in Fig. 95.

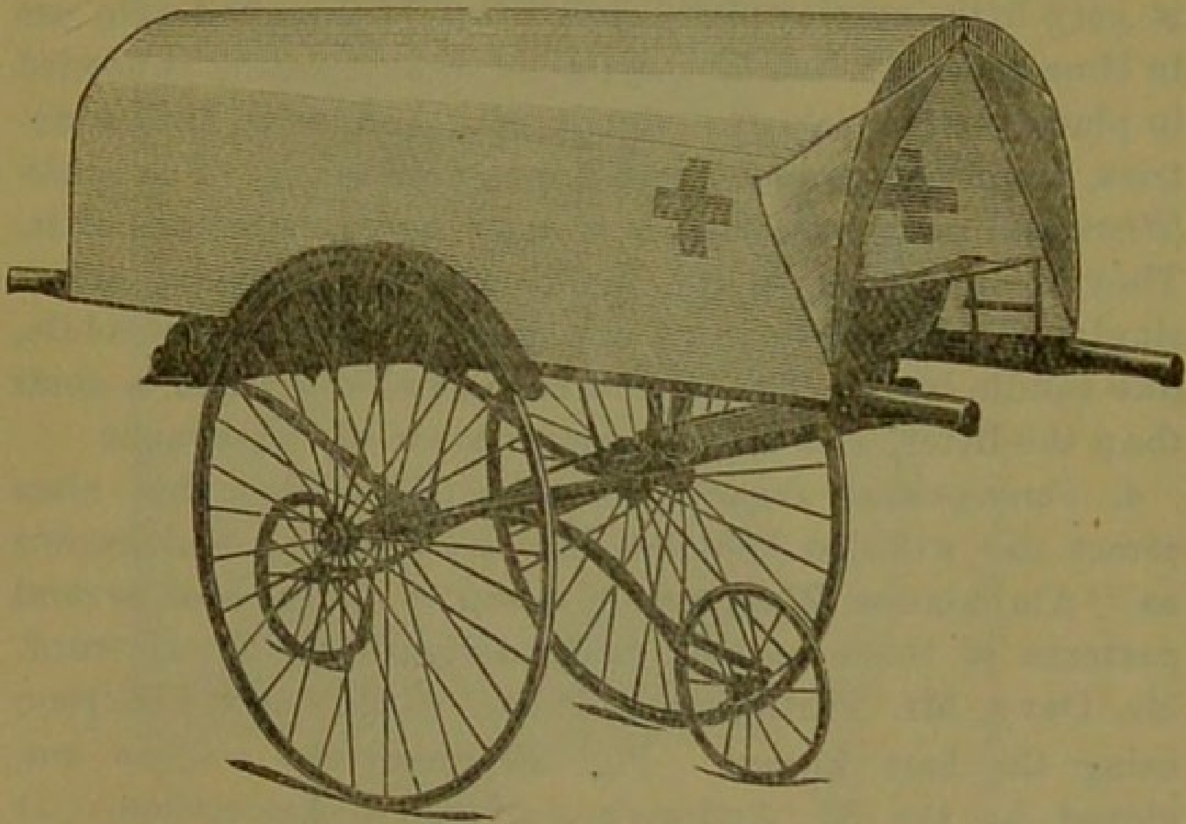


FIG. 95.—LITTER.

It is fitted with an awning, completely sheltering the patient; it is hung on Armstrong's Patent Springs, and runs on wheels with india-rubber tyres.

There can be no question as to the suitability of these wheeled litters for the public works in large towns, and for villages having no hospitals, as they allow of patients being very expeditiously conveyed, in the one case, directly to the hospital, in the other, to the railway station, to be conveyed by rail to the nearest town where hospital accommodation is available. In villages where they have been tried these wheeled litters have been very favourably reported on, both on account of their utility, and the saving of expense in the shape of the upkeep of an ambulance waggon. Of course they require that the roads over which they travel should be in good condition, and well laid. On rough and uneven ground they do not answer so well, and hence it is that in military service they have not proved a success.

3. *Conveyances borne by animals.*—This class of transport is very little employed in civil life. It is called into use in time of war, when long-distance transportation is needed in places where vehicles cannot approach, as in hilly countries, mountain recesses, and impassable roads. The *mule-litters* and *mule-cacolets* of our army are illustrations of it. They are mounted on the saddle of a pack animal, either singly or balanced in pairs, one on either side of the saddle, like saddle bags. The cacolet is somewhat more of a chair than the litter, and is a pleasanter mode of conveyance.

4. *Conveyances drawn by animals.*—Under this class comes the wheeled vehicles drawn by horses, and known as "Ambulance Waggons or Vans." There are several patterns of them in use, those designed by Dr. Howard, Mr. Davy, Mr. Furley, and Messrs. Atkinson & Philipson being the best known. Fig. 96 shews the waggon employed by the St. Andrew's Ambulance Association. It may be fitted for two, three, or four patients. It is hung in the most approved method on sensitive springs, the wheels having patent india-rubber tyres, so that in this way it possesses a great amount of steadiness, and there is little or no jolting to increase the sufferings of the occupants during removal. Externally it is a light, rather attractive looking one-horse vehicle, and altogether, from the ease with which patients can be placed in it, and removed from it, and from its steadiness when in motion, it serves as a quick and comfortable means of removing sick and injured persons, and it has proved itself a great boon to Glasgow and the surrounding country districts. At the same time, an ambulance waggon is not always obtainable, and then one may have to be improvised out

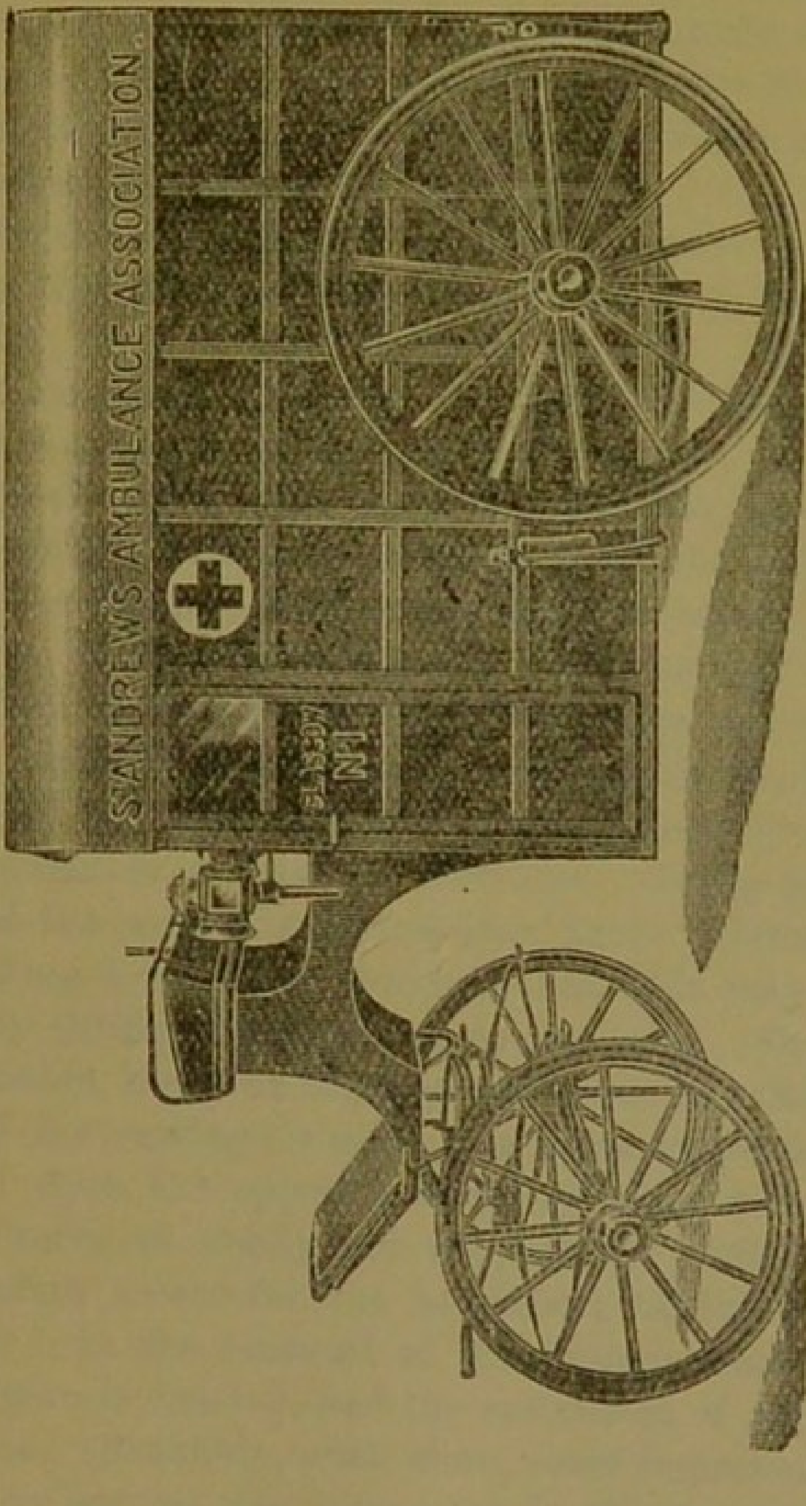


FIG. 96.—AMBULANCE WAGGON.—SIDE VIEW.

of a vehicle made for another purpose, such as a country cart, waggon, donkey cart, or a four-wheeled carriage. No definite rules can be laid down for dealing with such an emergency; but if a waggon or cart is used it should be filled with straw, hay, ferns, or other soft substance, on which the patient should be carefully laid; and if he has been placed in it on a stretcher, the handles of the stretcher should be secured to the framework of the cart, so as to prevent it jolting or shifting its place.

5. *Conveyances moved by steam power on railways.*—Under this heading comes the subject of the carriage by railway of sick and injured persons. On some lines there are invalid railway carriages; but they are few in number, and, as a rule, resort must be had to a well-cushioned third class carriage, for the absence of any divisions on their seats renders them the only ones available. In time of war, when large numbers of men may have to be sent by rail, goods waggons and cattle trucks may be utilized for this work, and there are certain recognised methods for rendering them available, but reference only will be made here to the conveyance by rail of a case of accident or sickness in civil life. Owing to the narrowness of the railway carriage door, there is often a difficulty in getting a stretcher through; but this may be done by slightly tilting the stretcher to one side. Should this not be possible, then the luggage van must be taken advantage of. If the carriage is used, two cross supports of wood are placed upon the opposite seats, one foot from each door. These serve to steady and support the stretcher, and they also afford a seat for the attendant taking charge of the patient. In the removal of the patient from the carriage great care is needed, and the assistance of three bearers is required. Probably, with time, some improvement will be made by our railway companies in the means of transport for injured persons; but meanwhile, the Ambulance pupil will find his ingenuity and tact called upon to the utmost under existing circumstances.

As all the subjects included in the Syllabus of Lectures of the St. Andrew's Ambulance Association have now been considered and discussed as far as space would permit, nothing remains but to close the chapter, and so end this Handbook. Since it was first commenced, more years have elapsed before its completion than was originally intended; but it is gratifying to see that the period has been one of prosperity and progress in Ambulance work, and to hear on all sides that the instruction imparted by the Association has been beneficial in affording relief to many. As the result of the Association's efforts there are few towns and cities in Scotland that have not taken steps to obtain proper Ambulance transport for their sick and injured, so that in this way not only has pain been alleviated, but life has been saved. The instruction, too, that has been imparted by means of the numerous classes held, has been a powerful factor for good, and many instances could be quoted where policemen, railway servants, miners, cabmen, and the numerous workers in our large ship-building yards, have skilfully helped those suffering from accident. It is satisfactory, too, to note that in very few instances have these Ambulance pupils forgot their position and the scope of their work, and the almost universal testimony of the medical profession has been that their services have been of a most valuable nature. It was with the desire of helping on such a philanthropic movement that this Handbook was undertaken, and I trust that its pages may help to make clear the nature of the duties and work that belong to the Ambulance pupil.

"Read my little fable—
He that runs may read;
Most can raise the flowers now,
For all have got the seed."

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