The Harrogate waters : data chemical and therapeutical with notes on the climate of Harrogate / by George Oliver.

THE HARROGATE WATERS

G. OLIVER, M.D.

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DATA CHEMICAL AND THERAPEUTICAL

WITH

NOTES ON THE CLIMATE OF HARROGATE

BY

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LONDON

H. K. LEWIS, 136, GOWER STREET, W.C.

1881.

TO THE

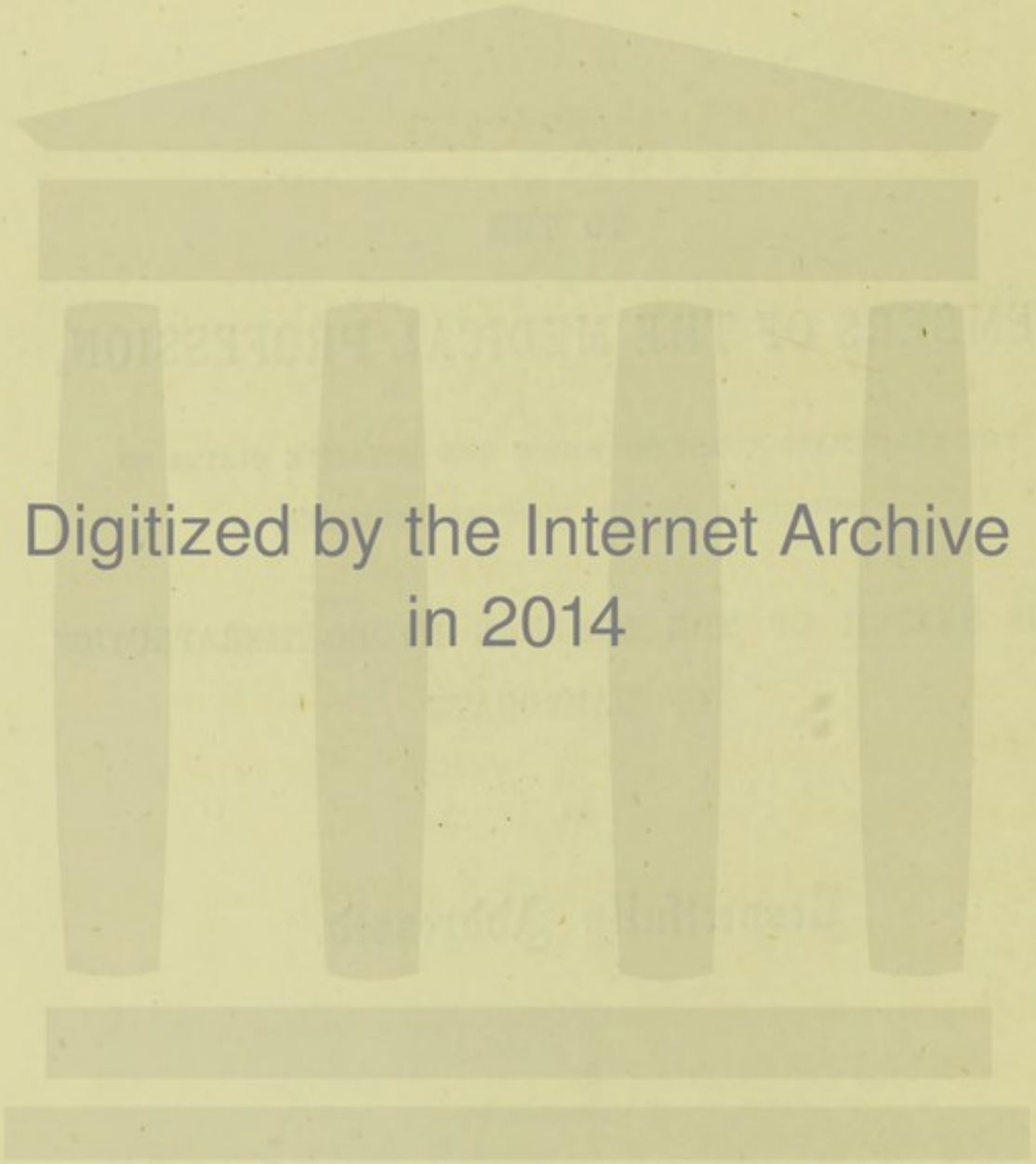
MEMBERS OF THE MEDICAL PROFESSION,

THE LEGITIMATE COURT TO WHICH THE CURATIVE CLAIMS OF MEDICINAL SPRINGS MUST BE REFERRED,

THIS SKETCH OF THE MINERAL HYDRO-THERAPEUTICS OF HARROGATE

IS

Respectfully Addressed.



PREFACE.

NEARLY all the medicinal springs of Britain have been discovered since Harrogate began its career as a mineral watering-place, *i.e.*, in the last quarter of the sixteenth century. At that time the only health-resorts worthy of the name were Bath and Buxton, whose thermal springs have been celebrated from the time of the Romans, and still enjoy a well-deserved reputation. Since then a large number of British mineral waters have been brought under professional notice: but nearly all of them have either failed to acquire more than a mere local or temporary name, or flourished as natural health restorers for a limited period only—and at last quietly settled out of view; and now, here and there may be found a rusty, incapable pump, or a moss-covered basin—relics of a faith departed—which may be mused over by the antiquarian who cherishes the odds and ends left behind in the track of human

progress or credulity.* Harrogate, however, having steadily developed during these three hundred years, which have witnessed the birth and decay of many mineral watering-places; and, moreover, still possessing the vigour of youth, and giving assurance of such a vitality as may enable it to outlive centuries yet to come, may be regarded with some show of justice as the survival of the fittest.† The mainsprings of its long and vigorous existence are not far to seek: for, unlike most other mineral water resorts, its reputation is sustained not merely by one or even two medicinal springs, but by a large number which form a system of treatment by natural resources nowhere else attainable; and on the fitting adjustment of a climate in accord with the curative operation of the waters which, besides enhancing its value as a mineral watering-place, enables it to maintain a foremost name among British health-

* The literature of the mineral hydro-therapeutics of this country records between one and two hundred medicinal springs in different localities, now either completely neglected or forgotten, or languishing towards decay. The reader will find the names of at least 200 such springs in a list of British health-resorts which appears in a paper, "Some Deficiencies in our Knowledge respecting Health-Resorts," by G. J. Symons, F.R.S., President of the Meteorological Society, read at the Sanitary Congress, Exeter, 1880.

† The flourishing condition of Harrogate is indicated by the large number of visitors—over 60,000—who annually resort to it.

resorts. Its geographical position—in the very centre of these Islands—and its accessibility from all parts —and especially from the three capitals of the kingdom—are, doubtless, fortunate aids to its development.

In sketching the medical aspects of this watering-place for the guidance of his professional brethren in the selection of cases, the writer has striven to provide reliable data on :—

1. The Climate of Harrogate viewed as a health-resort. This he has studied both from the side of Physical Geography as well as from that furnished by experience—Meteorological and Medical.

2. The Mineral Waters : the latest recorded facts and views as to their constitution, and their place among other similar springs at home and abroad.

3. The Therapeutic range and powers of the Waters ; illustrated by an outline of what the writer conceives they may do, on the pattern of what he has found they can do.

His desire not to exceed the limits of this work prevents him from recording some of the typical good deeds of these Offsprings of Nature to individual sufferers which he has himself witnessed ; but this omission is, perhaps, the less to be regretted, inasmuch as he could not furnish more striking examples

than already appear in other publications on the Harrogate waters.

He has likewise omitted the numerous details which relate to the administration and the various applications of the waters, because the insertion of them could serve no useful purpose: for, medical men beyond the borders of Harrogate cannot in justice to themselves and their patients direct a treatment, which—like any treatment worthy of the name—requires personal supervision, and which is outside the ordinary course of medical practice; they, therefore, as a rule, deem it advisable that the local treatment should be supervised by the practitioners who have acquired a specialized knowledge and experience of the waters.

The writer should remark that in bringing the curative claims of Harrogate under the notice of medical readers only, he departs from the line invariably followed by his predecessors, who have presented them in a less technical form, so as to serve not only as channels of information to medical men, but to those outside the profession. It is true this mode of handling the medical aspects of a watering-place is that commonly adopted; but it appears to the author to be one which almost necessarily involves some dilution of strictly medical data, which,

even when thus prepared, are apt to be assimilated imperfectly by the public; and he thinks the medical profession, which is the mainstay of the prosperity of an important mineral watering-place like Harrogate, claims more specific information respecting its curative resources than can be provided for the non-medical. But, in carrying out his design, the writer fears he provides for the guidance of his professional brethren but a few broken lights; and he is conscious of many shortcomings, which he must leave to the indulgence of his readers.

It is beside the writer's purpose to describe the varied and beautiful scenery in which Harrogate is set, and the other natural sources of recreation and enjoyment which help forward the curative power of the Waters and the Climate; for, these attractions are set forth in the local guide books. It should, however, be stated, that those whose culture and taste lead them to delight in scientific curiosity, may enjoy their reprieve from their accustomed routine of work by the recreative study of the numerous objects of Antiquarian and Geological interest with which Harrogate and its neighbourhood are richly provided; and by attempting to solve some of the all-absorbing chemico-geological questions relating to the mineral springs.

The writer must express his deep obligations to Mr. R. Hayton Davis, F.C.S., who unreservedly placed at his disposal all the results of his long and unwearied chemical labours in connection with these waters.

Finally, his best thanks are due to Mr. E. Wareham Harry, C.E., Town Surveyor of Harrogate, for the accurate and well-executed Map of the numerous Wells of Low Harrogate and the Bogs Field.

West End Park,
June, 1881.

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ERRATA.

Page 12, seventh line, *read* "wooded" *for* "wooden."
„ 17, end of fourth line *insert* "an."
„ 20, seventh line, *read*, "rain-free" *for* "rainfall."
„ 24, first line, *read* "medicinal" *for* "medical."
„ 39, thirteenth line, *read* "sulphate" *for* "sulphates."
„ 57, fifth line from bottom, *omit* "of."
„ 191, seventh line from bottom, *read* "of" *for* "in."
„ 210, eighth line from bottom, *read* "202" *for* "200"

THE

CLIMATE OF HARROGATE.

"I consider Harrogate to be as respects air, soil, climate and mineral springs, by far the most important watering place in this country, and unequalled by any on the continent of Europe for the diversity and curative influence of its waters in a large number of diseases."—Dr. Copland.

INTRODUCTORY.

THE remarkable, and indeed unrivalled array of medicinal springs with which Harrogate is endowed, do not embrace all its curative resources. Though the remedial advantages which pre-eminently belong to it as a *mineral watering-place,* seem to overshadow the climatic and hygienic properties which pertain to it as a *health resort,* the latter should not pass without recognition; for, when conjoined with the former, they frequently seem to help forward the good work of cure or relief, and even, when enjoyed alone, their restorative powers are daily witnessed, and are, moreover, highly prized by many invalids who annually resort to Harrogate merely on account of its climate.

Located in the undulating upland, which may be appropriately termed the Highlands of the West Riding, at an altitude of from 400 to near 600 feet above the sea-board, and distant from the con-

taminating influence of towns, Harrogate possesses an atmosphere remarkable for purity and freshness. The visitor—habituated even to the pure air of some rural district—at once recognises its invigorating properties, which inspire a feeling of buoyancy and capacity for increased exertion and enjoyment, but rarely induced by the air of valleys, plains, or low-lands, and even of protected uplands. But those who enjoy and flourish in the dry and stimulating climate of Harrogate more than others, are the dwellers in large manufacturing towns and cities,*

* The impurities of the air of towns have been demonstrated by the chemical analysis of the rain, which washes them out of the atmosphere. The following are a few of the numerous results obtained by Dr. R. Angus Smith, who may be called "the pioneer of chemical climatology"; they provide physical reasons of great force why the town air-breather rejoices in the atmosphere of the country, and especially in that of Harrogate, which is singularly pure and refreshing.

Analysis of Rain.

		Parts per Million.			
		Sulphuric Acid.	Nitric Acid.	Ammonia.	Albuminoid Ammonia.
Typically pure air.	Scotland-Inland country places.	2·06	·305	·532	·039
	England—ditto.	5·52	·749	1·070	·109
	Ireland-Valentia.	2·73	·370	·180	·034
Air of Cities.	London.	20·49	·840	3·450	·205
	Manchester.	44·82	1·179	6·467	·251
	Liverpool.	39·59	·582	5·380	·159
	Glasgow.	70·19	2·436	9·100	·300

or in the damp and relaxing parts of England, such as the South West Coast.

The obvious properties of the climate spring from physical conditions which should first be reviewed (Chap. I.); then may follow such experience of them as the writer has gathered from observation (Chap. II.); and finally, how far they conform to the therapeutic aims of the medicinal springs (Chap. III.).

CHAPTER I.

THE MAIN PHYSICAL CAUSES WHICH DETERMINE THE PROPERTIES OF THE CLIMATE.

General Conditions.

The position of Harrogate midway between the Irish sea and the German ocean, at a considerable elevation, is favourable to the free commingling of the higher reaches of the atmosphere extending from sea to sea, and the preservation of the marine qualities of air-currents prevailing from either. Hence, possibly *one* source of the freshness and elasticity which the air of Harrogate inspires:—qualities pre-eminent in sea-air, but much less pronounced inland except on high mountains; moreover, it may be said to blend certain qualities derived from both coasts—dry and bracing from the east, with the harshness of that quarter tempered by the mellowing influences of the west, while the moisture of the latter is greatly reduced.

To the westward the moorland plateau of Harrogate rises to higher and still higher altitudes; those within view—a radius of 15 miles—Brimham and Pately moors, Greenhow Hill, Simon's Seat, Blub-

berhouse moor, Rumble and Ilkley moors vary from 800 to 1600 feet; and the elevations 10 to 20 miles beyond these—Ingleboro, The Whernsides, Penyghent, Pendle Hill—attain to from 1800 to even over 2400 feet. These mountains and moors fill in the quarter of the compass from S.W. to N.W., and, intercepting the path of rain-laden clouds, and receiving their burden of moisture, form to the district east of them a rain-protecting area; hence the damp westerly winds, after traversing 30 or 40 miles of higher and more extensive moorland than belongs to the westward of most localities in England, reach Harrogate bereft of much of their moisture; a position confirmed by meteorological statistics, which show conclusively a much heavier rain-fall on the western, compared with that on the eastern portion of the highlands of the West Riding.

Average Annual Rain-fall from 1868 *to* '79 *(inclusive.)*
(Calculated from Symons' "British Rain-fall").

	Inches.	The number of days on which rain fell ($\frac{1}{100}$ In. or more).
1. Rain-guage Stations within 35 miles West of Harrogate*	50	190
2. Harrogate	33	156
Excess in the West...	17	34

* *i.e.* Clitheroe (altitude 217), Skipton (430-470), Crosshills (405),

These figures show that over 50 per cent. more rain —equivalent to an annual excess of nearly 400,000 gal. or over 1,700 tons per acre—descends on the country to the westward than on Harrogate itself, and the latter is likewise favoured in having annually nearly 22 per cent. fewer rainy days. This increased and more continuous rain-fall to the west of Harrogate is, however, but an apt illustration—perhaps more emphatic than can be adduced elsewhere—of the general fact known to all meteorologists, *i.e.*, the high westward rain-fall, and the much lower eastward one in these Islands. "Now the watery vapour in the air that rises from the heated water of the Gulf Stream is carried to the British Coast by the prevalent west and south-west winds, and is partly intercepted on its passage eastward by the mountains which rise to the west of Ireland and Great Britain. Everyone who has visited Cumberland and Wales knows how rainy these regions are compared with the centre and east of England. The reason is, that the air, laden with moisture from the Atlantic, rises with the winds against the western flanks of the mountains into the colder regions of the atmosphere,

Silsden (560), Barden (746), Cringle (760), Malham Tarn (1296), Otterburn-in-Craven (510), Thornton-in-Craven (456), Slaidburn (475), Settle (623), Arncliffe (750) and Wharfdale (1350).

and the air also expanding at these heights, rain is precipitated there and upon adjacent lands. The same is the case in Scotland, where the Highland mountains on the west produce a like effect; and thus, partly because it is the first land that the wind laden with moisture reaches, and partly because of the mountains, it happens, that a greater amount of rain is precipitated in the western than in the eastern parts of our island."*

For two-thirds of the year Harrogate enjoys from the S.W., W., and N.W., pure mountain air derived from altitudes greater than its own, and furthermore, an atmosphere drier than belongs to these mountains of the west. To the eastward the winds are somewhat broken by the Cleveland and Hambleton hills and the Wolds, and they are robbed of some of their harshness by traversing the intervening vales of Mowbray and York.

Thus, in a general way, the main peculiarities of the climate may be ascribed to the geographical position of Harrogate—high and midway between the seas—and the conformation of the country east and west of it; physical conditions which enable it to receive on the one hand the prevailing westerly

* *The Physical Geology and Geography of Great Britain, etc.*, by A. C. Ramsay, LL.D., F.R.S., etc., Lond., 1878.

winds after traversing a high and extensive mountainous region on which much of their moisture is precipitated, and on the other the modified sea air of the east.

Local Conditions.

The more general features of the climate derived mainly from the geographical position of Harrogate, are modified by physical causes pertaining to the district in which it is placed; such as the following:

1. *The Absence of Forests.*

Meteorologists are pretty well agreed as to the influence of forests in determining a damp and rainy state of the atmosphere; a position proved by the revolutionizing effect of forest-clearing on the climate of well-wooded countries and districts:—the air highly charged with moisture, and ever and anon condensing into rain, becoming dry and discharging its burden of vapour in tropical-like showers at long intervals. The dampness of the atmosphere in the neighbourhood of forests, and the frequent and increased rain-fall, are to be ascribed to the retention of moisture in the soil—trees retarding the natural

draining away of water—and the constant evolution of it from the leaves.

Forest-clearing in all cases is well known to reduce the moisture of the surface soil, and thereby contribute to dryness of the atmosphere. It is believed this result is mainly brought about by the vastly increased evaporation which follows the removal of trees. That there is a marked difference between this process in the 'open' and in a tree-covered area has been proved by experiment. Mr. Blou, F.M.S., at Wynbery Hill, South Africa, sunk in the ground to the depth of four inches, two cylindrical jars of the same size, and each containing 20 oz. of water; placing one in the soil partially protected, but not covered by bush, and the other in a newly cleared plot of ground measuring about 60 ft. in diameter, surrounded by sugar bushes, and otherwise protected from the prevailing wind by a belt of pine trees about 120 ft. distant; in five days the water was carefully measured, and it was found the loss by evaporation from the jar which had been placed in the cleared ground was more than double that from the jar in the bush, or as 1·854 in. is to ·8632 in.; the experiment was repeated with similar results.*

* *Symonds' Monthly Meteorological Magazine*, 1877.

If such a remarkable difference in surface evaporation can be noted in the limited conditions of such an experiment as this, surely we may reasonably infer it to be even more striking, could we gauge the rapid drying of the surface soil of a large open like that of the Harrogate upland, with the retarded process of evaporation in wooden districts where a constant store of moisture is retained.

Harrogate and the country for many miles around are by no means tree-less; but while the timber is sufficient to beautify the district, it is nowhere so excessive or aggregated into such dense masses of foliage, as to attract rain-laden clouds, or to induce a damp atmosphere in their neighbourhood. In days long past the Forest of Knaresbro' was worthy of the name; "this place and the forest, were formerly so thick with wood, that he was thought a cunning fellow that could readily find out those *Spaws*;"* at that time, the climate was probably far different from the present one—doubtless it was damp and raw, and perhaps a generator of disease rather than the health-giving agent it is now. The atmosphere of Harrogate must have gained considerably in dryness by the levelling of this dense forest.

* *The History of the Mineral Waters of Derbyshire, Lincolnshire, and Yorkshire, etc.*, by Thomas Short, M.D., 1734.

2. *The Absence of Rivers or of large bodies of Water.*

The atmosphere of Harrogate is also believed to gain in dryness from the absence of large river-beds and lakes for a considerable distance around it.

From Harrogate the westward strike of the compass is crossed by the Wharfe at a point 14 miles distant, and southward 6 miles: and the Nidd is distant from it 2 to 3 miles northward and 4 to 5 miles eastward. River beds,—often also thickly belted with luxuriant foliage—are known to attract rain and thunder storms, and to condense the vapour in their immediate neighbourhood; they therefore conduce to a moist atmosphere and frequent rains. A common illustration of this is frequently witnessed when thunder or rain storms in the west heavily threaten Harrogate, but nevertheless avoid it by traversing either the course of the Nidd or the Wharfe or by splitting and taking the tracks of both streams.*

* The local distribution of clouds as determined by terrestrial conditions, such as river-beds and forests, has a practical bearing not merely on rain-fall, but on the supply of sunshine:—one of the greatest sources of vigour and good health provided by nature, and of chiefest value to the young, the aged, and to those whose blood and tissues generally are ill-nourished and whose reserve stock of energy

Thus it is, that rain-laden clouds from westerly points of the compass are frequently led towards Knaresborough and the Vale of York, and leave Harrogate dry.

3. *The Configuration of the Country.*

The conformation of the upland on which Harrogate is built and of the district around it is peculiarly favourable to a free circulation of air from all points of the compass. There are no abrupt sheltering barriers to still down the air near the fine piece of undulating table-land, the Stray; around which the houses are scattered in all directions.

Whatever advantages the air acquires from motion are here secured, for—as at the sea side—it is rarely at rest beyond short periods, even when lowlands are close and sultry. Stillness of the atmosphere is an evil. Stagnant air, like stagnant water, becomes unwholesome. Vitality of the atmospheric ocean is maintained—as is the purity of the sea—by the continuous motion of its particles. There-

is exhausted. A plentiful supply of sun-light must be included among the natural remedial agents of Harrogate, for during summer and autumn especially, it has always seemed to the author to be more sun-favoured than other country districts, and—as every health resort should be—than large towns.

fore, whatever breaks up the play of the forces which keep the air in motion, is detrimental to health; such as confined rows of houses, high mountains, or thick belts of trees affording too great shelter from winds, and indoor life, however spacious, and even well ventilated the rooms;* an atmosphere in such situations is apt rapidly to lose freshness, to fail to invigorate, and even to depress, and, whether dry or moist, to become relaxing.

This quality, "freshness," is one which cannot be gauged altogether by chemical tests, or by instruments; it is, however, readily recognised by that

* The writer cannot forbear to quote the following illustrative passages from that invaluable contribution to chemical climatology, —"Air and Rain," by Dr. R. Angus Smith.

"Even very slight elevations sensibly affect the flow of air, and therefore the ventilation and climate of a place.....most of the close places in this country are made by art, although some are made by nature. The worst in the natural class are partly in the power of man; they are narrow glens with close woods. Devonshire has many such examples. The houses seem to nestle comfortably in them, but, as we may believe, with a loss to the inhabitants of some vigour. Even in some very narrow glens in the highlands of Scotland, where one would expect abundant rain and wind to cause sufficient mixture, I am informed that it is common for those who stay at the house, to lose their health, while those who go out among the sheep do not suffer. The state of the houses does not appear to be the cause, as these are no worse there than in better ventilated glens.

most sensitive of all meteorological tests—the human organism;

"But here I feel amends;
The breath of heaven fresh blowing, pure and sweet."

It is specially generated when pure air is set in motion; as when winds prevail, or when breezes frequently strike up; or when subjected to electrical discharges, as during thunder-storms. Some are inclined to ascribe it to the presence in more than ordinary quantity of that active oxidizer—ozone. Whether this be the proximate cause or not, experiments teach us that oxygen, when at rest, and, notwithstanding the removal of the products of respiration, may lose its property of sustaining animal life, but may acquire it again on receiving the molecular motion of an electrical discharge. "In some researches I conducted on the inhalation of oxygen gas, I observed that if an animal were made simply to breathe an atmosphere of pure oxygen gas, al-

.....It would appear, then, that the surface affects the air in more than one way by obstruction of its movements, which causes floating particles to be exchanged, and by sending out organic substances into the atmosphere, hurtful, perhaps, of themselves, and also when decaying.....Climate is affected by that which is on the ground, by the action of the porous ground, by the shape of the ground, and by the quality of the ground. Our climate is not all brought from distant places by the winds."

though the oxygen were perfectly cleared of the products of the combustion of the animal, it would not sustain life, but would allow the animal to fall into a somnolent condition, and to die. But if electrical discharge were passed at intervals through the oxygen, or if it were kept at a temperature above 75° F., it would continue to sustain life. In another series of experiments, I learned that if oxygen were freshly made, and passed in the fresh state through a chamber in which living animals were placed, the animals would continue to live. But if the oxygen that had swept through the chamber, although it were thoroughly purified of animal products, and although it still appeared to be absolutely pure oxygen, were used again, it failed to sustain life until it was subjected to the action of the electric spark, when it regained its activity. I infer from these observations that oxygen may exist in the atmosphere in an inactive condition, not inducing necessarily acute disease, but depression of mind, langour, torpidity, and cachectic feebleness of body."*

Freshness of the atmosphere is probably a condition not merely derived from the removal of im-

* *Diseases of Modern Life*, by B. W. Richardson, M.D., M.A., F.R.S., etc. 1876.

purities, but from this *plus* the presence of oxygen possessing oxydizing power—a property which it may derive from molecular or atomic motion, be it electric, thermic, or mechanical. From this standpoint one cause of the remarkable invigorating quality of the air of Harrogate is obvious; for the absence of any barrier to the winds from all points of the compass for many miles around, and the swelling rather than abruptly rising conformation of the country are conditions which must favour a continuous circulation and agitation of the atmosphere—an incessant unrest over sweeping hills and open dales, and from one grassy and heathery moor to another, whence oxygen may derive intense atomic activity.

4. *The Geological Structure of the District, and the Arrangement of the Formations.*

Dryness of the soil and of the atmosphere is aided by yet another cause; and one perhaps more powerful than the preceding, for it secures the rapid shedding off of rain, and the constant draining away of moisture from the ground on which Harrogate is built. The successive beds of Millstone grit which flank the upland of Harrogate form mas-

sive outer walls which slope away northward and southward at high angles, and enclose within them strata of shale and cherty limestone, which conform to the same general plan, only in a more pronounced way, being still more highly inclined. Wherever the observer turns he cannot detect a piece of undisturbed bedding—the rocks and shales being everywhere tilted from the horizontal. Even the stray—though called table-land—is broken up by undulations which, to the eye of the geologist, mark out a resisting skeleton of rock which denudation has failed to pare down, and the scooping away of the softer formations—the shale. The anatomy of the district could not, therefore, be more favourable to natural drainage.

The reader will readily conceive how different must be the water-charged soil of districts, generally low lying, under which impervious rocks are bedded in horizontal layers:—large tracts of country, unless artificially drained to an unusual degree, constantly exhaling moisture into the atmosphere.

All the foregoing considerations are so many physical reasons which establish beyond doubt the commonly accepted and easily recognised qualities of the air of Harrogate; they all converge in bearing testimony to its great purity and dryness, and to its

bracing and oxidizing powers, from which doubtless spring its health-restoring virtues.

5. *Meteorological evidence of the dryness of the air of Harrogate.*

The humidity of any locality cannot be inferred from the *annual* rain-fall; for the latter may be large, while the rain-fall periods being longer, the atmosphere may be drier than in other places in which a smaller annual rain-fall is less intermittent, and is therefore more evenly distributed throughout the year. The *daily* record of rain is a more sensitive index of atmospheric moisture than the yearly or even monthly totals of the depth of rain in inches; and it is more trustworthy than the use of hygrometers, which merely indicate the amount of humidity in the air at the moment when the daily observation is made, and which, unless skilfully managed, are apt to give inaccurate results. The annual number of rainy days is, therefore, a more important indication of the humidity of the atmosphere than the actual yearly rain-fall; for it may be accepted as a general meteorological truism, that *cæteris paribus* the more intermittent the descent of rain, the less the liability to a continuous surcharge of water in the surface soil, and the smaller the exhalation of moisture into the atmosphere, and *vice versâ*.

The rain-fall statistics of the twelve years from 1868 to 1879 show, that throughout the year Harrogate is more rain-free than other inland watering-places in this country—for it claims the lowest annual number of days on which rain descends.

Inland Watering-places.

The Average Annual Rain-fall and Number of days on which $\frac{1}{100}$ in. or more of Rain fell.

(Calculated from Symons's British Rain-fall from 1868 *to* 1879*—inclusive).*

	Inches.	Rainy days.	Observers.
Harrogate	33·4	156	Coupland.
Bath	33·2	180	Weston.
Buxton	54·7	211	Sykes.
Cheltenham	31·3	165	Humphries, Kay.
Clifton	35·3	174	North, Burder.
Great Malvern ...	31·7	173	Burrow, Sandoe.
Ilkley	41·3	196	Scott, Middleton, Dymond.
Leamington ...	27·1	169	Jones, Barnitt.
Matlock Bath ...	39·0	185	Chadwick.
Tunbridge Wells...	32·6	165	Stow, Miller, Brentnall, Townhend.
Average	36·2	179	

The dryness of the air of Harrogate is proved by the small yearly aggregate of the daily rain-falls. In this respect it excells even Scarborough, of which Dr. Cornelius Fox remarked in 1867, "on making

an examination of the rain records of other health-resorts, it becomes evident that the majority have a greater number of rainy days than Scarborough."* For in 1868, 1869, 1870, 1871, 1872 and 1873 the average annual proportion of wet days in the latter watering-place was 184·8 (data furnished by Dr. Fox in Symons's British Rain-fall) while that of Harrogate was 147·6; and in the twelve years—from 1868 to 1879—rain fell in each average year on 178 days at Scarborough, and on 156 days at Harrogate. But Scarborough is not the only sea-side health resort having more frequent rains than Harrogate. See the following table).

The rain-fall statistics of the twelve years from 1868 to 1879 show, that only two of the leading British health-resorts—Margate and Dover—were favoured by even fewer wet days than annually fell to the lot of Harrogate.

* *Meteorological Observations on the Humidity of the Air of Scarbro'* *etc.* by Cornelius B. Fox, M.D.

Coast Watering Places.

The average annual number of days on which $\frac{1}{100}$ in. or more rain fell.

(Calculated from data furnished by Symons's British Rainfall).

	Wet Days.	Periods of Observation.	Observers.
Bournemouth	163	1868 to 1874†	Newnham, Compton.
Brighton ...	167	1870 to 1879†	Sawyer.
Eastbourne ...	174	ditto	Hall.
Grange	182	1872 to 1879†	Beardsley, Massie.
Hastings ...	167	1870 to 1879	Lewis.
Ilfracombe ...	182	ditto	Clark, Weston.
Llandudno ...	178	ditto	Nicol.
Penzance ...	244	1873 to 1879†	Trelawny.
Sidmouth ...	176	1870 to 1879	Radford.
Southport ...	192	1872 to 1879	Braxendell.
Torquay ...	190	1868 to 1879†	Pengelly.
Ventnor ...	160	1870 to 1879	Ryde, Martin.
Whitby... ...	189	ditto	Simpson.
Average	181	Harrogate (corresponding periods)	158

† During these years the average annual number of rainy days in Harrogate were 149 ('68 to '74), 157 ('70 to '79), 169 ('72 to '79), 163 ('73 to '79) and 156 ('68 to '79).

CHAPTER II.

MEDICAL EXPERIENCE OF THE CLIMATE.

Inasmuch as Harrogate—apart from its medical springs—has acquired a steadily growing reputation as a health-resort, some notice of the medical aspects of its climate appears to be called for. These may be conveniently reviewed under two heads; the salubrity of Harrogate for residents and for the majority of visitors; and the climate in its more specially medical applications to invalids.

The Salubrity of the Climate.

The healthfulness of Harrogate, either for those who adopt it as their permanent residence, or who resort to it for limited periods, is abundantly proved by the following considerations.

1. *Harrogate as a resort for permanent residence.*

For more than twenty years past Harrogate has attracted an increasing number of strangers as permanent residents. The writer—who has had extensive opportunities of observing the effects of the climate on the health of this class—has generally

seen the happiest results follow the migration. Even when before venturing on this step, apprehensions have been entertained lest the cold months at Harrogate should prove too keen, experience has generally shown their groundlessness; and even that which was most feared, has, as a rule, become the source of firmer health. The highly bracing quality of the air of Harrogate, especially in the winter months is one of the strongest recommendations of the climate to outsiders. Much of the general debility produced by the depressing influence of town-life and other causes may be fostered and intensified by resorting more and more to protecting influences, such as those of mild or sheltered climates; while the remedies frequently required, though often shunned or feared, are such as provoke the healthful generation of new force and develope the power of resistance by testing it. Hence doubtless the value of the climate of Harrogate mainly consists in its powerful tonic quality, which soon declares itself in improved appetite, and more vigorous digestion and nutrition, and greater resistance to meteorological and other influences. It is soon discovered that the dreaded coldness of Harrogate in winter differs greatly from that of low-lying and generally damp districts, and of the less invigorating atmosphere of

towns—for the air being drier and more oxidizing generates an increased warmth which counteracts the chilling effects of cold; and furthermore, this greater combustion within the system incites to the ingestion of more fuel as food. Thus, providing there is a sufficient substratum of vigour and no exhausting organic disease, lowness of temperature in an atmosphere of this type no longer depresses, as a cold moist air is apt to do, but stimulates the whole round of the functions involved in nutrition, whereby the health becomes more vigorous and consolidated. Many of those who are settled in Harrogate were led to it chiefly because a temporary sojourn either relieved or cured an ailment or some defect of health which persisted elsewhere, and the wisdom of their choice has been confirmed, as a rule, by further experience of the climate. And there are others who less or more ailing or weakly, but without definite disease, and attracted to the place by its well-known character for healthfulness, are satisfied with the improved vigour which Harrogate has brought them.

2. *Harrogate as an Educational centre.*

For many years past Harrogate has been steadily growing in popularity as a locality well adapted for scholastic purposes; a popularity founded on its

salubrious climate more especially for the young. It has now become a large and important educational centre, possessing at least twenty-six boarding schools, while twenty-five years ago there were but two. The repute of the climate and waters often induces parents to send delicate children to these establishments; according to the writer's ample experience of these cases he can speak confidently of the almost invariable benefit derived from their sojourn in Harrogate; and futhermore, he must bear witness to the high standard of health maintained in all the schools.

3. *The Mortality.*

The annual death-rate is undoubtedly much below that of other watering-places, for in 1877, 1878, 1879 and 1880 it was, among residents, only 12·1, 12.6, 14.4 and 14.5 respectively per 1000, estimating the population at 9,500 as determined by the census returns of 1881.

The deaths of visitors cannot fairly be included with those of residents, for visitors to Harrogate are as a class more ailing than such as resort to seaside and other watering-places mainly for recreation, and they swell up the permanent population to more than double; while this excess of population cannot

be accurately known, and therefore fails to be estimated in the returns. However, even inclusive of visitors, the death-rate of Harrogate compares favorably with that of other watering-places, *e.g.* in 1880 it was only 16·5 per 1000.

4. *The Amount of Sickness.*

The prevalence of sickness as a test of salubrity, in the absence of definite statistical data, can only be correctly estimated by those continually conversant with it. The resident medical men believe it to be decidedly below the average, the character of the population duly considered. Certain diseases, *e.g.*, consumption, rheumatic fever, typhoid fever, are rare; and those, such as pneumonia and bronchitis, the prevalence of which ought to be anticipated from the nature of the climate in the cold months, are certainly not more frequently met with than in more protected districts, perhaps much less so. The climate undoubtedly corroborates the general health: may not this influence, assisted by the characteristic dryness of the air, thwart the ordinary action of cold on the system in setting up acute inflammatory attacks?

5. *The Domestic Water Supply.*

The essentials of a good water supply are—

1. Purity and freedom from the possibility of contamination (organic or metallic).

2. An abundant and uninterrupted supply at all seasons.

3. A low degree of hardness.

All these conditions are pre-eminently met by the water supplied by the Harrogate Water Works Company.

1. *Purity.*—The writer has carefully inspected the sources which feed the several reservoirs, at Haverah Park, Beaver Dyke, and those near Harrogate; they are far away from dwellings and the possibility of receiving impurities of any kind. The spring at Haverah Park gushes from the side of a rocky hill, and the source at Beaver Dyke is derived from the rain filtering from the Grit Moors—one of the purest of water-sheds. (See table p. 30).

2. *The supply* has never been known to fail, notwithstanding the enormously increased demand created by every season—when the population is more than doubled and continued droughts most apt to occur. It is a constant supply, as distinguished from the intermittent one to which water companies are sometimes from scarcity of water compelled to resort.

The reserve capacity of the reservoirs is no less than 81 millions of gallons; but when the Beaver Dyke reservoir is completed, it will be increased two-fold.

3. *Hardness.*—Among other water supplies, that of Harrogate is remarkable for the small quantity of solid matter held in solution, and for its softness. Its high position in these respects among waters supplied to other health resorts is indicated by the following table, drawn up from data furnished by the Report of the Rivers Pollution Commission, "Domestic Water Supply of Great Britain, 1874."

Waters supplied to health-resorts.

Results of analysis, expressed in grs. per gal.

Town.	Total solids.	Hardness.	Previous Sewage or Animal Contamination.	Formations whence Derived.
Harrogate	5·53	2·94	0	Millstone Grit.
Bath	22·16	17·64	4·917	Lias and Oolite.
Buxton	6·28	3·08	0	Yoredale Grit.
Brighton	21·92	14 94	7 845	Chalk.
Cheltenham ...	14 85	10·57	2·730	Upper Lias.
Clifton	19·56	17·22	1·525	New Red Conglomerate and Mountain Limestone.
Eastbourne ...	30·18	14·63	1·010	Lower Greensand.
Ilkley	7·99	6·02	0	Millstone Grit.
Leamington ...	48·24	19·25	1·590	New Red Sandstone.
Malvern	5·57	3·18	1·275	Granite and Gneiss.
St. Leonards ...	20·80	16·94	1·190	Lower Greensand.
Scarborough ...	25·29	15·05	2 745	Coralline Oolite.
Tunbridge Wells	8·58	2 31	4·640	Lower Greensand.
Average	19·28	11·65	2·455	

One feeder (Haverah Park Spring) contains but 4 grains of solid residuum per gal:—a quantity almost identical with that of the celebrated Loch Katrine (3·92).*

These qualities of the water are determined by the geological structure of the collecting area; made up as it is of massive beds of Millstone grit and shales, which, like all other gritty or sandy and argillaceous or slaty strata, contain but little soluble matter, which can be washed out by rain. How different the water which has percolated over or through calcareous formations, such as the Chalk, Oolites, Lias, Limestone (Carboniferous or Permian) and Gysiferous New Red sandstone; then, as with many instances in the foregoing table, the load of earthy salts is declared by excessive hardness.

6. *The Sewerage, etc.*

Within recent years, Harrogate has been provided with a costly system of sewerage, which, in every detail, has given great satisfaction; it is constructed on the irrigation principle, of which it is one of the most successful examples in this country, and may be regarded as a model of this form of the utilization of sewage.

* The analysis of Oct. 14th, 1873. *Water Supply of Great Britain*, 1874, p. 347.

The sanitary condition of Harrogate will compare favourably with that of any other watering-place in this country, and by far excels that of most Continental spas; this fact is attested by the rarity of epidemics. No one can fail to recognise the public zeal of those in authority—though abused beyond measure when in office—and of others alive to the fact that Harrogate is more richly endowed by the hand of nature than its fellow resorts, to maintain by every available means its healthfulness, and thereby to preserve unimpaired its acquired reputation as a mineral watering place.

The Climate for Invalids.

Observation of the effects of the climate of Harrogate suggests, however, certain indications and contradictions, which, as with any climate of decided effect in special directions, should serve on the one hand, as guides to the selection of cases best adapted to its beneficial influence, and on the other as warnings to exclude others. Of these the writer can but give a mere outline sketch, which may, nevertheless, be more useful as a chart without the heavy shading in of many details.

1. *Indications.*

While marking out some of the special morbid conditions which observation leads the writer to view

as more than others likely to benefit from the climate of Harrogate, only that experience is here formulated which appears to him to be most worthy of attention.

1. *Relaxation and debility of tissue*: whether occurring as a general condition affecting less or more all the organs of the body, or as a more special and local affection of certain structures; such as:

(a) The debility arising from town-life, and the loss of tone induced by sedentary employment; exhaustion from overwork, or from work continued on from year to year without reprieve, until the sources of reserve force are partially used up by a continued expenditure which has exceeded the income, so that now there is but a limited balance left; the tissue-exhaustion of protracted convalescence, or that which arises from a prolonged drain by purulent or other discharges, etc.

(b) Some local debility in advance of a general loss of tone—*e.g.*, relaxed and debilitated conditions of the skin; flabby and toneless mucous membranes, atonic dyspepsia, atony of the bronchial mucous membrane, relaxation of the pharynx. The writer has frequently observed the curative power of the climate of Harrogate over a liability to bronchitis, in which, conjointed to a loss of tone generally, there

appeared to be a specially relaxed bronchial mucous membrane; a condition which warm climates—especially when moist—may fail to cure, but which is met by building up and bracing influences.

2. *Scrofula*, whether with or without local manifestations, is a morbid condition to which the treatment of Harrogate is specially adapted, both by virtue of the tonic climate, as well as by the medicinal springs of established reputation as anti-scrofulous agents. Though strumous cases, like others, usually resort to Harrogate during the season, the writer holds they would derive still more benefit by a course of treatment extended through the winter months. Harrogate possessing curative advantages of exceptional power over all forms of malnutrition in the young, as well as ample choice of high-class schools for both sexes, offers rare hygienic as well as educational benefits to children in whom the nutritive and developmental processes are sluggish or defective.

3. *Nervous debility and prostration from mental over-strain*, when not attended by excessive nervous irritability and sleeplessness.

4. *Anæmia and chlorosis.* The dry oxidizing air is undoubtedly a valuable auxiliary to the operation of the powerful ferruginous springs in blood-building.

The treatment of these cases is sometimes even more effective in the cold months.

5. *Degenerative changes in the elderly.* The writer has repeatedly noticed a marked improvement in the health of those who, previous to resorting to Harrogate, appeared to be declining prematurely; this and other similar experience incline him to regard it as one of the healthiest of localities for the aged.

6. *Heart diseases etc.* The level walks in and about High Harrogate where the tonic properties of the climate may be enjoyed with less physical exertion than in hilly watering places, conduce greatly to the comfort and progress of cardiac and other cases in which locomotion is difficult or impaired.

7. *Some cases of chronic phthisis* may resort to Harrogate during the warm months with great benefit; such, for instance, as require, after spending the winter in the south of France or elsewhere, a dry bracing climate during the summer and autumn; and in which the clinical features are—absence of febrile movement, the local disease quiescent, or taking a favourable course, digestive organs toneless with liability to disturbances of the liver, and signs of a strumous diathesis combined with the tubucular.

2. *Contra-Indications.*

Though nearly all those who resort to Harrogate either for limited periods or for permanent residence are invigorated thereby, the writer must state the few conditions—exceptional though they be—which have appeared to him to contra-indicate the climate, *especially during the cold months.*

1. *Chronic pulmonary disease* characterized by the signs of a tubercular rather than of a strumous diathesis; by febrile disturbance; by progressive wasting; by advancing and advanced local disease.

2. *Progressive organic disease* exhausting the digestive power, and impairing assimilation.

3. *Irritability of the mucous membranes,* such as a dry hypersensitive condition of the larynx; irritable bronchial and nasal mucous membranes; great susceptibility to gastric catarrh, and irritability of the stomach.

4. *A highly sensitive and irritable state of the nervous system.* The climate of Harrogate is apt to be exciting—over stimulating—in certain forms of nervous debility, marked by excessive irritability; a condition sometimes associated with an irritable state of the gastric mucous membrane and sleeplessness.

CHAPTER III.

THE CLIMATE IN CONJUNCTION WITH THE MINERAL WATERS.

Viewed in conjunction with the prescribed courses of the waters, the climate is found to be of exceptional medical value.

The operation of the various springs may be epitomized as depurant or tonic, or some combination of these therapeutic actions. Medical practice aims at conserving the powers of the system, even when it is found depuration is most needed, and prefers a conjunction of restorative agencies whenever the aim is to tone and reconstruct. Hence, from whichever side the curative powers of the waters are approached, the invigorating property of the climate must be construed as a powerful auxiliary. This fitting combination becomes all the more noteworthy when it is found that other medicinal springs of similar constitution and virtues elsewhere are, as a rule, associated with climatic conditions less favourable to their therapeutic aims. Other watering-places at home may be dismissed from consideration, inasmuch as the climate of none can approach that of

Harrogate in freshness, dryness, and invigorating properties; and of the foreign springs, those who have visited such of them as resemble the Harrogate waters, must admit that they are situate for the most part in mild, moist districts: Homburg appearing to be the sole exception.

Besides the immediate advantages which visitors to Harrogate derive from the tonic climate while undergoing the prescribed courses of waters, they avoid, as a rule, even when restricted throughout to the aperient and diuretic waters, the debility apt to ensue from depurant treatment, followed up in watering-places possessing a warm moist atmosphere or a less bracing climate; an exhaustion, for the removal of which a bracing mountain or sea-air is often sought. A recruiting visit after the Harrogate treatment is, however, generally unnecessary, for it is usually found that the restorative process has kept pace with, or even outstepped the depurating action.

Furthermore, the writer believes the tonic properties of the climate is one reason* why many visitors are enabled to undergo longer treatment by the evacuant waters than they could do without injury in a moist relaxing atmosphere. He has frequently

* Doubtless others may be also assigned, such as the *sui generis* constitution of the waters, and their special suitability to cases.

been surprised at the remarkable duration—even months without interruption—to which, for instance, a course of the Old Sulphur spring may be extended; the patients the while gaining in weight and strength, and their ailments quietly and steadily dispersing.

Besides the climate, another auxiliary to the curative operation of the medicinal waters should not be overlooked; namely, THE WATER SUPPLY. The value of pure soft water in this connection will be illustrated more forcibly by briefly reviewing the deleterious effects of hard water.

1. Drinking-water highly charged with earthy salts (especially calcium sulphates) is frequently injurious to the dyspeptic, the constipated, the gouty, and to those whose renal function is precarious, and furthermore, to the aged, in whom calcareous degeneration of the arteries, besides failure in all the processes of elimination, are progressing.

To these, and in fact to all other visitors to Harrogate, the town water is most grateful, as well as a valuable hygienic aid to the operation of the medicinal springs.

2. Daily ablution in hard water is apt to injure the skin, and to obstruct its functions. The fats and volatile fatty acids of the perspiration and sebaceous secretion may form—as soap does--in-

soluble compounds with lime, which may readily block up the oil and sweat glands, and harden the epidermis. The injurious effect may with delicate skins go beyond this stage, and, reminding one of the inflammatory œdema in the portions of the skin long varnished in Edenhuizen's experiments, may set up forms of eczema, which, once established, may be perpetuated by the further use of hard water. Ablution in hard water is unquestionably injurious to inflammatory skin diseases; hence one of the softest and purest waters of Britain must be a boon to the thousands of cutaneous cases which are annually attracted to Harrogate.

THE

HARROGATE WATERS.

PART I.

CHEMICAL DATA.

"For art may, but nature cannot miss."—DRYDEN.

INTRODUCTORY.

1. *The number of medicinal springs.*

"A place that may justly challenge Britain and perhaps all Europe for its great numbers and variety of mineral waters." So wrote Dr. Thomas Short in 1734 while introducing Harrogate to the notice of the medical and scientific world;* a remark, however, even then more than 100 years old; for in 1632 it was thus penned in rather similar terms by Dr. Stanhope, one of the earliest writers on the medical virtues of the Harrogate waters. "Our spaw can in justice yield to none in England for the great consequence and variety of its springs, there being a great many sorts within two miles of one another. Had they but one year such an ingenious examiner as Dr. Jordan, we might expect nations to

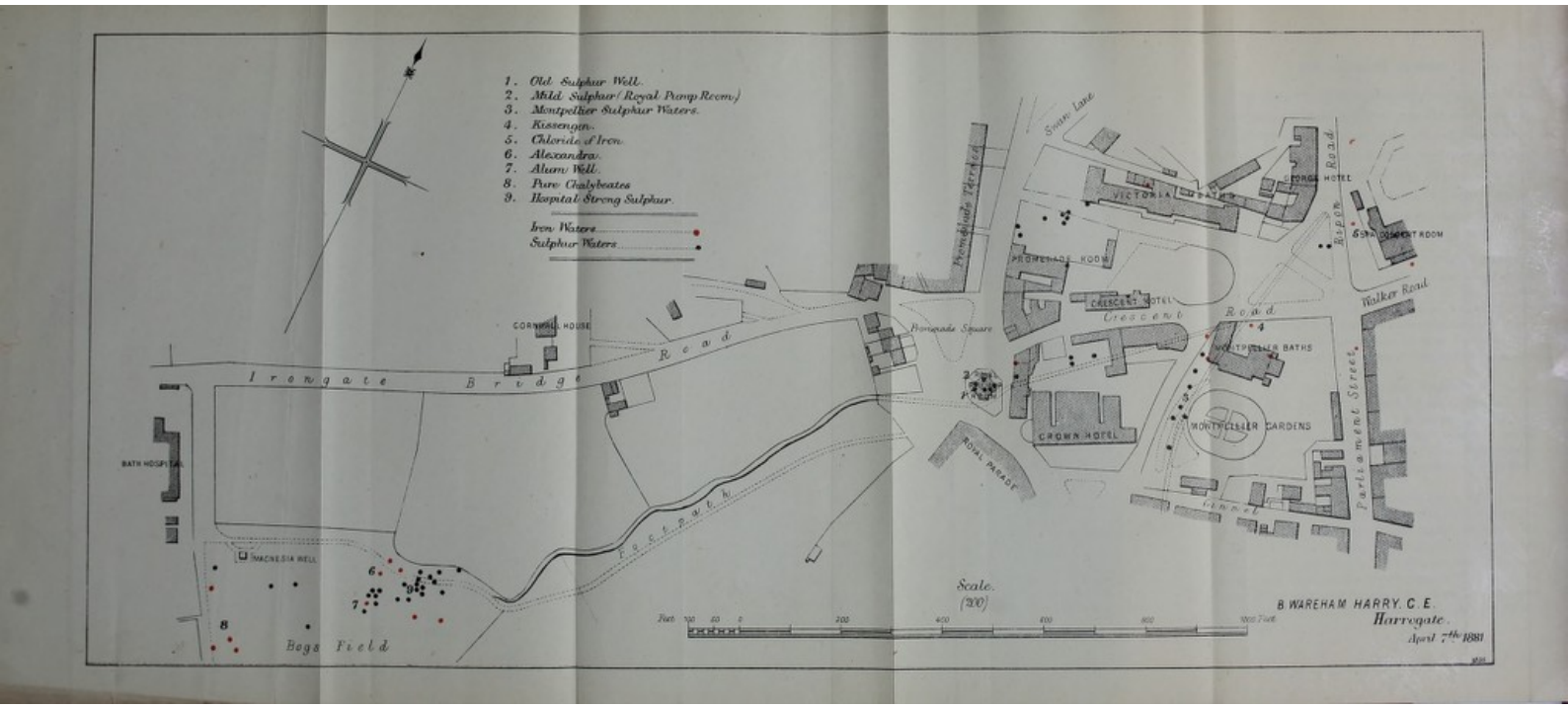
* "The natural, experimental, and medicinal history of the mineral waters of Derbyshire, Lincolnshire, and Yorkshire, etc.," by Thomas Short, M.D. Sheffield, 1734. Published by request of the Council of the Royal Society.

flock to them."* These statements may appear to us somewhat ambitious when we note the small number of different springs in use in the time of Stanhope—only six†—and in that of Short, certainly not more than twelve.‡ But surely we may be permitted with justice and without ostentation to apply similar terms to the Harrogate of to-day, inasmuch as the district embraced by two miles East and West of it possesses no fewer than eighty medicinal springs,

* "Cures without care; or a summons to all such as find little or no help by the use of Physick, to repair to the Northern *Spaw* wherein by many precedents of a few late years, it's proved to the world that infirmities of their own nature desperate, and of long continuance, have received perfect cure by virtue of mineral waters near *Knaresburgh*, in the West Riding of *Yorkshire*," etc., by Michael Stanhope. 1632.

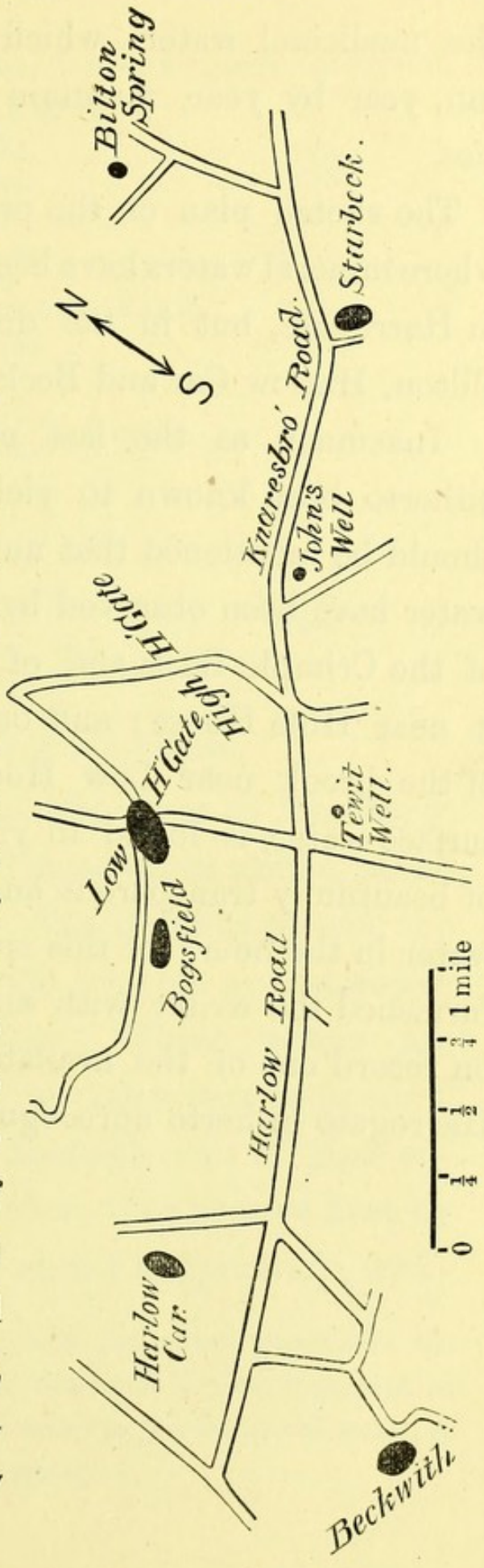
† These were: the Tewit well; three stinking wells, viz., one at Bilton Park, one near Knaresbro' and one at Harrogate (the old Sulphur well); the dropping well of Knaresbourgh. All these springs are mentioned by Dr. Dean in his "*Spandarine Anglica*, or the *English Spaw* Fountain," etc., 1626, the first medical treatise on the Harrogate waters. Stanhope adds the Sweet spaw (or John's well) discovered by him in 1631.

‡ In addition to the foregoing: the alum well in the Bogs-field; two sulphur wells, making three at the Village (Harrogate); the Starbeck chalybeate; the strong hospital sulphur, Bogs-field?; and a chalybeate S. W. of the alum well, a chalybeate oozing 100 yards S. E. of the three sulphur wells. Dr. Short also refers to issues of sulphur water "about a mile and quarter West of Harrogate on the brook side" evidently referring to the sulphur-water issues of Harlow Car, inasmuch as he says the "Bogg above the Village" is "a mile east of this."


1. Old Sulphur Well.
2. Mild Sulphur (Royal Pump Room)
3. Montpellier Sulphur Waters.
4. Kissengen.
5. Chloride of Iron.
6. Alexandra.
7. Alum Well.
8. Pure Chalybeates
9. Hospital Strong Sulphur.
Iron Waters
Sulphur Waters
Irongate
Bridge
Road
CORNWALL HOUSE
BATH HOSPITAL
MAGNESIA WELL
Bogs Field
Footpath
Promenade Square
Promenade Terrace
Swan Lane
VICTORIA BATHS
GEORGE HOTEL
Ripon Road
PROMENADE ROOM
CRESCENT HOTEL
Crescent
Road
Walker Road
MONTPELLIER BATHS
MONTPELLIER GARDENS
CROWN HOTEL
ROYAL PARADE
Parliament Street
Scale.
(200)
B. WAREHAM HARRY. C.E.
Harrogate.
April 7th 1881

no two of which are alike, and some of them, both from a chemical and from a therapeutic standpoint, unrivalled elsewhere.

The accompanying map will enable the reader to realize a better conception of this incomparably rich store of mineral waters, than can be furnished by a description of their several localities and relative position. It represents the groups of wells on the Bogs-field and in Low Harrogate —localities which are literally studded over with them. Many of them are so clustered together, and they all occupy so small an area, that it is a matter of astonishment to all, how



the medicinal waters which issue into these wells can, year by year, maintain their distinctive qualities.

The sketch plan on the preceding page indicates where mineral waters have been discovered, not merely in Harrogate, but in the district, viz., at Starbeck, Bilton, Harlow Car and Beckwith.

Inasmuch as the last named locality has not hitherto been known to yield medicinal springs, it should be mentioned that numerous issues of sulphur water have been observed by the author in the beds of the Crimple Beck and of the stream which joins it near Hole House; and one of these by the side of the brook near Low House, when isolated from surface water, is found to yield at least nine gallons of beautifully transparent and well aërated sulphur water in the hour; of this spring Mr. Davis kindly furnished the writer with an analysis, which places on record one of the available medical resources of Harrogate hitherto unrecognised.

Specific gravity 1000·56. *Reaction—decidedly alkaline.*

GRAINS IN 20 OZ.

Ca	·321	Calcium sulphate	·072
		Calcium carbonate	·743
Mg	·151	Magnesium carbonate	·52
Na	1·140	Sodium carbonate	2·019
		Sodium chloride	·421
		Sodium hydrosulphide (NaHS)	·241
K	·040	Potassium chloride	·076
Si O_2	·066	Silicic acid	·066
Li, Fe	traces	Lithium chloride, Ferrous sulphide	traces.
Radicles: SO_4	·049		
Cl	·293		
CO_3	1·965		
S	·138		
	4·163		4·167

June, 1880.

2. *Temperature of the waters.*

All the Harrogate waters, like those of Homburg, Kissengen, Kreuznach, and some other similar saline springs, are non-thermal. The Sulphur waters, the Kissengen, and the Chloride of Iron are, however, dispensed in thermal doses. These waters are warmed during transit by an ingenious apparatus, the Therma ;* circulating through coils of pipe enclosed in a hot-water chamber, they receive heat by conduction, and are served at any temperature, with-

* This improved method of heating the waters supersedes the primitive practice still adopted at many non-thermal spas, such as adding a small quantity of very hot water to the medicinal water, or placing the latter in a vessel of hot water.

out loss of gases or precipitation of dissolved constituents. In some respects this arrangement surpasses even the conditions of thermal waters; for, it enables the temperature to be adjusted to the requirements of cases, and, moreover, it avoids the waste of gas (notably sulphide) during the requisite cooling of too hot waters, as at Aix-la-Chapelle, Burtschied, Toplitz, Luchon, and other thermal sulphur springs of unnecessarily high temperature.

Inasmuch as heat, whether natural or added, is the same force, the waters thus warmed by conduction in enclosed tubes become essentially thermal, and the importance of this quality in conjunction with strong charges of saline matter—as in these waters—comes out the more when it is remembered that all naturally thermal waters (and especially those exceeding 90° F.) are poor in solids, and that a high temperature is required for the rapid absorption of salines, especially chlorides in concentrated solution: nature, however, keeps apart hot water and water well charged with salts.

3. *The continuity and constancy of mineralization.*

The continuous outflow of waters charged with various solid and gaseous constituents, in much the same proportions year by year for even centuries,

is a matter of interest and astonishment, even to the scientist conversant with the processes of nature.

This constant washing out of the soluble portions of the strata traversed by the waters furnishes a large yearly output of salts: and this must be specially the case in a district like that of Harrogate with its remarkably numerous issues of mineral springs. Two examples will suffice to illustrate the busy mining operation of water in mineralizing the various issues.

The OLD SULPHUR SPRING, in its continual overflow of 12½ gallons in the hour, is computed to throw off year by year—7 tons of the Chlorides of Sodium, Potassium, Calcium, and Magnesium; 240lbs. of Sulphide of Sodium; 100lbs. of Chloride of Barium; 37lbs. of Iodide and Bromide of Magnesium.

The CHLORIDE OF IRON WELL, estimated to flow at the rate of 12 gallons per hour, delivers annually —3 tons of the Chlorides of Sodium, Potassium, Calcium, and Magnesium; 217lbs. of Protochloride of Iron; 173lbs. of Protocarbonate of Iron; 100lbs. of Chloride of Barium and Strontium; 14lbs. of Chloride of Manganese; 5½lbs. of Bromide of Magnesium.

But, in connection with the mineralization of the springs, the matter of practical importance to medi-

cal men and their patients, is the constancy of it; do the waters steadily maintain, at all times, such a uniformity of composition as not to disturb or impair their trusted therapeutic operations? The constituents of all medicinal springs, whether derived from a large collecting area of rain-fall, or from deep sources, or otherwise, do vary in quantity from day to day, from week to week, and even from year to year; for all the analyses of any well-known spring executed at different times, however carefully, and even by the same chemist, are not alike—they differ beyond the limits allowable for the necessary imperfections in the methods. But all such variations may be traced to physical causes, and are merely of interest to the student of chemico-geology. They have no practical bearing on the treatment of disease —for, though they may be distinctly traced in a large volume of water, they assume minimal therapeutic importance in the smaller quantities prescribed.

The limited space at the disposal of the writer does not enable him to illustrate the constant integrity—*from a therapeutic standpoint*—of all the numerous Harrogate waters in daily use further than by selecting two prominent representative examples: one from the Sulphur, and the other from the Iron

group; and moreover one *a natural issue* of mineral water (the Old Sulphur spring) and the other *a well* (the Chloride of Iron water).

(1) *The Old Sulphur Spring.*

For nearly 300 years this water has persistently maintained its therapeutic powers: and hence the preservation throughout this long period of an unimpaired chemical constitution may be fairly presumed.

The earliest records of its well-known effects are furnished by Dr. Dean in the early part, and by Dr. French in the middle, of the seventeenth century, though they were doubtless recognised towards the close of the sixteenth century, if not before. Dr. Dean refers to its curative powers thus: "Such as drink the water verily believe there is gunpowder in it, and they vomit it up again . . . The common people drink them, and they expel Reef and Fellon."*

And Dr. French, writing on the same theme, observes: "Cold dull bodies can bear more than others: but, in generál, let the quantity be such as

* "*Spandarine Anglica*, or the *English Spaw* fountain; being a brief Treatise of the acid, tart Fountain in the Forest of *Knaresburgh* in the West Riding of *Yorkshire*, as also a relation of other Medicinal Waters in the said Forest." *By Edm. Dean*, Doctor in Physick, *Oxon*, dwelling in York; Lond. 1626.

may move the belly five six or seven times, as the body can bear. This water often works too quickly upon several bodies."*

Until the last quarter of the last century there were no reliable data bearing on the chemical constitution of this spring—nor is this surprising considering the imperfect state of chemistry during the last century and that preceding it. Though Dr. Short gives us the total solids in 1734: "A gallon of the upper well (or that commonly drunk) exhaled, left near two ounces of salt,"† and though Dr. Higgins in 1780 obtained a similar, though a somewhat smaller quantity, it was not until 1783, when Dr. Joshua Walker,‡ and 1791 when Dr. Garnett,§ analysed the water with more pretention to accuracy, and attained results comparable with those of subsequent analysts.

The trustworthy chemical history of this spring extends therefore over a period of 100 years, and is

* "*Yorkshire Spaw*, or, a Treatise of four famous Medicinal Wells, *viz.* the *Spaw* or Vitrioline Well; the Stinking or Sulphur Well; the dropping or petrifying Well; and St. Mungo's Well near *Knaresburgh* in *Yorkshire*: together with the causes, virtues, and uses thereof." By *John French*, M.D. 1654.

† *Op. cit.* p. 195.

‡ *An Essay on the Waters of Harrogate and Thorpe-arch.* By Joshua Walker, M.D., Physician to the Leeds Infirmary, 1784.

§ *Treatise on the Mineral Waters of Harrogate.* By T. Garnett, M.D. 1792.

Analyses of the Old Sulphur Well from 1783 *to* 1881.

	Analyst ... . / Date	Walker. 1783	West. 1828	Hunter. 1830	Hoffmann. 1853	Muspratt. 1867	Davis. 1872	Thorpe. 1875	Davis. 1879	Davis. 1881
	Temp.	48° F.	...	...	48° 2 F.	...	48°·9 F.	48°·2 F.		
	Sp. gr.	...	1013·24	...	1011·13	...	1011·16	1011·04	1011·60	1011·405
Grs. in imperial gallon.	Lime	...	39·8	43·5	48·243	46·233		38·697		
	Magnesia	...	14·7	18·0	3·446	27·392	(1866)	23·839		
	Baryta	...	...	...	...	3·68	4·719	4·833	4·539	4·670
	Lithia	...	...	...	...	trace	...	0·266		
	Potash	...	...	...	33·869	44·165	...	6·063		
	Ammonia	...	...	...	...	...	...	0·328		
	Soda	...	484·0	471·0	474·054	470·635	...	477·022		
	Chlorine	...	623·9	608·0	650·384	654·908	615·62	613·770	619·611	627·57
	Bromine	...	...	...	trace	trace	...	1·985		
	Iodine	...	...	...	,,	,,	...	0·103		
	Sulphur	...	. .	...	6·353	6·737	6·412	6·532		6·460
	Carbon dioxide ...	...	...	...	...	...	...	35·404		
	Silica	...	...	...	0·241	...	...	0·703		
	Sulphuric acid... ...	...	absent	absent	0·101	absent	absent	absent	absent	absent
	Residue on evaporation.....	1111·	1021·8	1016·0	1095·919	1108·781	1046·56	1047·013	1061·720	1048·25
Cub. in.	Free H_2S	...	...	...	0·531	7·01	...	10·16		
	,, CO_2	...	...	...	22·03	25·55	...	40·10		
	Total in cub. in. ...	...	36·4	34·0	36·09					

epitomized in the table on the preceding page—based on that constructed by Prof. Thorpe*—from which we learn the water has preserved the main feature of its constitution throughout the past century with remarkable constancy.

A falling off in mineralization—either in regard to the total contents, or to the sulphur, or to the salines—has not been detected, notwithstanding the unprecedented chemical scrutiny to which the water has been subjected during the past quarter of a century; and, moreover, the local rain-fall and the season fail in disturbing the normal charge of the constituents. (See p. 59).

It may be safely asserted that this spring possesses a constant mineralization—or so constant as not to impair its therapeutic action—not only all the year round, but from year to year, and has probably maintained much the same stability of composition for centuries.

(2) *The Chloride of Iron Water.*

That chapter of the chemical and therapeutic record of this well opened by Professors Muspratt and

* *A Contribution to the History of the Old Sulphur Well, Harrogate.*" By T. E. Thorpe, Ph.D., F.R.S. Professor of Chemistry in the Yorkshire College of Science, Leeds. Philosophical Magazine, July, 1876.

Miller in 1865, has ever since preserved its unity; and the recent painstaking researches of Professor Thorpe show that this remarkable water still maintains unimpaired the integrity of its chemical composition.

Mr. R. Hayton Davis, F.C.S. has tracked the chemical history of the leading constituents during the period from July 1865 to the present time; and he has kindly placed at the writer's disposal all the data collected during his praiseworthy and patient enquiry. The author is therefore enabled to present a valuable and reliable resumé of the chemical variations in the proportions of the principal ingredients —and of these as a whole—which have occurred subsequently to 1865.

Though throughout this long period the *remarkable constitution* of the water has remained intact, the leading constituents have been frequently detected in different quantities both relatively to each other and to their collective amount; but the writer believes the recorded changes are only such as may be discovered in any well into which water as strongly mineralized as this issues, were it subjected to a similar chemical scrutiny over an equally long period of time.

From a medical stand-point, the most satisfactory outcome of these chemical observations is the proven

fact, that whenever changes were detected, they were mainly on the side of increase rather than decrease; for out of 160 analyses, in 102 (or 64 per cent) the Chloride of Iron, the Carbonate of Iron, the total amounts of Iron, of Chlorine, and of solids exceeded the quantities recorded by Prof. Miller in 1865: while in only 58 (or 36 per cent) were they detected below them; and furthermore the average aggregate rise of all these constituents was *nearly double* that of the fall: and the average rise and fall of Iron—one of the most important ingredients—was in the proportion of 14 to 1, and the average increase of Protochloride of Iron exceeded the average decrease by 4 to 1. The observations which recorded maximal and minimal variations emphasize these conclusions still more.

The practical bearing of these facts on the therapeutics of the water is obvious; for they show that, at least the ferrugenous impregnation, and, especially that of chloride of iron, has not only kept faith to its early promise, but in the main has far exceeded it.

The chloride of iron water.

GRAINS IN 20 OZ.

		Protochloride of iron.	Protocarbonate of iron.	Total Iron.	Total Chlorine.	Total Contents.
Miller.						
1865	... ...	1·81	1·45	1.49	35·62	58·18
Davis.						
From 1865 to 1879	average Increase ...	1·21	·08	·42	6·03	7·76
	average Decrease ...	·34	·18	·03	4·14	4·14
Thorpe.						
1880	Increase ...	—	—	—		1 76
	Decrease ...	·15	·06	·09	1·31	—
1881	Increase ..	—	the	—		5·76
	Decrease ...	·07	same	·03		—

It may be noted that changes in the quantities of of constituents, however considerable in a large bulk of water,—*e.g.* a gallon—assume minimal proportions in the small average dose prescribed, *e.g.* four ounces. This fact is demonstrated by the following table.

Grains in 4 oz. (the average dose) of chloride of iron water.

	Protochloride of iron.	Protocarbonate of iron.	Total iron.	Total solids.
Miller's analysis.	·36 ($\frac{1}{3}$)	·29 ($\frac{3}{10}$)	·50 ($\frac{1}{2}$)	13·63
Davis' analysis.				
average { Increase	·24 ($\frac{1}{4}$)	·01 ($\frac{1}{100}$)	·08 ($\frac{1}{12}$)	1·55
average { Decrease	·06 ($\frac{1}{17}$)	·03 ($\frac{1}{33}$)	·006 ($\frac{1}{166}$)	·81
The highest recorded and lowest recorded { Increase ...	·50 ($\frac{1}{2}$)	·05 ($\frac{1}{20}$)	·22 ($\frac{1}{5}$)	2·3
The highest recorded and lowest recorded { Decrease ...	·14 ($\frac{1}{7}$)	·09 ($\frac{1}{11}$)	·08 ($\frac{1}{12}$)	1·35
Thorpe's analysis.				
1880 { Increase	—	—	—	·35
1880 { Decrease	·03 ($\frac{1}{33}$)	·01 ($\frac{1}{100}$)	·01 ($\frac{1}{100}$)	—
1881 { Increase	—	the	—	1·15
1881 { Decrease	·01 ($\frac{1}{100}$)	same	·006 ($\frac{1}{170}$)	—

It is sometimes asserted that the consumption of the waters created by the season and an increase of the local rain-fall diminish the mineralization. But the following data* show a remarkable constancy in the impregnation of the Old Sulphur spring and the Chloride of Iron spa throughout the whole year, and the slight variations recorded appear to be independent either of the season or rain-fall.

* *Monthly Analytical Examination of the Harrogate Spas*, 1872. By R. Hayton Davis, F.C.S., Jour. Chemical Soc.; Nov., 1873.

Old Sulphur Well.

	Temp. in Well.	Specific Gravity.	Grains per Imp. Gallon. Sulphur.	Chlorine.	Total Residue.	Rainfall each month in In:
1872.						
January 31 .		1011·14	6·248	613·49	1029·28	4·50
February 29 .	46°	1011·37	6·344	616·93	1044·25	3·15
March 30 . .	46°	1011·23	6·052	615·62	1042·01	2·31
April 30 . .	47°	1010·34	6·540	614·45	1049·69	3·51
May 31 . . .	48°	1010·83	6·532	603·91	1034·20	1·64
June 29 . .	50°	1011·95	6·592	616·22	1028·43	4·70
July 31 . . .	52°	1011·11	6·300	617·46	1056·26	5·90
August 31 .	52°	1010·84	6·496	612·46	1047·87	4·48
September 30	52°	1010·80	6·800	610·22	1041·14	5·18
October 31 .	50°	1011·42	6 304	619·62	1058·13	5·10
November 30.	48°	1011·46	6·352	621·71	1067·10	5·23
December 31.	47°	1011·47	6·392	625·32	1060·43	4·18
Average . .	48·9	1011·16	6·412	615·62	1046·56	49·88 Total*
1854.						
Hofmann . .	48·2	1011·13	6·348	650·38	1095·51	
1867.						
Muspratt . .			6·732	655·27	1108·78	
1875.						
Thorpe . . .	48·2	1011·04	6·532	613·77	1047·01	
1881.						
Davis . . .		1011·40	6·460	627·57	1048·25	

* This was a remarkably rainy year not only in Harrogate but elsewhere, *e.g.* the rainfall of England was more than one-third in excess of the average of previous years.—*Symonds's British Rainfall*, 1872.

Chloride of Iron Spa.

	Specific gravity.	$FeCl_2$*	FeO, CO_2.	Chlorine.	Total residue.
		Grains in imp. gallon.			
1872.					
January	1006·26	34·50	11·84	334·29	523 89
February	1006 47	33·77	11·12	340·19	517·89
March	1006·27	30·10	10·07	335·20	550·80
April	1006·17	28 97	11·33	339 89	557·09
May	1006·32	30·49	11·49	345·54	556·39
June	1006 33	29·88	11·17	346·69	555·43
July	1006·28	30·67	11·82	342 33	549·84
August	1006 12	26·97	9·73	339·68	540 96
September	1006 04	26·36	10·70	335·06	544·16
October...	1006·31	32·27	10·32	334·40	532 04
November	1006·43	31·29	10·92	333·54	534·75
December	1006 25	31·62	10·07	329 53	528·45
Average	1006·27	30·57	10·88	338 02	540·97
1865.					
W. A. Miller	1005·09	14·49	11·62	283·25	465·47
1866.					
Muspratt	—	16·01	10·84	311·68	465.05

* During the year 1872 the Chloride of Iron appeared in remarkably large quantity.

CHAPTER I.

A SKETCH OF THE CHEMICAL CONSTITUTION OF THE HARROGATE WATERS.

The Variety of Waters.

Harrogate is as remarkable for the variety as for the number of its mineral springs; a variety, however, which embraces both the different shades and degrees of any one group of similar waters, as well as several distinct kinds which, as a rule, are only to be met with elsewhere scattered in different localities widely apart. A reputation of over 250 years for Sulphur waters has so associated them with Harrogate in the public and professional mind, that whenever mentioned, the name of the place instinctively calls up the not altogether pleasant conception of "Stinking Wells." It is true these are a rich posession; but it is only to outsiders they appear to completely outvie and overshadow the other medicinal springs. Those engaged, however, in the daily use of the Harrogate waters find the large and important classes of mineral waters outside the sulphur group quite as useful as the latter in the special curative

work allotted to them—work which Sulphur waters alone cannot be made to compass.

The good name of Harrogate should therefore rest not merely on the Sulphur waters which are found there in all varieties—some even unique—but besides, and to at least an equal degree, on many other medicinal springs: and of the latter, it should be noted, some are so remarkable that merely one of them, such as either the Kissengen or the Chloride of Iron water would suffice to establish the reputation of a watering-place.

Classification.

The waters may be broadly divided into such as contain an alkaline sulphide or a proto-salt of iron.

The Sulphur and the Iron groups may each be split into two others; *the first* is characterised by the union of the alkaline sulphide or the proto-salt of iron with a body of saline matter, less or more considerable, and possessing a chemical constitution similar throughout; hence the *Saline sulphur* and the *Saline-chalybeate waters*, which are furthermore divisible into the "strong" and "mild" according to the concentration of the salines; *the second* sub-group is constituted by the sulphide, or the iron-salt being

associated with other salts in comparatively small or in minimal proportions, such as below 20 grains in 20 oz.:—hence arise the *Pure sulphur* and the *Pure chalybeate waters.*

There is, however, one water—the albuminous chalybeate in the Bogs Field—which does not conform to these general statements; it contains a per- as well as a proto-salt of iron, and its other constituents differ from those present in the other waters.

All the numerous and varied medicinal springs of the Harrogate district may be conveniently gathered into the following groups and classes.

GROUP I. Sulphur Waters.

Class 1. *Pure Sulphur Waters.*
(Total solids *not more* than 20 grs. 20 oz.)
Starbeck Sulphur Wells.
Bilton Sulphur Spring.
Harlow Car Sulphur Wells.

Class 2. *Saline Sulphur Waters.*
(Total solids from 30 to 130 grs.)
(*a*) *Strong.* (Total solids *not less* than 120-30 grs.)

The Old Sulphur Spring (Royal Pump Room).

Strong Montpellier Sulphur Well.

(*b*) *Mild.* (Total solids *not less* than 35 grs.)

Mild Sulphur Well (Royal Pump Room).

Mild Montpellier Sulphur Well.

Magnesia Well (the Bog Field and Royal Pump Room).

GROUP II. Iron Waters.

Class 1. *Pure Chalybeates.*

(Total solids *not more* than 5 grs.)

Tewit Spring. (The Stray).

John's Spring. (The Stray).

The Harrogate Pure Chalybeate (Royal Pump Room).

The Carbonate of Iron Well (Cheltenham Rooms).

Class 2. *Saline Chalybeate Waters.*

(Total solids from 27 to 109 grs.)

(*a*) *Strong* (Total solids *not less* than 58 grs.)

Kissingen Well (Montpellier Gardens).

Chloride of Iron Well (Cheltenham Rooms).

(*b*) *Mild.* (Total solids *not less* than 27 grs.)
Alexandra Well (Royal Pump Room).

CLASS 3. *Sulphated Chalybeate.*
(Total solids nearly 50 grs.)
The Alum Well (the Bog Field).

SALINE CONSTITUENTS.

The constituents common to both the saline-sulphur and the saline-iron waters may now be conveniently considered before the members constituting these groups are reviewed. In the several springs the saline matter ranges in concentration from 19 to 131 grains, and possesses a similar constitution in all:—namely chlorine combinations with a small proportion of carbonates. These waters must therefore be classed with the Chloride or Salt springs, with which *only* should they be compared for either purely chemical or therapeutic purposes.

The annexed table sets forth the constitution of the saline basis of the principal Harrogate springs, and of the best representatives of Chloride waters elsewhere; and it will enable the reader to readily recognize the following distinguished features of the former.

The Saline Constituents of the Principal Harrogate Waters, and of the best known Salt Springs—grs. per 20 ozs.

	Chlorine Combinations						Sulphates	Carbonates	Calcium Salts in Total Salines 100.	Calcium Salts	Salts of Ba and Sr
	Chlorides to 100 Total Solids	+ Na	+ K	+ Mg	+ Ca	Total Chlorides					
Old Sulphur Well	94	111	1	6	5	123	0	4½	7	9	¾ Ba
Strong S. (Montp.)	97	103	½	8	10	121	‡	1	9½	11	½ Sr and Ba
Kissengen		84	2½	8	11	105½	‡	2½	12	12	⅜ Ba and Sr
Mild S. (Roy. P. Room)	91	72	1½	2½	3½	78⅓	0	4½	7	6	⅓ Ba
Mild S. (Montp.)	93½	48	½	4	4	56½	‡	2	11	6	⅓ Sr
Chloride of Iron	93	34½	½	7	12	54	0	1½†	20	12	⅛ Ba
Magnesia	88	27	3	⅓	0	30	0	4	6½	2	⅛ Ba
Alexandria	84	20	¼	⅓	2½	23⅓	1	3	9½	2½	trace Ba
Woodhall—Lincs	99·5	152	0	11	13	176	0	0	8	13	0
Kreuznach (Lowig)	97⅓	91	¾	5	17	114½	‡	2	16	15	$\frac{1}{100}$ Ba
Hall‖	94⅓	116	0	2	3¾	121¾	‡	0	3	3¾	0
Wiesbaden (Fresenius)	93½	65	1⅔	2	4½	73	‡	4	11	9	0
Soden‖	90	117	0	0	0	117	‡	12½	12½	11½	0
Nauheim—Kurbrunnen‖	90	137	5	2½	10	154½	‡	14	9	15	0
Homburg (Leibig) Elizabeth	87	99	0	9½	9½	118	‡	18	18½	23	0
Homburg (Leibig) Ludwigsbrunnen	90	105½	2½	7½	12	127½	‡	12½	21	24½	0
Kissengen (Leibig) Ragoczy	75	56½	2½	3	0	61⅓	9⅓	10	20½	14	0
Kissengen (Leibig) Pandur	76	52		2	0	57	5⅔		21½	15½	0
Saratoga New-York—Gyser Spring (Walton)	70	70	3	0	0	73	0	32	14	14½	½ Ba and Sr

* Chloride of Iron. † Carbonate of Iron. ‡ Less than ½ gr. § 73 + 11⅓ Am. Cl. ‖ Quoted by Braun.

1. *The Chlorine Combinations.*

Chlorine is combined with the alkaline metals (Sodium and Potassium), the alkaline earthy metals (Barium, Strontium and Calcium), and Magnesium. These chlorides form a larger proportion of the total salines than is found in other muriated waters, except the Woodhall saline.

Chloride of Sodium, as in other salt springs, forms the bulk of the saline residue; but it is associated with the Chlorides of Potassium, Calcium, Magnesium, Barium, and Strontium, in richer proportion than in allied waters.

In *Magnesium Chloride* the Old Sulphur Well, the Montpellier Strong Sulphur and the Kissengen, equal Homburg (Ludwigsbrunnen), and excel by far Kissengen (Ragoczy and Paudur), Wiesbaden and others.

Calcium Chloride is the salt in which lime mainly exists in these waters rather than as Carbonate or Sulphate; and it occurs more largely in the Chloride of Iron, the Kissengen and the Montpellier sulphurs than in the Continental Spas.

2. *Carbonates.*

While most of the springs are alkaline not one is sufficiently so to entitle it to be classed with waters remarkable for alkalinity.

The *Carbonates of the Alkalies* (soda and potash) are present only in the pure sulphur waters outside Harrogate, viz., at Harlow-Car, Beckwith, Bilton and Starbeck.* Their absence from all the saline waters in Harrogate is probably ascribable to a charge of calcium and magnesium chlorides, which are well known to convert alkaline into earthy carbonates (carbonates of lime and magnesia)—chlorides which, however, cannot be detected in the pure alkaline sulphur waters.

In 1870 the late Dr. Muspratt asserted the presence in the Alexandra Water (Bogs Field) of over 2 grains of sodium carbonate as well as 3 grains of the incompatible chlorides of calcium and magnesium in 20 oz.: this chemical incongruity, as well as the fact that no chemist has subsequently succeeded in detecting the presence of a carbonate of an alkali in this water, cast a suspicion on Dr. Muspratt's

* They are, however, reported by Mr. Davis and Mr. Fairley as constituents of the Old Crescent Well, or Leamington Spa in Low Harrogate.

analysis, or rather on the interpretation of results which it represents; hence the writer rejects it.

The absence of alkaline carbonates from the Harrogate salines is not an exceptional fact in the chemical history of mineral waters; for analysts have failed to detect them in all other springs well charged with chlorine salts: for instance in those of

Kissengen.
Homburg.
Kreutznach.
Nauheim.
Wiesbaden.
Pyrmont.
Woodhall.
Cheltenham.
Leamington, etc.

On the other hand waters notable for alkalinity are poor in chlorides: *e.g.*

	Carb. Sod. grs. in 20 ozs.	Chlorides.	
Vals (Magdelene)	63·7	·14	Ossian Henry.
Vichy (Celestine)	44·6	·46	Bouquet.
Fachingen	35 0	5·60	Fresenius.
Bilin	28·7	3·60	Reatenbach.
Ems	19·7	9·60	Fresenius.

The *Carbonates of Lime and Magnesia* are found in much smaller proportions in these saline waters than in other muriated springs. (See p. 66).

The Barium and Strontium combinations with chlorine and carbonic acid are so important from a therapeutic standpoint as to demand separate notice.

3. *Barium and Strontium Salts.*

Barium chloride was discovered in 1865 by the late Prof. Miller in the Chloride of Iron water:—not, however, as is usual when recorded in mineral waters, as a mere trace, but in the large proportion of $\frac{4}{5}$ of a grain in 20 ozs.; and in 1866 Mr. R. Hayton Davis, F.C.S., estimated Barium salts in the

Kissengen.
Old Sulphur Spring.
Strong Montpellier Sulphur.
Mild Montpellier Sulphur.
Magnesia Water.

And, moreover, this observer, was the first to gravimetrically determine the salts of Strontium in these waters.*

The Barium and Strontium impregnations of these

* *The Chemical News*, 1866.

springs have since been confirmed by Muspratt in 1867 (Old Sulphur Spring, Kissengen, and Magnesia Water), Thorpe in 1875 (Old Sulphur Spring) and in 1881 (Chloride of Iron water) and Attfield in 1879 (the Montpellier Sulphur and Kissengen Wells), and furthermore, these salts have been determined in the Royal Pump-room Mild Sulphur by Muspratt and Miller. The presence of large proportions of Barium and Strontium salts in these by far the most important of the Harrogate waters during the past 15 years has therefore been attested by several competent analysts, and precludes the possibility of doubt.

The latest and most trustworthy analyst of the Old Sulphur Spring—Prof. Thorpe—thus refers to the Barium salt which he estimated in 1875. "The amount of barium salt in the water is unusually large, and appears to be increasing. So far as is known, no mineral springs in this country or on the Continent contain so large a proportion of this substance as the Harrogate waters. The quantity indeed in the Old Sulphur Well is as large as the entire amount of soluble matter contained in many of the waters used for domestic supply in our towns. So potent an agent present in such large proportion must undoubtedly exercise considerable influence on

the therapeutic action of the water; and therefore it is highly desirable that the determination of its amount should be repeated from time to time."*

The latest Estimations of Barium and Strontium Salts in the Harrogate Waters: gr. in 20 oz.

	Barium Salts.	Strontium Salts.	Analyst.
The Old Sulphur Spring	·820	—	Thorpe 1875.
	·770	—	Davis 1879.
	·845	—	Davis 1881.
Chloride of Iron	·811	—	Miller 1865.
	·794	—	Davis 1879.
	·676	—	Thorpe 1881.
Kissengen	·331	·111	Attfield 1879.
Magnesia...	·153	—	Muspratt 1867.
Mild Sulphur (Royal Pump Room)	·098	—	Miller 1869
Strong Montpellier S.	—	·418	Attfield 1879.
Mild Montpellier S.	·052	·191	Attfield 1879.

It would appear from these analytical results that Barium is more abundant than Strontium in the Harrogate waters; while in other medicinal springs in which these constituents appear the former is the more uncommon. The Old Sulphur Spring, (the strongest Sulphur water) and the Chloride of Iron (the strongest Iron water) contain larger proportions of Barium than have been estimated elsewhere—exceeding the largest recorded charge by 4 to 1; and the Montpellier Strong Sulphur is the richest strontium water by nearly 2 to 1.

* *Philosoph. Mag. July*, 1876.

Barium and Strontium in Mineral Waters: grs. in 20 *oz.*

	Barium Salts.	Strontium Salts.	Analyst.
Harrogate Waters from	·052	·111	
to	·845	·418	
Saratoga (Congress Springs)			
Geyser } the }	·206	·041 }	Walton.
Hathorn } strongest }	·178	trace }	
Luhatschowitz Vincenbrunnen ...	·087	·116 }	Fersth.
,, Luisenguelle ...	·075	·150 }	
Kreuznach, Elizenquelle	·012		Lowig.
Weilbach...	·010	·001	Fresenius.
Hunyadi Janos	—	·235	Bunsen.
Franzensbad, Weisenquelle... ...	—	·061	Berzelius.
Carlsbad, Malktbrunnen	—	·047	Wolf.
Leuk...	—	·039	Brunner.
Toplitz	—	·034	Wolf.
Marienbad, Kreuzbrunnen	—	·021	Kersten.

Others (*e.g.*, Fachingen, Aix-la-Chapelle, Ems, Baden Baden, Seidlitz, Vichy, Birresborne) contain still smaller proportions of Barium and Strontium salts.

The chemical reason why the soluble salts of Barium and Strontium are permitted to appear so largely in some of the Harrogate waters is not far to seek; it is furnished by the absence of soluble sulphates which characterizes these springs. From the well known paramount affinity of Barium and Strontium for sulphuric acid and the insolubility of the sulphates thus formed,* it follows, in order to obtain in

* Sulphate of Barium is, however, *sparingly* soluble, and the Strontium Sulphate is somewhat more soluble in saline solutions: hence small quantities of these salts have been detected in some of these waters.

natural solution a pronounced proportion of Barium or Strontium, soluble sulphates must be absent, or laid by precipitation by some excess of the soluble salts of Barium or Strontium long before the water issues from the earth; but inasmuch as soluble sulphates are found generally in medicinal springs the rarity of waters highly charged with Barium and Strontium is apparent.

4. *Salts of Lime.*

These are recorded by analysts as Calcium Chloride and carbonate:—the former in much larger proportion than the latter; while in other muriated waters the reverse obtains.

When objections are raised as to the presence of Lime in medicinal springs, they should apply more particularly to the Sulphate and Carbonate than to the Chloride; of the former, the Sulphate is a comparatively rare constituent of the Harrogate waters, and, when detected, it is found in little more than traces (see sulphates): and the Carbonate appears in much smaller quantities than in most other salt springs. And, moreover, the total charges of lime salts in the waters containing effective doses of aperient salts (the Old Sulphur Spring, the Mont-

pellier Strong Sulphur and the Kissengen waters) are smaller than those recorded by analysts in the salt springs of Kreuznach, Nauheim, Kissengen, Homburg and Saratoga. The checking influence which they are apt to exert on the aperient quality of a water is, however, more correctly expressed by the *percentage* of them in the total salines; and this view of the matter brings out still more clearly the same conclusion, *e.g.*, the average charge of Lime in the aperient Harrogate waters is only 9 per cent. while it is at least 21 in the Kissengen springs (Ragoczy and Pandur).

The assertion as to the Harrogate aperient waters containing more lime than those of Kissengen* or other continental springs is therefore without foundation. Furthermore, of all chloride waters, the Magnesia water contains the least amount of Lime, and in this particular the Mild Sulphur (Royal Pump Room) and the Montpellier Mild Sulphur waters are only excelled by Hall—a water remarkably free from earthy salts.

On the other hand the Chloride of Iron well is richly charged with Calcium Chloride, and the Montpellier waters contain more of this salt than the other Harrogate waters.

* See p. 217 *The Curative Effects of Baths and Wells*, by Dr. Braun, Lond. 1875.

5. *Sulphates.*

The Harrogate waters like other chloride springs* are either Sulphate-free (as the Old Sulphate Spring, the Mild Sulphur—Royal Pump Room—the Chloride of Iron, and the Magnesia water) or contain but mere traces of Sulphates. The absence of indigestible and constipating Sulphates—particularly Calcium Sulphate—is a fortunate chemical fact in the constitution of these salines. "A glance at the amount of sulphate of lime contained in the usual mineral waters will show that it is just those which contain little or no sulphate of lime that are drunk most frequently and in larger quantities, and that in proportion with the increasing amount of gypsum in the others in the doubtful character of their reputation."† Nearly all the saline springs of this country well charged with chlorine salts—save Woodhall Spa—contain a large proportion of Sulphates, *e.g.*, these salts constitute about one-half the total contents of the Cheltenham and Leamington waters, which are therefore chemically allied to the Bitter waters rather than to the Muriated, or they may be classed as occupying an intermediate position between purely Sulphated and Chlorided springs.

* Kissengen springs and Pyrmont are, however, notable exceptions.

† *Curative Effects of Baths and Waters*, by Dr. Braun, p. 426.

CHAPTER II.

THE SULPHUR WATERS.

The Constituents Compared with those of other Sulphur Waters.

The constitution of all the Harrogate Sulphur waters, and the relation it bears to that of other similar springs will be illustrated best by reviewing, in the first place, the chemical agents from which they derive their sulphuretted properties, and then, the constituents associated therewith.

1. *Sulphides.*

The form in which Sulphur is presented in these waters is a matter of much chemical and therapeutical interest. In the majority of sulphur waters it is recorded by analysts combined with hydrogen as sulphuretted hydrogen gas (H_2S) but in every member of the Harrogate sulphur group this combination, though undoubtedly present, represents

but a portion, and, that generally, a small portion of the total sulphur charge, and is subsidiary to—possibly derived from—an alkaline sulphide. In 1843 Dr. Bennett* states there is no free sulphuretted hydrogen present in these springs, but that sulphur exists in combination with calcium and sodium. This position has, however, been somewhat shaken by later analysts (*e.g.*, Prof. Hofmann in 1853 and Prof. Muspratt in 1867) who record the sulphur combinations as free sulphide gas in small proportion, and an alkaline (sodium) sulphide representing the bulk of total sulphur.

Prof. Thorpe, who in 1875 analysed the most important of these springs—the Old Sulphur—says† "It would seem to be certain from the above determinations that it (sulphur) exists entirely as a sulphide, either as hydrogen or alkaline sulphide, or more probably in both forms" and further "it is quite certain that a portion of the sulphur in the water exists as free sulphuretted hydrogen;" and this analyst distributes the sulphur nearly equally between an alkaline sulphide salt (sulph-hydrate of

* *Treatise on the Sulphurous Springs of Harrogate*, 1843.

† *A Contribution to the History of the Old Sulphur Well, Harrogate* by T. E. Thorpe, Ph.D., F.R.S., Professor of Chemistry in the Yorkshire College of Science, Leeds, *Philosoph. Magaz., July*, 1876.

sodium—NaHS) and the free gas (H_2S). From this consensus of analytical results the presence in these waters of an alkaline sulphide embodying a considerable portion of the sulphur, besides that of free sulphuretted hydrogen may be safely inferred.

The therapeutic advantages of sulphur waters—such as those of Harrogate—charged mainly with sulphide Salt rather than Gas are obvious; for while the latter is apt to be quickly dissipated by exposing the water,* and to be dispelled by eructation, the former meeting the acids of the system, evolves sulphuretted hydrogen throughout the body—the water containing it becoming actually stronger in gaseous sulphide after imbitition and absorption.

* Hence Fardel thus speaks of the waters of Aix-les-Bains: "Fontan remarks that the waters of Aix are slightly sulphuretted. It would be, perhaps, more correct to say that they very quickly lose their sulphur principle. They also deposit much sulphur and a quantity of sulphuric acid, which proceeds to organise itself in forming sulphates upon the walls, the iron-works, the timber it encounters, reddening the material." *Traité Therapeutique des eaux minérales de France et de l'etranger, par Durand-Fardel*, 1857.

Indeed those waters containing merely sulphuretted hydrogen, freely emitting the characteristic odour of this gas, may be readily regarded by the casual observer as stronger sulphur waters than those sulphided purely by a sulphide-salt containing much more sulphur available as a remedy: apart from any difference in the original impregnation with the respective sulphides, this erroneous impression arises from the gaseous form rapidly leaving the water while the saline sulphide remains in solution.

The silica and carbonic acid with which the Harrogate are better endowed than other sulphur waters, will determine the conversion of a small portion of sodium sulphide (Na_2S) or sulph-hydrate (NaHS) into sulphuretted hydrogen, and may thereby account for the modicum of free sulphide gas recorded by Hofmann and subsequent analysts; according to the formulæ:

$$Na_2S + H_2O + CO_2 \text{ or } SiO_2 = NaCO_3 \text{ or } NaSiO_3 + H_2S$$

$$2\,(NaHS) + 2\,(H_2O) + 2\,(Co_2 \text{ or } SiO_2) = 2\,(NaCO_3 \text{ or } NaSiO_3) + 2H_2S$$

The principal sulphur waters reported by analysts to be sulphided mainly or entirely by an alkaline sulphide are recorded in the following table, in which it may be noted the charge of this salt in the strongest Harrogate sulphur waters is only excelled by that of Challes; and, as a class, with this sole exception they contain more sodium sulphide than has been discovered in other sulphur waters.

		Parts of Alkaline Sulphide in 10,000 Parts of Water.
The strongest Harrogate Sulphur Waters.	Strong Sulphur (Montpellier)	2·07
	Old Sulphur Well	1·18
	Mild Sulphur (Montpellier)	1·25
	Mild Sulphur (Roy. Pump R.)	·98
	Challes (latest analysis, Willin)	3·59
	Mehadia (latest analysis, Schneider and Kottsdorfer)	1·07
	Luchon	·77
	Marlioz	·67
	Le Vernet	·59
	Massena	·56
	La Bassère	·46
	Cauterets	·30
	Strathpeffer	·26
	Barèges	·22
	Eaux Bonnes and St. Sauveur	·21
	Amélie	·12

According to published analyses, nearly all other sulphur waters are sulphided entirely, or almost so, by free sulphuretted hydrogen gas.

In determining the charge of sulphur for purposes of comparison some standard must be adopted :— either the total sulphur contained in the sulphide combination calculated and represented as such, or in cubic inches of sulphuretted hydrogen ; the writer prefers the total sulphur standard. It is, however, difficult if not impossible to gauge accurately gradations of the actual sulphide strength of different springs, for in nearly all it depends largely on the hydrogen sulphide—a gas which is subject to great variations in quantity, determined by temperature,

atmospheric pressure and other causes ; comparisons within limited ranges cannot, therefore, be reliably made, and fine distinctions should not be attempted. And furthermore, "as Harrogate is almost the only place that has of late years had its sulphur waters completely analysed, it is very difficult to compare the quantity of its sulphuretted hydrogen with that of other places, the waters of which have been examined less carefully."†

The reader will derive a clear notion of the positions occupied by the several Harrogate Sulphur Waters, as to the proportions of sulphur—contained in the sulphides—and of total contents, among other best known sulphur springs, by perusing the following tables, framed after those of Dr. Macpherson—in which the calculations of the amount of sulphur present were taken from Lersch's Hydro-chemie.‡ The author's additions are marked by an asterisk, and the Harrogate Waters are in brackets.

Cold Sulphur Waters.

	Parts in 10,000.	
	Sulphur.	Total Content
*Challes (Willin, see Compt. Rend., v. 86)	2·100	12·1
*Challes (Corrigon)	1·970	10·2
[Old Sulphur Well	·923	148·0]
[Strong Montpellier S.	·824	143·2]

† *Our Baths and Wells*, by J. Macpherson, M.D., 1871, p. 121.

‡ *Baths and Wells of Europe*, 1873, p. 150.

	Parts in 10,000. Sulphur.	Total Contents.
*Strathpeffer (Thomson)	·206 to ·668	16 to 59
*Eilsen	·578	27·1
[Mild Sulphur (Royal Pump Room)	·615	97·2]
[Mild Montpellier S.	·514	69·3]
Enghien	·435	30·7
*Askern (Lankester)	·420	25·5
Nenndorf	·326	27·6
*Marlioz (Bonjeau)	·275	4·2
*Massena, America (Mayer)	·259	19·8
La Bassère	·203	4·8
Langenbrucken	·064 to ·28	13·0
*Lisdoovarna, Ireland (Apjohn)	·214	3·7
[Harlow Car	·168	5·9]
[Beckwith (R. H. Davis)	·157	4·7]
Uriage	·150	141·0
*Croft New Well (Canney)	·130	3·7
*Guagno (Poggiale)	·098	2·6
[Magnesia Well	·094	40·0]
[Bilton (R. H. Davis)	·080	14·4]
[Starbeck	·080	21·6]
Weilbach	·071	11·6
*Moffat (Johnstone, see *Chem. News*, vol. 31)	·026	15·0
Gurnigel	·015	19·3
Cambo	·012	32·4

All the *warm* sulphur waters are feebly sulphided except Schinznach ; this is, however, rivalled by the Old Sulphur Spring, which is "perhaps the strongest sulphur well in Europe, at least, of those whose constitution is well ascertained. It is as strong as the strongest well at Schinznach."† Hence it is sufficient to contrast the sulphide charge of merely the *milder* sulphur waters in and around Harrogate with that of *warm* sulphur springs.

† *Our Baths and Wells, op. cit.*

Thermal Sulphur Waters.

1. *Containing less Sulphur than the Magnesia Water.*

	Parts in 10,000. Sulphur.	Total Contents.
La Preste	·054	1·3
Eaux Chaudes	·048	3·0
Aix-la-Chapelle	·039	41·0
*Aix-les-Bains (Willin)†	·071	4·8
Burtscheid	·007	38·0
*Molitz (Bouis) and Bagnols (Henry)	below ·006	1·5 to 6·1

2. *Sulphur less than in Harlow Car Springs.*

*Amélie (Anglanda)	·165	3·0
Olette	·124	4·3
*Saint Gervais (Bourne and Grange)	·102	50·4
Saint Sauveur	·097	2·5
Eaux Bonnes	·096	6·0

3. *Less Sulphur than in Mild Sulphur (Royal Pump Room).*

*Mehadia (Schneider and Kottsdorfer)‡	·57 to ·63	61·1 to 71·9
Acqui	·299	63·0
Luchon	·230	2·5
*Labassère (Filhol)	·188	4·8
Vernet	·177	2·7
Barèges	·176	2·1
Stachelberg	·141	5·3
Abano	·078 to ·154	65·9
Cauterets	·135	1·8

The sulphide strength of the Old Sulphur Well has been frequently misstated by writers on mineral waters: the modicum of sulphur represented by the free sulphuretted hydrogen having been recorded

† See *Compt. Rend.*, vol. 86.

‡ See *Wiln. Akad. Ber.*, 64.

without reference to the larger portion allied to sodium, and thus held in solution by the water; doubtless an accidental omission, but, nevertheless, apt to impair the reputation of the spring, and to permit the pretensions of less valuable sulphur waters to flourish on what appears to be the whole truth.

Inasmuch as it has been asserted, for example, that the Strathpeffer water surpasses the strongest Harrogate spring in the sulphur element—leaving it open for any one to infer it is more strongly sulphided—a passing notice must be given to the grounds on which this allegation is based. They are set forth in the following passages. "Being sulphurous they belong to the same class as the sulphur waters of Harrogate, Moffat and Aix-la-Chapelle. The sulphur element however, in one or other state, enters more largely into them than into any of these. It exists in combination with hydrogen, forming sulphuretted hydrogen gas, and as an element in several sulphate salts, forming the sulphates of magnesia, lime, and soda, and as a sulphuret in combination with potassium, sodium, and iron, and by itself in a state of suspension. There exist altogether in the water of the Strong or New Well, the sulphates being taken into account, a little over thirty grains of sulphur to the

imperial gallon. In the strongest sulphur water of Harrogate, the quantity of sulphur is some eight grains to a gallon; while in the Moffat water it is little more than two thirds of a grain; the sulphur in the two last being in combination with hydrogen and sodium only, forming sulphuretted hydrogen gas and sulphuret of sodium. . . . . With regard to the quantities of sulphuretted hydrogen gas, it will be seen by reference to the analysis, that while the strongest Harrogate water contains 5·31 cubic inches to the gallon, and the Moffat a little over a third of a cubic inch, the Strathpeffer New Well contains 11·26 cubic inches, which is the largest quantity of sulphuretted hydrogen in any known spring in Great Britain. Aix-la Chapelle has the gas represented by only 0·73 grains of sulphuret of sodium to the gallon." *

It is scarcely necessary to remark, that in estimating the sulphur strength of sulphuretted springs the invariable rule is to take the *sulphides only* into account; the position of the Strathpeffer water must therefore be determined apart from sulphates † and

* *On the Sulphur Waters of Strathpeffer.* By D. Manson, M.A., M.D., 1879.

† It may be said that sulphides may be generated within the body after imbibition of waters containing sulphates, and it may be argued, therefore, these salts should be included—being possible

free suspended sulphur.* Its sulphide charge is, however, large, and places the water high in the scale of similar springs; but it only slightly exceeds that of the mild saline sulphur waters of Harrogate, and is about one-third less than that of

sources of sulphides—with the ordinarily recognized sulphide charge of sulphur waters. The same line of reasoning may lead to the classing of Hunyadi Janos, Friederichshall and other strongly sulphated waters, with sulphur waters. But it is extremely doubtful if sulphates taken into the system are generators of sulphides as therapeutically available as those actually present in sulphur waters. The deoxidation of sulphates is not effected in the *blood;* hence the remark of Braun: "The formation of this gas (SH_2) by sulphates in the *blood* has never been observed, and it is also highly improbable," and if it be asserted the presence of decomposing organic matter in the *alimentary canal* may enable sulphuretted hydrogen to be liberated from sulphates, this fact may be accepted as true; but the gas thus generated cannot be therapeutically of any value, inasmuch as it is only found in the large intestine, where feculent matters are apt to lodge or move on very slowly, and absorption is very limited compared with that of the stomach and small intestines and expulsion a greater probability: or as Braun says, "but in the *intestinal canal*, where sulphates very frequently develop sulphuretted hydrogen, this gas is rarely absorbed, but it passes away with other gases of the intestines." Hence authorities are justly agreed in accepting sulphides as the only reliable source whence sulphur waters derive their chemical and therapeutical properties.

* The sprinkling of *free* sulphur in the Strathpeffer waters is not likely to share the physiological and therapeutic effects of sulphides: for crude sulphur and sulphides appear to possess the properties of two distinct remedies (see p. 150).

the Old Sulphur Well. According to published analyses the sulphides of the Strathpeffer and the Old Sulphur stand thus :—

	Strathpeffer.	Old Sulphur. Well.
Alkaline Sulphide, gr. . .	·228	·908
Hydrogen Sulphide, cu. in. . .	1·407	1·270

That is, the sulphide gas is nearly equal in both, and the sulphide salt in the Old Sulphur Well is nearly fourfold that in the Strathpeffer Strong Sulphur.

2. *Saline constituents.*

A prominent chemical feature of the Harrogate sulphur waters is at once recognized by any one glancing over the analyses, namely, the presence in the majority of them of a considerable body of saline matter. This fact has coloured the reputation of the whole group, and inclined medical writers to treat all the Harrogate sulphur waters as salt springs.* All degrees of saline concentration are, however, represented, from that of the strongest sulphur saline known to chemists, to the small charge of some of the purest sulphur springs.

The general survey of the leading chemical features of the saline constitution of the Harrogate waters already given, must now be compared with

* See the *Baths and Wells of Europe* (Dr. Macpherson): *The Curative Effects of Baths and Wells* (Dr. Braun).

that of other sulphuretted springs. The principal distinguishing points relate to—(*a.*) Chlorine combinations; (*b.*) Sulphates; (*c.*) Barium and Strontium; (*d.*) Alkaline salts; (*e.*) Iodine and Bromine.

(*a.*) Chlorides.

The following table shows the Harrogate sulphur group to be more richly endowed—both relatively to other saline constituents and absolutely—with Chlorine salts than any other sulphur waters: the strongest members containing beyond twice the largest charge elsewhere—Uriage; and, moreover, the Harrogate series presents several gradations of chloride impregnation. The practical value of this combination of Chlorides with Sulphides rests on the similarity of the curative properties of both—their union enforcing the power of each.

Chlorine Combinations in Sulphur Waters.

	Chlorides. grs. in 20 ozs.	Proportion of Chlorides to 100 Parts Total Solids.	
[Old Sulphur Spring	123	94]	
[Strong Montpellier S.	121		
[Mild Sulphur (Royal Pump Room)	78½	91]	
[Mild Montpellier S.	56½	93½	
[Magnesia	30	88]	Analysts.
Uriage	56½	58	Lefort.
Aix-la-Chapelle	25	64	Liebig.
Saint Gervais (S. de Torrent)	17	38	Bourne.
Moffatt	10	88	Macadam.
Schinznach	6	31	Grandeau.
Burtschied	27	70	quoted by
Mahadia	23	94	Braun.

The published analyses of other sulphur waters, as a rule, indicate the presence of less than 5 grains of Chlorides to the pint. The medical resources of Harrogate, however, afford the choice of sulphur waters, not merely more chlorided than others, but also such as contain Chlorides in the smallest proportions, such as those of Starbeck, Bilton, Harlow Car, and Beckwith.

(*b.*) Sulphates.

Sulphur waters are, as a rule, rich in Sulphates. Out of 29 of the best known Spas, according to the analysis of 22 these salts form more than one-fourth—and of several of these, even one-half and three-fourths—of the total contents; and six possess a minor yet moderate quantity of Sulphate—while there remains but one recorded as Sulphate-free—Harkang. The Harrogate sulphur springs in this respect contrast remarkably; three—the Old Sulphur spring, the Mild Sulphur (Royal Pump Room) and the Magnesia waters—are Sulphate-free, and the others contain merely Sulphate traces.

Sulphur waters are apt to contain the indigestible and constipating Sulphate of Lime in considerable quantity: *e.g.*

	grs. in 20 ozs.	
Uriage	$13\frac{1}{3}$	(Lefort.)
Baden (Swetz)	$13\frac{1}{2}$	(From data furnished by Braun.)
Eilsen	12	
Kreuth	$10\frac{1}{2}$	
Nenndorf	10	
Burtschied	$7\frac{1}{4}$	
Strathpeffer	$6\frac{1}{3}$	(Thomson.)

The absence of this salt from all the sulphur salines of Harrogate should be noted as a remarkable exception to the ordinary chemical constitution of other sulphur springs.

(*c.*) Barium and Strontium.

These rare constituents of medicinal springs, present in large proportion in several members of this group, are recorded in only a few sulphur waters elsewhere, and then in quantities scarcely exceeding traces. The Old Sulphur Well is the strongest known Barium water, and the Strong Montpellier Sulphur excels all other waters in Strontium.

(*d.*) Alkaline Salts.

Sulphur springs rarely contain more than mere traces, or feeble quantities, of Alkaline salts. The *highest* recorded charges are the following :—

Cold S. Springs.

	Sod. Carb. grs. in 20 ozs.	Analyst.
Uriage	4·8	Lefort.
Weilbach	3·8	Fresenius.
Challes.	1·5	Henry.
Guagno	1·1	Poggiale.

Warm S. Springs.

Aix-la-Chapelle . . .	6·0	Liebig.
Burtschied	6·0	Quoted by Braun.
Molitz	2·9	Bouis.
Bagnols	2·0	Henry.

These salts, as previously stated, do not appear in the strong Saline sulphur waters, but are found in the Pure sulphur springs to the east and to the west of Harrogate.

	Sod. Carb.
Beckwith	2·0
Harlow Car	1·9
Starbeck	1·8
Bilton	Abundant.

These issues excel in Alkaline Carbonates other cold sulphur springs—except those of Uriage and Weilbach; and these are weaker sulphur waters (see p. 83).

(*e.*) Iodine and Bromine

Have been discovered by Professor Thorpe in the Old Sulphur Well, and he records them as allied with magnesium. These elements, are rarely met

with in sulphur waters. The water of Challes is believed to contain them in larger proportions than other sulphur springs. The quantities estimated by Professor Thorpe in the Harrogate Sulphur exceeds, however, those of Challes by more than 2 to 1: and those of Marlioz—another celebrated Bromo-Iodized sulphur spring—by 12 to 1.

PARTS IN 10,000 OF WATER.

	Iodine and Bromine.	Iodine.	Bromine.
Old Sulphur Well (Thorpe) . . .	·2951	·0146	·2805
Challes (Willin)*	·1337	·1045	·0292
,, (Corrigon)	·1050	·0890	·0160
Aix-les-Bains (Ossian Henry) . .	·0006	·0004	·0002
Marlioz (Bonjean)	·0024	·0019	·0005

The Iodo-Bromide charge of the Old Sulphur Well vies even with that of Kreuznach.

Kreuznach (Potstorf)	·0820	·0035	·0785
,, (Lowig)	·3900	·0457	·3445

3. *Gases.*

Sulphur waters are, as a rule, singularly poor in gases, and in carbonic acid gas in particular; many of them do not contain the latter, *e.g.* the Pyren-

* Recent analyses, see *Compt. Rend.*, vol. 86.

ean Spas; compared with others the Harrogate sulphur waters are remarkably well charged with this and other gases; in this respect, they are only excelled by a few, such as Langenbrücken and Nenndorf.

The Montpellier Sulphurs (strong and mild) are better aërated than the rest.

The Saline Sulphur Waters.

All the sulphur waters in Low Harrogate and the Bogs Field are of this class; their sulphides and salines present all degrees of concentration.

The strong waters (the Old Sulphur Spring and the Strong Montpellier Sulphur) are the only sulphur waters known, at home or abroad, so richly charged with *both* sulphides and salts.

In the table, page 82, the reader will note the *sulphide* impregnation of these springs is only excelled by that of Challes, which is specially weak in salts; and the *saline* charge is only approached by that of Uriage, which, however, contains less than one-sixth of the sulphur charge of the Old Sulphur Well: and, moreover, one-seventh of the salinity of Uriage is due to sulphate of lime—a salt which is not present in the Harrogate Sulphur Spring, and which

is believed by all authorities to be an undesirable constituent of an evacuant mineral water.

The Pure Sulphur Waters.

The issues at Bilton, Starbeck, Harlow Car and Beckwith must be classed with other Pure sulphur springs: for, as in these, their sulphides are associated with only a small proportion of other constituents. They are all moderately well sulphided (see table p. 83), and, besides, contain alkaline carbonates in such quantity as to place them high among other Alkaline sulphur waters (see p. 92).

Analyses of the Sulphur Waters.

GRAINS IN 20 OZS.

	CHLORIDE OF			CARBONATE OF						CUBIC INCHES IN 20 OZS.
	Sodium.	Potassium.	Magnesium.	Calcium.	Calcium.	Magnesium.	Sodium Sulphide.	Silica.	Total Solids.	Gases.
OLD SULPHUR SPRING. Analyst, Thorpe, 1875.	111·708 Traces of	1·199 Calcium Aluminum	6·035 Fluoride and	5·451 Organic	3·721 Phosphate;	·748 Strontium	·652* Chloride,	—	130·945	CO_3 = 5·012 H_2S = 1·270
							Barium Chloride ·820 Lithium Chloride ·094 Ammonium Chloride ·129 Magnesium Bromide ·285 Magnesium Iodide ·013			
STRONG SULPHUR (Montp.). Analyst, Attfield, 1879.	103·421 Traces of	·602 Iodides,	7·249 Bromides,	9·992 Fluorides,	1·094 Lithium.	—	1·813	·446	125·375	CO_3 = 7·500 CH_4 = ·287 N = ·462 O = traces.
							Barium Sulphate ·052 Strontium Chloride ·352 Strontium Sulphate ·066 Sodium Nitrate ·112 Ammonium Chloride ·124 Iron Carbonate ·052			
MILD SULPHUR (Royal Pump Room). Analyst, Miller, 1869.	72·868 Traces of	1·417 Lithium	2·475 Chloride.	3·863	2·300	2·100	·861	·300	86·282	CO_3 = 3·480 H_2S = 1·436 N = ·847
							Barium Chloride ·098			
MILD SULPHUR (Montp.). Analyst, Attfield, 1879.	48·60 Traces of	·711 Barium Salts	3·449 Sulphate of Lithium	3·912 Iodides, Bromides, Iron.	2·089	—	1·097 Fluorides,	·479 and	60·656	CO_3 = 6·750 CH_4 = ·100 N = ·400
							Strontium Chloride ·077 Strontium Sulphate ·114 Sodium Nitrate ·046 Ammonium Chloride ·082			
THE MAGNESIA WATER. Analyst, Muspratt, 1867.	26·987 Traces of	3·489 Strontium Lithium	·224 Chloride, Sodium	— Iodide,	2·309 Carbonate and	1·600 Bromide.	·201 Manganese,	·201	35·051	CO_3 = 1·450 CH_4 = ·683 N = ·751 O = ·240
							Barium Chloride ·153			
STARBECK SULPHUR. Analyst, Fairley, 1879.	14·555 Traces of	— Lithium	— and	— Barium	1·251 Chloride.	·439	·170	·408	18·948	Not estimated.
							Sodium Carbonate 1·809 Potassium Carbonate ·081 Calcium Sulphate ·235			

* Sodium Sulph-hydrate (NaHS) equivalent to ·908 Sodium Sulphide.

CHAPTER III.

THE IRON WATERS.

THE Iron-Salts present in the Chalybeate Springs are:—

1. The Proto-Carbonate.
2. The Proto-Chloride.
3. The Proto- and Per-Sulphate.

I. THE SALINE CHALYBEATES.

The Chloride of Iron and the Kissengen Wells are the best representatives of this group. They are both rich in iron and salts; the former, however, more forcibly illustrates the Chalybeate, and the latter the Saline side of the constitution of Ferrated-Saline waters. The Alexandra water furnishes a connecting link between them and the pure Chalybeates.

The Chloride of Iron Water.

The following prominent features place this water in a unique and distinguished position among other medicinal springs.

1. *Iron Salts.* The Chalybeate charge is one of the strongest among potable iron waters: whether pure or compound, at home or abroad. It is derived

from both Ferrous Chloride and Carbonate—the former predominating. Protochloride of Iron is undoubtedly a very rare constituent of chalybeate waters. The writer believes it has hitherto been detected in two other springs only; namely, at Alexisbad — the Selkebrunnen bath Spring — and Buckowina; but, according to the published analyses of these waters, it is present in much smaller quantity in both than in the Harrogate Chloride; and is, moreover, associated with Ferrous Sulphate, and in Buckowina also with Alum; and, furthermore, in these springs the iron salts are not accompanied by Chlorine combinations, as in the Chloride of Iron water; in constitution, the latter, therefore, differs widely from the Chalybeates in which Proto-Chloride of Iron has hitherto been detected.

2. *The Saline Constituents.* The presence of a considerable quantity of saline matter with a large proportion of iron salts, somewhat allies this water to Compound iron springs. But it differs from other members of this class of mineral waters, in possessing a charge of salts *purely chloride;* it is, in fact, *the only ferruginous water known in which iron is linked purely with Chlorides:* earthy sulphates, carbonates, &c. (the ordinary constituents of strong iron waters) being absent.

In Saline constitution this spring is, therefore, unique.

3. *Barium* is recorded by analysts (Miller, Muspratt, Thorpe) in the most soluble form—that of Chloride. This is not merely the only known Chalybeate containing Barium, but it stands unrivalled among all mineral waters, in holding the largest known charge of this powerful medicinal agent—the Old Sulphur Spring alone excepted.

4. *Manganese and Bromine.* Professor Thorpe—the latest analyst of the water—has detected *Chloride of Manganese.* Hitherto a trace of manganese has been recorded; now it appears as chloride, in the proportion of $\frac{1}{5}$ gr. (calculated with its 4 atoms of water of crystallization) in 20 oz.; this is a rare constituent of medicinal springs in quantities beyond mere traces. The writer is only acquainted with two estimations of manganese in other waters—both ferruginous—which exceed Professor Thorpe's: the published analyses of all other springs indicating much smaller quantities.

Manganese:

	Part per 10,000 of Water.	
Pyrmont (Neubrunn)	·55	Wiggins.
Marienbad (Ferdinandbrunn) . .	·08	Kersten.
Schwalbach (Stahlbrunn) . . .	·06	Fresenius.
The Chloride of Iron Water . .	·06	Thorpe.

For the first time in the analytical history of the

water, *Bromine* (recorded as Magnesium Bromide) has been quantitatively determined.

The Kissengen Water.

The Harrogate Kissengen is the sole representative in this country of the strong chloride waters efficiently charged with iron—a class of medicinal springs possessing even but few foreign members.

Though deriving its name from the Kissengen Springs, the solid contents of the Harrogate Kissengen are more closely allied chemically to those of Homburg, as may be gathered from the following table:—

	Total Solid Contents, 100.			
	Chlorides.	Sulphates.	Earthy Carbonates.	Iron Carbonate.
Harrogate. Kissengen.	97	·06	1·2	1·09
*Homburg.				
Stahlbrunnen.	91	·30	7·1	·89
Elizabethbrunnen.	87	·35	12·0	·42
*Kissengen. Ragoczy.	75	11·4	12·4	·36

The resemblance to Homburg is shown by the almost total absence of sulphates (while $\frac{1}{9}$ of the

* Calculated from Liebig's analyses.

total contents of the Ragoczy Spring are sulphates), by the large proportion of chlorides to other salts, by the high charge of carbonate of iron (far exceeding that of Kissengen), and by a similar though somewhat smaller concentration of solid constituents. The reader will, moreover, gather from the table on p. 66 that the Magnesium and Calcium Chlorides of Homburg are in much the same force in the Harrogate Kissengen.

The Alexandra Water.

This spring somewhat resembles the stronger waters; it is, however, less ferruginous than the Chloride of Iron, and less saline than the Kissengen. It possesses a saline concentration suitable for tonic medication, with a preponderance of Sodium Chloride to accompany the charge of Iron in the process of absorption, and a minimal quantity of Potassium Chloride.

II. Sulphated Chalybeate.

The Aluminous Chalybeate, or the Alum well, differs totally from all the other waters of Harrogate: inasmuch as sulphates form the bulk (90 per cent.) of its total constituents, and of these ferrous and erric sulphates furnish 60 per cent. The well has

been carefully analyzed by Mr. R. Hayton Davis, F.C.S.

			Grains per 20 ozs.
Fe	5·94	Ferric Sulphate	9·84
		Ferrous ,, ...	8·67
Al	1·78	Aluminium ,, ...	11·19
Ca	2·19	Calcium ,, ...	7·11
Mg	1·43	Magnesium ,, ...	7·17
K	·17	Potassium ,, ...	·39
NH_4	·07	Ammonium ,, ...	·27
Na	1·67	Sodium Chloride	4·25
SiO_2	·41	Silica	·41
Cl	2·57	Radicals.	
So_4	33·18		
	49·41		49·30

The following extract from Mr. Davis's paper on this well, read before the Chemical Society of London, and which appeared in the Journal of the Society, contains the best account of it hitherto published.

"Dr. Thomas Garnett, a physician in practice at Harrogate in the year 1791, and afterwards Professor of Chemistry at the Royal Institution, London, in his treatise on 'The Mineral Waters of Harrogate,' wrote as follows :—

"'In one of the sulphur wells situated in the bog, I have discovered alum, and I suspect salited clay. In a chalybeate water near the road, and not far from the Crescent garden, the iron is dissolved by the muriatic acid.'

"Dr. Adam Hunter, a physician resident in Leeds, in his book entitled 'The Waters of Harrogate and its Vicinity,' published in 1830, commenting upon these statements, says :—

"'The reader will, I believe, look in vain for alum or muriate of iron in the waters referred to.'

"The discovery of ferrous chloride in 1865 in one of the Harrogate spas, near the site indicated by Dr. Garnett, and the substance of my paper this evening, strongly support Dr. Garnett's observations. So far back as 1733 Dr. Thomas Short, of Sheffield, F.R.S., mentions an alum well in the bog-field at Harrogate, describing its position, the nature of the ground, and the experiments he made with the water.

"Dr. Garnett, referring to these observations, says :—

"'From Dr. Short's experiments it seems to have been a chalybeate water in which the iron is held in solution by the sulphuric acid;' then he adds: 'I have found two or three springs of this kind in the bog, very near some sulphur wells.'

"Since Dr. Garnett's residence in Harrogate a period of eighty years has elapsed, and the existence of the alum well passed quite out of memory. It was not until 1870, when excavations were made in

the bog-field for the purpose of increasing the supply of sulphur-water, that this aluminous water again came to light; the excavation was afterwards deepened, earthenware pipes were put down, forming a well about 4 feet deep and 14 inches diameter, where the water slowly collects. This aluminous water is of a pale reddish-brown colour, strongly acid to litmus and of very astringent taste; after keeping a short time, if exposed to the air, a portion of the iron is precipitated as basic sulphate, and the protosulphate gradually changes into the ferric salt.

"The ground in its vicinity is strongly acid to litmus, tastes austere, even after heavy and continuous rains; depressions in the ground after a shower, more particularly in summer, are found filled with water corresponding in colour and taste with that in the well.

"Immediately under the peaty soil in various places around the well, there is a layer of deposit having a sulphur-yellow colour; its appearance has no doubt given rise to the statements of Dr. Short and other old writers, respecting the prodigious quantities of sulphur to be found in the locality. I find, on examination, it contains about 60 per cent. soluble in hydrochloric acid, consisting of SO_3 14·60, Fe_2O_3 29·32, and small quantities of Ca,

Mg, Na, &c.; it bears a remarkable resemblance to two of the ferruginous deposits found in the neighbourhood of the Caspian Sea, the analyses of which by A. Frenzel, are published in the September number of the Journal of this Society.

"To revert to the alum well: its position is remarkable, in being almost surrounded by sulphur wells, which circumstance, together with the surface of the soil being so strongly impregnated with the constituents of the water, strengthens the opinion that the water is of comparatively superficial origin, and is continually produced by natural causes.

"The old deposits from the chalybeate waters situate on higher ground, and the sulphur waters rising through the stratum of shale at a lower level, appear to be the factors in the production of this remarkable water."

III. The Pure Chalybeate Waters.

In solid constituents the Harrogate pure chalybeates compare favourably with any of the same class of medicinal waters:—a class distinguished from others by a small chalybeate impregnation with minimal quantities of saline matter. These waters contain an average charge of iron: the Carbonate of iron water of the Cheltenham Rooms is,

however, one of the strongest pure chalybeates ; and they are more *purely* chalybeate in holding a much smaller proportion of accompanying alkaline and earthy salts in solution than kindred waters. From this point of view the Tewit and John's Springs and the Harrogate Pure Chalybeate (Royal Pump Room), like the Tunbridge Wells Spring, are singularly pure solutions of carbonate of iron.

Gases in the Iron Waters.

The charge of carbonic acid gas is more than sufficient to preserve the proto-carbonate of iron in perfect solution at the wells ; but though it is at least equal to that of other chalybeate waters in this country, it is below that of many continental springs.

Analyses of the Iron Waters.

	Grains in 20 ozs.								Cubic Inches in 20 ozs.
	Chloride.				Carbonate.				
	Sodium.	Potassium.	Magnesium.	Calcium.	Calcium.	Iron.	Silica.		Total Solids.	Gases.
Kissengen. Analyst, Attfield, 1879.	84·325 Traces	2·678 of Brom	8·174 ides, Io	10·917 dides and	1·107 Lithium.	1·199	·466	Ammonium Chloride ·054; Barium Sulphate ·064; Barium Carbonate ·267; Strontium Chloride ·111	109·342	CO_3 = 2·662; O = ·187; N = ·650
Chloride of Iron. Analyst, Thorpe, 1880.	34·695 Traces	·370 of Magn Cupric	7.165 esium I Chlorid	11·752 odide, Lit e.	— hium Chl	1·381 oride	·177 and	Ammonium Chloride ·051; Iron Chloride 1·652; Barium Chloride ·651; Barium Sulphate ·025; Strontium Chloride ·078; Manganese Chloride ·122; Magnesium Bromide ·043	58·162	CO_3 = 3·285; N = 1·010; Estimated by Professor Miller, 1865.
Analyst, Thorpe, 1881.	—	—	7·198	11·933	—	1·452	·174	Iron Chloride 1·737; Barium Chloride ·734; Manganese Chloride ·107	—	
Alexandra Water. Analyst, Davis, 1870.	22·046 Traces	·141 of Magn	·592 esia, Lit	— hium, Iod	1·137 ·73 Mag. Carb. ine, Brom	·752 ine, A	·084 mmo	Calcium Sulphate ·137; nia.	26·585	CO_3 = 2·23; O = ·31; N = 1·23
Carbonate of Iron. Analyst, Muspratt, 1865.	1·456 Traces	·019 of Lithi	1·643 um Chl	·289 oride.	·043	·755	·025	Calcium Sulphate ·953	5·183	CO_3 = ·973; N = trace.
Harrogate pure Chalybeate. Analyst, Muspratt, 1870.	·080	—	·130	·190	·281	·376	·005	Magnesium Carbonate ·116; Sodium Carbonate ·021; Sodium Sulphate ·058; Magnesium Nitrate ·011	1·268	CO_3 = 2·507
Tewit Well. Analyst, Hofmann, 1854.	·035 Traces	·165 of Magn Bromin	— esium C e, Iodin	— arbonate, e and Am	·179 Lithium C monia.	·169 hlorid	·130 e,	Calcium Sulphate ·087; Magnesium Carbonate ·333; Potassium Carbonate ·132; Organic Matter ·083	1·313	CO_3 = 1·480; O = ·050; N = ·690

THE

HARROGATE WATERS.

PART II.

THERAPEUTICS.

"In nature, there are no false valuations . . . . . All things work exactly according to their quantity, and according to their quality . . . . . It is only on reality that any power of action can be based."—EMERSON.

INTRODUCTORY.

THE THERAPEUTIC AS DISTINGUISHED FROM THE CHEMICAL VARIETIES OF THE WATERS.

THE exceptional variety of the medicinal springs of Harrogate raises the curiosity of the chemist and the student of chemico-geology; but it is of more than scientific interest to the physician, whose work and aims pertain to the relief and cure of diseases, rather than merely to the study of the facts and speculations of science. From this aspect the variations are still more striking: for, while the scientist may be satisfied with a general classification of the waters into groups, or with the discovery of certain constituents which may aid his inquiries into the ways of nature, the physician must know the clinical behaviour of each water, which may thus become a therapeutic variety, though allied chemically to others possessing different curative properties. The varying proportions of the same constituents in the same chemical group of springs may, therefore,

furnish different curative results; so that any one member of it may meet clinical needs with greater aptness than its neighbours, however much akin their features as reflected by the chemist. Perhaps the most numerous of these therapeutic varieties, which enable the physician to adapt his treatment with greater nicety to the peculiarities of individual cases, is to be ascribed to the gradations of saline concentration of the Harrogate waters; for it is found the successful prescriber of saline waters, such as these, cannot afford to ignore, in certain cases especially, not merely the amount of the salts to be administered, but also the percentage it bears to the water in which it is held in solution. The same quantity of salines in different proportions of water is not the same therapeutically; for, when concentrated, their disturbing action on the mucous surfaces with which they are brought into contact, and thence on the whole organism, will be different from that of the more dilute solution; and, therefore, a choice of different saline concentrations forms no insignificant part of the curative resources of Harrogate.

The Temperature of the Waters.

Though the Harrogate waters are naturally non-thermal, they may be used in either undiluted

thermal, or cold doses (see p. 47). Watering-places—especially those possessing saline springs—where the waters are dispensed both cold and hot, obviously offer greater curative advantages over others—for instance, thermal stations—where there is no choice of temperature:

1. The stronger salines, which require a high temperature for their rapid absorption, when efficiently warmed in the Therma, surpass the generality of Thermal saline waters, which are, as a rule, comparatively weak in salts.

2. A choice is provided—but not, however, by thermal watering-places — for the selection, not merely of gradations of warm doses to meet the digestive peculiarities of cases, but also of cold and invigorating draughts of the same water.

3. It is found that any deficiency of gas in strongly saline water—especially when also chalybeate—may be compensated by warmth; so that, for instance, the thermal doses of the Kissengen water are as readily digested and absorbed as the more gaseous saline chalybeates of Homburg or of Kissengen.

The Season.

From the days of Dr. Dean (1626) and of Dr. French (1654) to the present, the Harrogate season

has been limited to the period between April and October; and undoubtedly the warmer are better adapted than the cold months to the efficient external and internal application of the waters. Inasmuch as the climate during the winter months is, as a rule, dry and still more invigorating than during the summer, the writer is inclined to think highly of it in cases of mal-nutrition, such as struma, which demand a long course of treatment in a highly tonic atmosphere, and the continued administration of such a blood and tissue restorer as the Chloride of Iron water; during the winter he has frequently witnessed scrofulous children—for instance, in the boarding-schools—to flourish even better, both in general health as well as in their local ailments, than in the warm months.

The Sulphur waters and baths are not contra-indicated by the winter months, providing they are used with care, and in a less persistent manner than they are wont to be in the season.

CHAPTER I.

THE PHYSIOLOGICAL AND THERAPEUTICAL ACTION OF THE LEADING CONSTITUENTS.

THE mineral waters of Harrogate—like many others elsewhere—are compound remedies; for they contain for the most part several curative agents blended together in different proportions, some of which are recognized in general medical practice as reliable.

The chemical anatomy—to coin a phrase—may be regarded as a useful and general introduction to the study of their physiological properties; but their therapeutical application demands the guidance of intelligent experience, which, as in other practical matters, is apt to modify theoretical or physiological conceptions; for the prescriber of mineral waters, like other practitioners, knows full well how often promising suggestions derived from the laboratory—whether chemical or physiological—are either demolished or reshaped by clinical observation.

But notwithstanding the independence of clinical observation, it should not be assumed that chemical

investigation into the constitution of mineral waters should be regarded as valueless as an aid to the therapeutic study of them; for analytical results may serve practical ends without being made the basis on which chemico-therapeutic theories may be constructed. They roughly show the practitioner the complex structure of the tools which nature provides him for fashioning the health of those submitted to them, and it may be inferred that he will be none the less efficient in the use of them because he is acquainted with the nature and complexity of their constituents, which may be likened to the several parts of intricate machines; and, though he may justly regard each or several of the ingredients isolated from their natural associates—resembling detached pieces of a complex instrument—as no longer capable of producing the entire effects of the waters to which they belong, his convictions, grown by observations of the curative power of the latter, become somewhat assured, when he can collate with them the corroborative results of physiological and chemical inquiry, and of independent clinical experience of the leading constituents; then he may recognize the reason of the faith within him, and regard the waters whose healing powers are capable of such demonstration akin to other curative

agents, and not altogether mysterious compounds endowed with such exaggerated or imaginary virtues as banish them beyond the pale of therapeutics.

The object, therefore, of the following brief survey of the physiological and therapeutic properties of the principal ingredients of the Harrogate waters is not to attempt to demonstrate therefrom all the curative powers of the latter, but to afford some reasonable grounds of probability for the belief in their efficacy which clinical observation has established.

Inasmuch as the Harrogate waters are more medicinal, in containing active curative agents of known power in tangible proportions, a therapeutic analysis of them appears to be more permissible than in the case of many other springs whose recognized virtues cannot be thus illustrated.

The most trustworthy analysts of the waters have revealed the presence in them of the following remedies in perfect solution, in inimitable combinations, and mostly in doses which, according to independent experience, are quantitatively medicinal.

I. Chlorine Combinations.

(*a*) The Alkaline Chlorides.

(*b*) The Chlorides of Magnesium and Calcium.

II. Barium Salts :—Chloride and Carbonate.

III. Sulphides.

(*a*) Sodium Sulphide.

(*b*) Hydrogen Sulphide.

IV. Iron-Salts.

(*a*) Proto-carbonate.

(*b*) Proto-chloride.

(*c*) Sulphates (Proto and Per).

These leading constituents, which are distributed in various proportions in the different waters, may now be briefly reviewed from the standpoint of physiology and therapeutics; whence some of the proved effects of the springs may be illustrated—rather, however, by broken and prismatic rays which are but parts of the unified light shed by the practical knowledge of the waters themselves.

I. CHLORINE COMBINATIONS.

I. Sodium Chloride.

The large absolute and relative proportion of Chloride of Sodium in all the saline waters suggests its prominence as a therapeutic constituent; and its presence in all the fluids of the body as a constant and predominant mineral ingredient indicates its

physiological importance, and the purely physiological character of its curative operations when administered in these mineral waters.

Its properties have been well-defined by observation and experiment.

1. LOCAL ACTION ON THE ALIMENTARY ORGANS.—The immediate effects of Chloride of Sodium are to stimulate the gastric glands to increased secretion, to tone the mucous membrane and to invigorate the stomach. Doses varying in degrees of concentration according to individual susceptibility, excite the alternative of vomiting or purging. It promotes the digestion and assimilation of the albuminous and starchy foods: and being the solvent of the fibrin generators—fibrinogen and paraglobulin—of the chyle and lymph, the rôle it plays in building up the corresponding constituents of the blood may be inferred.

2. REMOTE EFFECTS.—Viz., on the blood, the tissues, the secretions, and the extra-vascular circulation of fluids.

a. On the blood. The singularly important relation borne by Sodium Chloride to the integrity of the blood is shown by its large percentage—65 according to Schmidt—among the other mineral constituents of the liquor sanguinis, and by its power to maintain

in solution the proteids of the blood (fibrinogen and paraglobulin),* and to check the solution of the blood corpuscles.

b. On the tissues. The elimination of urea—the representative product of the retrograde metamorphosis of the proteids—is believed by some writers† to depend on the quantity of Chloride of Sodium in the blood; an increased supply of salt being followed by a greatly augmented removal of it, and anything which diminishes the saltness of the blood—such as lessened consumption of Sodium Chloride, or a diversion of it into pathological transudations—leads to a reduced evacuation of urea. Hence, probably, the value of Sodium Chloride in eliminating nitrogenous waste. It is believed that it accelerates tissue change; not, however, as an *immediate* effect, simultaneous with the rapid absorption of it and with the elimination of it by the bowels and kidneys, but afterwards, while the tissues lay up a store of it, which they retain for a time (Klein and Versen)—a conclusion somewhat supported by the increased outflow of urea accompanying or even following the

* When a solution of paraglobulin in salt water is placed on one side of a dialyser, and pure water on the other, as the salt diffuses into the latter, the paraglobulin is precipitated.

† See Braun, *op. cit.* p. 386.

later stages of the augmented elimination of Chloride of Sodium in the urine. Its power to stimulate the construction of the tissues is suggested by the presence of it in large quantity in the fluids in which rapid cell-growth is going on, and by its being the solvent of proteids in the animal fluids—the blood, lymph, chyle, muscle-juice, &c.

c. On the secretions. Salt is present in large quantity in all the secretions; especially in those concerned in assimilation, viz., the saliva, the gastric juice, the intestinal juice, the pancreatic juice, and the bile. The physiological activity of all these fluids will doubtless be impaired whenever the store of Chloride of Sodium in the blood, whence they derive it, is not maintained, or will be stimulated by an increased charge of this crystalloid in the circulating fluids.

d. On the extra-vascular circulation of fluids. Saline fluids constantly circulate outside the visible and closed channels of the blood-vessels and of the lymphatics. They daily pass in large volume from the blood; either into the intestinal tract, as secretions, whence, for the most part, they return to it,*

* The remarkable completeness of the circulation of Sodium Chloride from the blood into the alimentary canal, and thence again to the blood, is proved by the fæces being either chloride-free, or

or into the tubules of the kidneys and are eliminated: the intestinal circulation of salt-charged fluids is associated with assimilation, while the renal out-flow is bound up with elimination of nitrogenous waste.* But, besides these copious

containing mere traces of salt; though the collective quantity of NaCl conveyed into the digestive tract by all the secretions must be very large.

Referring to this extensive circulation of fluids from and to the blood in the digestive tube, the late Prof. Parkes remarks: "The amount of fluid poured into the intestines and reabsorbed in twenty-four hours is almost incredible, and constitutes of itself a secondary or intermediate circulation never dreamt of by Harvey. The amount of gastric juice alone passing into the stomach, and then reabsorbed, amounted in a case lately examined to nearly twenty-three imperial pints (if we put it at twelve we shall certainly be within the mark). The pancreas furnishes twelve pints and a half in twenty-four hours, while the salivary glands pour out at least three pints . . . the amount of the bile is probably over two pints. . . . The amount given out by the intestinal mucous membrane cannot be guessed at, but must be enormous. Altogether, the quantity of fluid effused into the alimentary canal in twenty-four hours amounts to much more than the whole amount of blood in the body. . . . The effect of this continual out-flowing is supposed to be to aid metamorphosis; the same substance, more or less changed, seems to be thrown out and reabsorbed until it is either adapted for the repair of tissue or has become effete."

* "As the chlorides are deposited with the organic matter in all the acts of nutrition, they are found to be eliminated constantly with the products of disassimilation of the nitrogenized parts, and their absence from the food does not completely arrest their discharge in

circulations of saline fluid out of the closed vessels, there is yet another equally, if not more, extensive, and also extravascular, which, however, marks the track of both sides of nutrition—integration and disintegration of the tissues : it consists of the continuous passage of fluid from the blood to the tissue-elements, and thence again to the blood or to the lymphatic vessels. This perpetual motion of the liquid constituents of the blood and of the lymph, through and beyond the corpuscle-holding channels is controlled by various forces, chemical as well as physical ; but the latter are, perhaps, not less essential than the former, and of them the diffusion of liquids after the manner of Graham's experiments on dialysis may be regarded as the chief, *i.e.*, the diffusion of "crystalloids," *e.g.*, NaCl, out of a "colloid" solution. It may be concluded from the invariable complexity of the chemico-physical processes of the organism, the examples here cited of the dialytic process will not be essentially simple, like the experiments of the physicist, but may be greatly modified, as by the inimitable composition of the fluids, by structural conditions not hitherto recog-

the urine. . . . A certain portion of the chloride of sodium exists in combination with urea."—*The Physiology of Man*, by Austin Flint, Jr., M.D.

nized, and by the individualism of cell-work yet beyond explanation by the laws of physics: hence, in the intestinal system, the dialytic out-flow of salt may be linked with the natural ferments of the secretions—probably altered colloids of the blood; in the urine, with the latest break down of the nitrogenous colloids—urea; and in the tissues, with materials to replace loss by wear and tear, and by force-production, and then, with the residua of work and disintegration.

This extensive extra-vascular circulation of saline fluid may not, therefore, be merely a simple diffusion of the crystalloid with which the blood is richly charged—NaCl—while the liquor sanguinis retains completely the colloids; but a partial separation of the latter also in soluble forms, and perhaps in chemical union with the crystalloid, without the aid of which they may not be able to pass readily through a membranous septum.

To maintain healthful and vigorous nutrition, it may be inferred, the blood which holds the store of salt, whence that large portion which permeates beyond the range of the vessels is derived, should be kept sufficiently charged with it; for when it fails, the secretions probably becoming inefficient in quality and quantity, the assimilation of new mate-

rial may be impaired, and waste products may be apt to hang about the tissues.

Inasmuch, therefore, as Chloride of Sodium is the main natural crystalloid on which the extravascular circulation of fluids largely depends—without which neither the repair of the tissues, nor the removal of old and used material can be effected—the presence of it as a predominant constituent in mineral waters, like those of Harrogate, suggests a place for the latter, by the side of other valued agencies which accelerate the nutritive processes.

The purgative action of Sodium Chloride—aided by that of Magnesium Chloride—in the concentrated salines (the Old Sulphur Well, the Strong Montpellier Sulphur and the Kissengen) will doubtless stimulate a languid, and relieve an embarrassed and overcharged intestinal and biliary intermedial circulation,* and sweep from the alimentary mucous

* The reader may be reminded that recent physiological inquiries show that only a very small portion—some two or three per cent—of the two and a half pounds of bile daily secreted escapes with the residua of intestinal digestion, and is therefore excrementitious; while the remainder circulates through the bile-ducts into the contents of the small intestine, where it is quickly absorbed, and returns to the liver by the portal vein to be re-excreted. This biliary intermedial preserves the general circulation from contamination with bile-elements.

membrane epithelial débris and irritating and fermenting substances—the products of chronic catarrh and of disordered bowel-work—and, furthermore, improve the circulation as an absorbent apparatus; while, in the waters containing smaller proportions of salts, or in the non-aperient doses of the strong salines, the absorbable quantities of Sodium Chloride are believed to play their part in treatment, by stimulating the constructive operations of the organism, and by accelerating the removal of nitrogenous waste from the tissues. The association in these waters of Chloride of Sodium with Sulphides, with salts of Iron and Barium, &c., appears to be valuable, because it doubtless favours the absorption and assimilation of these constituents.

2. Potassium Chloride.

This salt is by no means a prominent constituent of any of the waters. Its physiological action differs from that of NaCl; for it specially excites retrogressive change of tissue (see p. 208).

3. Calcium Chloride.

Until about sixty years ago, Muriate of Lime flourished as a well-trusted anti-scrofulous remedy;

then its reputation, like that of barium, waned before iodine—the active competitor in the same therapeutic field, the treatment of lymphatic ailments. Though the fair repute of Calcium Chloride was blighted by that of its successful rival, and though the main body of practitioners ceased to regard it as *the* remedy for scrofula, there outlived through this reverse in its therapeutic history a steady and firm belief in its curative powers, held by a few whose faith in them had been nurtured by repeated successful trials, guided by well-directed observation—the only source whence a remedy can acquire an enduring name, contrasted with the fleeting one borne up by a wave of fashion characterized by the gregarious use of newly introduced drugs which, for a time, may consign to obscurity old and established remedies. In this generation the earlier and well-proved virtues of Calcium Chloride have been re-asserted by the late Dr. Warburton Begbie,* Dr. Bell of Glasgow,† Dr. Coghill and others. The testimony of Dr. Coghill to the anti-scrofulous powers of the remedy, as well as the estimate which this observer forms of the operation

* *The Therapeutic Action of Muriate of Lime* (Edin. Med. Journ., July, 1872).

† *Muriate of Calcium as a Therapeutic Agent* (Lancet, 1877).

of iodine in cases of scrofula, agree so closely with those which the writer has formed, that he does not hesitate to quote them.

"It is well known that my lamented friend, the late Dr. Warburton Begbie, had the highest opinion of this remedy, which he told me he had derived from his father's recommendation. On one occasion, some three years ago, he showed me in his consulting room the case of a young lady, in which he had succeeded, with the continued use of the solution of the muriate of lime, in procuring the absorption of the greatest enlargement of the cervical glands on both sides he had ever seen, and which had previously resisted long and repeated courses of cod-liver oil and the iodides. The young patient was a typical specimen of the olive-complexioned struma, and the axillary and femoral glands had also been involved, but to a much less degree. I myself have again and again seen chronically indurated and enlarged glands, amounting in many instances to deformity, yield even in adults, to the steady internal administration of this salt. I have been frequently struck by the softening without diminution of bulk, which precedes the commencing discussion of the tumour. There is at present a domestic in the Royal National Hospital here, who is a striking

instance of the good effects of this drug. She originally presented herself as a patient with an enormous hypertrophy of the glands on the left side of the neck, quite disturbing the axial position of the head and face, which had previously resisted all treatment, but readily yielded to the chloride of calcium. The almost invariable tendency of iodine and its salts to occasion inconvenience from the development of their physiological symptoms, their proneness to cause dyspepsia and disturbance of the functions of the mucous surfaces generally, and above all their liability to induce, when long continued, emaciation, and also absorption, more especially of the osseous structures, greatly impair their otherwise valuable properties, and limit their employment, particularly in young persons. It is of course in the latter we are so often called upon to treat the various outcomings of the strumous diathesis, and it is precisely in this class of ailments that the chloride of calcium will be found to possess therapeutic properties, which render it altogether a much more potent, and certainly more manageable remedy than any of the various preparations of iodine. I do not mean for a moment to disparage unnecessarily the valuable properties of the iodides in purely strumous or tubercular affections, but even

if their employment were unattended with the inconvenience above mentioned, yet it is well known how desirable it is to have an alternative remedy, and that one of equal efficacy. But it is when associated as an external application with the chloride of calcium given by the mouth, that the best results are to be seen." *

In scrofula the curative operation of Calcium Chloride may be summarized as favouring :—

(*a*) The absorption of lymphatic swellings—whether external or internal.

(*b*) The cure of skin-diseases—especially lupus, eczema, and impetigo (Cazenave).

(*c*) The removal of some forms of dyspepsia from which strumous children are apt to suffer—characterized by foul breath, loaded tongue, enlarged tonsils, capricious appetite, irregular, fœtid, and often lienteric stools and restless sleep.

The experiments of Perl have shown that each element of this chloride departs from the system by a separate channel—calcium by the bowels, and

* *Therapeutic Notes on the Chloride of Calcium*, by J. G. Sinclair Coghill, M.D., &c., "Practitioner," Oct. 1877.

chlorine by the kidneys. Hence it is probably broken up in the digestive tract, where it may meet with acids—such as lactic, butyric, acetic—which effect the decomposition;* if so its usefulness in strumous dyspepsia may be in some degree explained.

The ordinary dose—from 7 to 25 grains—is provided by the Chloride of Iron, the Kissengen and the Strong Sulphur waters. (See Table, p. 132.)

4. Magnesium Chloride.

The writer has prescribed this salt extensively during the past few years, with results which satisfy him in the belief that it is an aperient preferable in most cases to the sulphate of magnesium; chiefly because it relieves the bowels copiously, is not disposed to excite them to continued action, and is less liable than the sulphate to leave them constipated after its operation. The chloride is perhaps less irritant to the alimentary mucous membrane than the sulphate. The proportions in which it exists in the ordinary morning draughts of the Old Sulphur Well, the Strong Montpellier Sulphur and the Kissengen doubtless contribute to the aperient action of these waters.

* This supposition does not seem improbable, for Lehmann found that Chloride of Calcium is decomposed *at the ordinary temperature* during evaporation with lactic acid *in vacuo*.

TABLE.

IN GRAINS.

		NaCl.	KCl.	$CaCl_2 6H_2O$.	$MgCl_2 6H_2O$.
24 ozs.	Old Sulphur Well .	139	$1\frac{1}{3}$	$12\frac{1}{2}$	$15\frac{1}{2}$
	Strong Montpellier S.	129	$\frac{3}{4}$	24	18
	Kissengen . . .	105	3	24	21
6 ozs.	Chloride of Iron .	$10\frac{1}{2}$	$\frac{1}{10}$	7	$4\frac{1}{2}$
30 ozs.	Magnesia Water. .	40	5	—	—

Besides the effects produced by chlorides taken internally, there are others developed by saline waters used externally as Baths and Douches, which may be summarized as stimulation and improved nutrition of the skin and increased tissue-metamorphosis.

II. BARIUM SALTS.

The soluble salts of Barium are well known to possess energetic properties. According to the experiments of Boehm, they cause very definite disturbances of function in both frogs and mammals, and the experience of them as remedies has induced many trustworthy practitioners to believe they produce pronounced curative effects in certain therapeutic directions.

Their presence in several of the Harrogate waters in proportions which approach, or even equal,

in the prescribed quantities of the waters, the doses which independant experience of them has declared to be curative, is therefore a matter of medical interest; and, moreover, inasmuch as medicinal springs elsewhere rarely contain them—or only in mere traces—the Harrogate Barium waters rise further in therapeutic importance as the only known natural solutions of Barium Salts in quantities recognized in ordinary medical practice as effective. The Barium charge of these waters may, therefore, be seriously discussed from the acknowledged therapeutic standpoint furnished by the clinical experience of Barium; an experience which, moreover, illustrates or confirms some at least of the proved curative effects of the waters.

The Old Sulphur Spring and the Chloride of Iron water—the strongest known Barium waters—bear much the same relation to Barium, as do the springs of Bourboule to Arsenic; for, like the latter, they are unique in holding in solution the largest known proportion of the active remedy, while all other waters in which it has been detected, present it in infinitely smaller quantity.

Before deciding how far a high charge of Barium may influence the therapeutic action of the waters containing it, it is desirable first to state, succinctly,

the recognized effects of Barium as a remedy, and then to inquire—can this independent experience be fairly collated with that of the waters?

Résumé of the therapeutics of Barium.—The history of Barium as a remedy extends over a period of ninety years. In 1789 Dr. Adair Crawford brought the chloride under professional notice as a valuable curative agent in scrofula.* From that time to our own day its virtues have been repeatedly extolled, not merely in the treatment of this affection, but in that of other disorders—a widening of its therapeutic range as observation extended and, latterly besides, as physiological experiments suggested. The following are the main lines in which clinical observation has run.

1. *Scrofula.* Crawford's estimate of the anti-scrofulous property of Barium Chloride was re-affirmed by numerous observers from 1792 to 1820; in these early days the remedy was prescribed apparently with benefit in all manifestations of scrofula: such as glandular swellings, ulcerations, inflammation of the eyes, skin affections, &c. But in 1820, the rising reputation of this, as well as of that other very promising, if not well-proved remedy—Calcium Chloride—in scrofulous disorders, was

* *On the Medicinal Properties of Muriated Baryta.*

thwarted by the introduction of Iodine by Coindet —an agent which soon became the text of a voluminous literature, and acquired a prominent position in the treatment of strumous and allied diseases.

In 1841 M. Payan of Aix re-asserted the position of Barium Chloride in the treatment of scrofula, and declared it to be "a powerful and even heroic remedy;"* and in 1846 Dr. A. J. Walsh, while assigning to it a prominent place among anti-scrofulous remedies, believed the province of its operation is not overlapped by that of Iodine. "I do not," he says, "wish it to be understood as my opinion, that muriate of barytes should supersede iodine in the treatment of scrofulous diseases, in which we frequently derive such eminent service from the latter; but I think I am warranted in inferring, after a careful examination of these cases, that there are some cases of scrofulous disease in which iodine is useless, or may be worse than useless, and when we may derive considerable service from the muriate of barytes; and further, that there are some cases in which we experience beneficial results from iodine up to a certain point, beyond which, if it be persisted in,

* *Mémoire sur l'Hydrochlorate de Baryte dans les Maladies Scrofuleuses*, par P. S. Payan, Aix, 1841. Also "*Journal de Connaissances Medico-Chirurgicales.*"

its beneficial action ceases, and it proves noxious. In these cases the treatment may be advantageously taken up with the barytes, and *vice versâ*." *

Without tediously repeating the same view, by quoting from subsequent writers whose observations confirm the anti-scrofulous power of Barium, the writer will merely quote the corroborative opinion of Dr. Hudson of Dublin, who regards from experience the Chlorides of Barium and Calcium and the Iodides, "as remedies of powerful efficacy in affections of the lymphatic system." †

2. *Diseases of the circulatory organs.* According to the experiments of Boehm on frogs and mammals, barium salts "either stimulate powerfully the whole nervous sympathetic system, or have a special relation to involuntary muscular fibre." Inasmuch as in small doses they cause both the heart and arteries to contract, and as a consequence, the arterial blood-pressure to rise very greatly, the clinical indications appear to be debility, or loss of tone of the muscular element of the whole circulatory apparatus. But as

* *On the Use of Muriate of Barytes in the Treatment of Scrofulous Affections*, by A. J. Walsh, M.D., Dublin Med. Press, Feb. 18th, 1846, p. 100.

† See *Address in Medicine: Laennec, his Labours, and their Influence in Medicine*, by Alfred Hudson, M.D., &c., Brit. Med. Journal, 1879.

yet—judging from the paucity of published experience—physiological inquiry has borne but little fruit in the direction in which it appears most suggestive of practical results: namely, the successful employment of Barium as a vascular tonic. Medical literature is, however, not without some contributions to this position; and the author would refer the reader specially to a noteworthy paper published in the Practitioner, Vol. XXIII., "*The Probable Value of Chloride of Barium in Internal Aneurism*," by F. Flint, M.D., in which it is remarked "the drug appears to have a decided affinity to the muscular coat of the arterial system; and I imagine that it restored tone to the diseased portion of the arterial coat, and thus gave rise to consolidation of the weakened arterial wall."

3. *Diseases of the nervous system.* The powerful stimulant action of Barium on the nervous system has found expression in the prescription of it by Hammond in diffuse and multiple cerebral sclerosis.

4. *Skin affections.* All through the therapeutic history of Barium references to its curative property in skin diseases are to be found; but its use appears to have been restricted to what were believed to have been cutaneous manifestations of scrofula. The writer's observations, however, assure him that

Barium Chloride—apparently apart from its anti-scrofulous properties—is a valuable remedy in skin diseases; they are not, however, sufficiently numerous to enable him, as yet, to draw from them definite conclusions, as guides to the clinical limitations of the prescription of it. But, inasmuch as he has seen one fifth of a grain three times a day cure irritable forms of dry eczema in the non-scrofulous, after the failure of arsenic, he is led to believe Barium to be a remedy which should be further cultivated in cutaneous medicine, and he is inclined to give it a prominent place among the curative agents of eczema.

The Barium salt which has nearly always been preferred is the Chloride; and the dose prescribed by most observers may be said to vary from $\frac{1}{12}$ to $\frac{4}{5}$ of a grain three times a day—but it should be noted, some practitioners incline to the smallest doses *e.g.* gr. $\frac{1}{12}$ (Walsh), and gr. $\frac{1}{5}$ (Flint).

Turning to the Barium charged waters, we find the form and quantity of this active agent conform closely to those preferred by independent clinical experience. Analysts of the highest repute—the late Professor Miller, the late Professor Muspratt and Professor Thorpe, F.R.S., among others—have each independently established the same facts: namely,

the presence of Barium Chloride in the proportions of over one grain * in the average morning draughts of the Old Sulphur Spring (20 ozs.), and of from *$\frac{1}{6}$ to *$\frac{1}{4}$ gr. in each dose of the Chloride of Iron water.

The question may now be asked: inasmuch as these quantities of Barium Chloride are at least equivalent to the average doses of the remedy declared by experience to be effective, should they go for nothing in the collective operation of all the constituents of the waters? Surely not. We are fairly warranted by the activity of the agent in question, and by the sufficiency of the dose in recognizing this Barium impregnation as a therapeutic reality; but, inasmuch as, when thus administered, it is accompanied by other powerful remedies—such as sulphides, proto-chloride and proto-carbonate of iron, calcium chloride, &c.—it becomes difficult, if not impossible, for the clinical observer to definitely recognize its share in the medicinal effects of the waters. It may, however, be safely inferred, though the waters themselves compass a much wider therapeutic area than can be claimed for Barium medication, countless observations have proved their remarkable curative powers within the

* Calculated as $BaCl_2\ 2H_2O$—the crystallized salt of the shops.

provinces which Barium alone is said to cover; namely, scrofula, skin-diseases, and forms of neuro-vascular debility. But, it may be asked, as menstrua for the administration of Barium do these waters possess advantages over artificially prepared solutions? The following considerations point strongly in favour of these natural solutions.

1. The soluble salts of Barium, even when largely diluted, are apt to irritate the mucous surface of the throat and stomach; and this injurious property has been known to bar out the remedy from certain cases in which it seemed otherwise indicated. A solution of Barium Chloride in distilled water, in the proportion as in these springs, on being sipped, leaves a somewhat disagreeable and persistent sensation of dryness on the palate; the natural solutions are, however, free from this unpleasant effect, and do not possess the ordinary irritating qualities of Barium; an example of the smooth blending of a harsh constituent by the hand of nature which the chemist will imitate in vain.

2. The constituents accompanying the Barium impregnation form with it apt therapeutic combinations, for they probably corroborate the reputed curative properties of Barium Chloride.

(*a*) The chlorine combinations common to both the Strong Iron and Sulphur waters, besides stimulating primary digestion, are believed to favour that most important physiological process intimately associated with nutrition—the extra-vascular circulation of fluids (see p. 121). Hence their value in restoring the various textual debilities which characterize scrofula, and as concomitants of Barium regarded as an anti-scrofulous remedy.

(*b*) The linking of Sulphides with Barium Chloride in the Old Sulphur Well appears to be a happy association of remedies of allied power in the treatment of skin diseases, chronic eczema, &c.

(*c*) The depurating action of the Old Sulphur Spring appears to be well balanced by the neuro-vascular tonic properties of Barium Chloride. During courses of this water, when the purgative action was well-maintained, the writer has repeatedly observed a decided increase of intra-arterial pressure; the pulse becoming more resistant—a fact which he has many times verified and estimated by a sphygmometer;* as well as other indications of improved tone and vigour in the circulatory organs, such as a diffusion of warmth throughout the

* The author prefers a dial pressure-gauge sphygmometer, made by Mr. Hawksley, 100, Oxford Street.

system, and the face, previously pale and sallow, or congested, acquiring a healthier tint, as if either from the opening up of imperfectly filled arteries and capillaries, or the bracing of relaxed arterial walls. The circulatory depression here referred to may—as has recently been forcibly insisted on by Dr. Brunton — immediately arise from a sort of self-poisoning by the products of disordered bowel and liver-work; and it may be said the freedom of those organs afforded by the Sulphur water should explain the consecutive improvement in the action of the heart and blood-vessels. Clinical observation leads one to admit the force of this explanation: but it is doubtful if it be all-sufficient in this particular instance, for we cannot ignore the proved stimulant action of Barium on the heart and blood-vessels as one more than probable factor of the observed increase of intra-arterial pressure, and the writer has not remarked the latter after prescribing the strong Montpellier Sulphur—a water in all respects resembling the Old Sulphur Well, save in being almost Barium-free.

(*d*) The constitution of the Chloride of Iron water is, from a therapeutic standpoint, most remarkable. It presents most appropriate combinations for the treatment of impoverished states of the blood and of

the tissues, such as may be often noted in scrofula, skin-diseases, and in vascular and neurotic debilities: in fact the morbid conditions with which Barium is said to cope. Chlorides—and among them calcium chloride (see p. 126)—and ferruginous salts in effective doses blended with Barium Chloride, here form a congeries of remedies, the curative operations of which converge to the same therapeutic ends, and probably afford a sufficient reason for the proved reputation of the water in the directions just now indicated, but above all in scrofula—in whatever form this genetic type of mal-nutrition may manifest itself.

The mere linking together of the Chlorides of Iron and of Barium—quite apart from the other noteworthy combinations of this water—seems to be a happy association of remedies addressed to the circulatory organs: for, while the Barium may tone the whole apparatus from the heart to the capillaries, the Iron may be fairly credited with at least the ordinary restorative properties of this metal on the blood; and it is interesting to note the curative value of the combination of Chloride of Iron with that of Barium did not escape the practical acumen of the therapeutist even thirty years ago; that is, long before the constitution of the Chloride of Iron Well was dis-

covered, and when yet physiological inquiry had to unfold the neuro-vascular properties of Barium as hints to its remedial application: for, in 1846, Dr. Walsh of Dublin, records valuable results in certain skin diseases, and in scrofula, from the prescription of a solution of the "muriate of barytes" with the "muriate of iron" in distilled water.* This combination of Barium with Ferruginous salts is suggestive, in affording at least some clue to the well proved efficacy of the Chloride of Iron Water in chronic skin diseases; in cases broadly characterized by malnutrition of the blood and of the tissues, which demand from the first constructive treatment rather than depuration; and in other cases after the latter process has been sufficiently effected by the Sulphur water.

Viewed, therefore, from all sides of their constitution these medicinal springs are of exceptional therapeutic value, not merely in being charged beyond all others with a soluble Barium salt in tangible doses, but in furnishing besides various constituents—themselves also remedies of known efficacy—which enforce and suggestively supplement its recognized curative powers. The Barium charges of some other Harrogate waters are overshadowed

* *Dublin Med. Press*, Feb. 18, 1846.

by those of the Old Sulphur Spring and the Chloride of Iron water; but though they cannot be so definitely connected with the therapeutics of Barium, they may nevertheless exert their legitimate influence; for instance, the daily dose of Barium conveyed by a course of the Kissengen water—gr. $\frac{2}{3}$, or even by that of the Magnesia Water—gr. $\frac{1}{3}$, should not be ignored; for the remedial power of these smaller quantities is fairly within the grasp of probability.

But the ample choice furnished by the varied therapeutic resources of Harrogate provides the prescriber, not merely with several degrees of Barium impregnation, but also with waters practically free from it, though similar in other respects to the Barium-waters: for instance, instead of the Old Sulphur Spring, or the Chloride of Iron Water, he may prefer the strong Montpellier Sulphur, or the Alexandra Water.

The salts of Strontium have been discovered in several of the Harrogate waters. But inasmuch as nothing is known of them as remedies—not even whether they are as closely allied therapeutically to those of Barium as they are known to be chemically—the rôle they play in the operation of the springs cannot therefore be determined.

III. SULPHIDES.

There is much yet to be learnt as to the physiological effects of Sulphides on the organism; and still more as to their therapeutics.

1. It was affirmed by Roth, of Weilbach, that Sulphuretted Hydrogen entering the portal vein by diffusion, attacks the iron of decaying blood corpuscles, and thus aids their destruction. The strong affinity for iron which the sulphur present in Sulphides is well known to possess, as well as the clinical value of sulphur waters in congestive states of the liver and portal vein favour this theory.

2. Sulphides probably stimulate powerfully exosmosis from the blood in the alimentary tract, and may thus relieve engorgements of the portal circulation. Dutrochet, while investigating the physical conditions of exos- and of endos-mosis, observed that the presence of a very small quantity of Hydrogen Sulphide in a solution of gum or of sugar on one side of the septum, with water on the other, diminished very considerably the endosmotic action —*i.e.*, the diffusion of water into the solution of gum or sugar—by giving rise to a powerful exosmotic current from the sulphided solution to the water.*

* Dutrochet, *De l'Endosmose-Mémoires.* Paris, 1837, p. 64.

If the chlorides present in the Saline-sulphur waters be taken to favour the absorption of the Sulphides, and if the blood circulating in the stomach and bowels be substituted for the sulphided solution of Dutrochet, rapid exosmosis from the portal system may possibly ensue. The diuretic action of sulphur waters is also open to this explanation.

3. The large amount of loosely combined sulphur which chemists find in the epidermis, suggests the probability that this element may hold a similar nutritive relation to the outer coverings of the skin, as, for example, iron does to the red blood corpuscles. Keratin, the organic substance chemically alike in cuticle, horn, nails, hair, &c., contains five per cent. of sulphur (v. Laer), and when dissolved in alkalies evolves Sulphuretted Hydrogen on the addition of acids. "When heated with barium hydrate and water in sealed glass tubes, nearly the whole of the sulphur is obtained in the form of $Ba(SH_2)$"* If sulphur otherwise combined than that furnished by the proteids is available for the nutrition of the epidermis, no more absorbable forms can be provided than the Alkaline Sulphides of the Harrogate waters.

* Hoppe-Seyler, quoted by Prof. Gamgee :—*Physiological Chemistry.*

Many cases of chronic eczema suggest a resemblance to wounds which refuse to heal because skin fails to be constructed; but the breach of surface is more superficial: it suggests merely a defective development of the outer covering scales, as if these, from lack of some nutrient element—it may be sulphur—cannot be formed, or consolidated, rendering the final efforts of cure abortive.

This possible relation of sulphur to the epidermis does not include the whole of the therapeusis of the remedy in chronic skin-diseases; it however, at least, affords one reason for the long-established and deeply-rooted conviction of its efficacy in cutaneous ailments.

4. There is good ground—both physiological and clinical—for believing that Sulphuretted Hydrogen, and the Sulphides from which it may be generated, possess a *sedative action* on all the tissues of the body, more particularly, however, on those through which it escapes from the organism, such as the skin and all the mucous membranes; hence, probably, its power of quieting and curing inflammatory action of which these tissues may be the seat; and hence, perhaps, the reason why it often reduces irritability of the nervous system. "It is certain that the nervous system and the blood are particularly influenced by this gas, which has a very manifest

stupefying power. Accordingly, one can understand up to a certain point, how it diminishes the inflammatory stimulation of the lungs in chronic catarrh, and in commencing phthisis, and how the mineral sulphur waters give the most unlooked-for results in the diseases of which we are now speaking."*

But on the other hand, the element Sulphur, both when taken internally, and when applied externally, possesses *stimulating properties;* and they are thus described by another master in therapeutics—Prof. Gubler. "Once having reached the blood, sulphur acts as a diffusible stimulant; it accelerates the circulation, raises the temperature, inflames the viscera, almost determines hæmorrhages, causes headache, sometimes giddiness, increases cutaneous transpiration, and produces—when the dose is large and long continued—an appreciable febrile movement. This fever is accompanied by an eruption—erythematous, miliary, or vesico-pustulous—which can assume also other forms in accordance with the intensity of the cause, and the constitution of the subject. This exanthema is known in thermal stations under the name of poussée.†

. . . . . .

* *Traité de Thérapeutique*, par MM. Trousseau et Pidoux.

† The writer's observations lead him to adopt a different interpretation of the cause of *poussée* in sulphur watering-places. See p. 154.

"The stimulant or irritant action exercised by sulphur upon the skin and the respiratory mucous membrane, is explained by the passage of this principle through the excretory apparatus of these teguments. Sulphur, in fact, is metamorphosed in the circulation: one part into sulphuric acid, then into sulphates, which pass in the urine, hence its diuretic action;* and the other part into sulphuretted hydrogen, which, like other volatile substances, escapes by the lungs and the sudoriparous glands."†

Now the sulphur present in sulphur waters is usually believed to be similar in its therapeutic effects to ordinary free sulphur used in medicine—effects due to its stimulant action. The writer is inclined to discredit this view, and to regard *free Sulphur* and *Sulphides* as totally—or almost totally—different remedies, and to believe the stimulant action of the former is modified or reversed to a sedative one when sulphur is combined with hydrogen or an alkali metal in sulphur waters. Various considerations, apart from medical experience, point forcibly to this conclusion, such as the following:—

* The writer is inclined to ascribe the diuretic property of Sulphur to the exosmotic action of Sulphides.

† *Commentoires Thérapeutiques de Codex Medicamentarius*, par A. Gubler, Profess. de Thérapeutique à la Faculté de Médecine de Paris, &c.

(1.) Pure* sulphur, when taken internally, is built up by the chemical re-actions of the organism into soluble forms—sulphides and sulphates—which can only be constructed by expenditure of energy; and, inasmuch as chemical changes cannot occur without physiological disturbance, it is probable this extensive linking together throughout the tissues of hydrogen on the one side, and of oxygen on the other to sulphur, will be accompanied—as similar re-actions out of the body are—by the development of heat, which in the system may be furthur attended by vascular and nervous excitement. Hence the immediate action of free sulphur may be stimulant, as Prof. Gubler asserts. One branch of these constructions—the union of sulphur with hydrogen—is already formed in sulphur waters; and, when constructed within the body from free sulphur, may, by its sedative power, modify the irritant action of the oxygen products of sulphur—though the latter may still predominate.

(2.) Some chemical matters, though merely theoretical and analogical—may be taken for what they may be worth, as suggestive of the distinction which

* Free acids "have been found in the proportion of from ten to thirty parts in ten thousand parts of ordinary sublimed sulphur."—*The National Dispensatory*, by Stillé and Maisch, 1879.

clinical observation draws between Sulphur and Sulphides as remedies.

Nothing is known of the effects produced on the animal economy by the other members of the Sulphur group—Selenium and Tellurium; they and their hydrogen compounds, however, greatly resemble in chemical properties Sulphur and Hydrogen Sulphide. But whatever the physiological action of Selenium may be, there is no doubt that Seleniuretted Hydrogen (H_2Se) is energetic according to Berzelius: "In order to become acquainted with the smell of this gas, I allowed a bubble not larger than a pea to pass into my nostrils. In consequence of its action I so completely lost my sense of smell for several hours that I could not distinguish the odour of strong ammonia, even when held under my nose."*

On turning to some other elements which form hydrogen compounds, it will be noted the irritant properties of the former are lost or become modified in the latter; for instance, how all the stimulating effects of Phosphorus are reversed in the deadly poisonous gas Phosphuretted Hydrogen, and of Oxygen are lost in the neutral liquid—Water!

(3.) Sulphuretted hydrogen appears to kill plants

* *Lehrbuch*, 5 Aufl. ii. 213.

by way of narcotism. Its deadly stupefying qualities, contrasted with the more localized irritant effects of an oxygen compound of sulphur (SO_3H_2) on plant life, are thus well described by Dr. Brunton. "When plants are exposed to sulphurous acid the leaves shrivel up, wither, and fall off; but if the plant be now removed from the noxious influence of the gas, and placed under favourable conditions, it will recover and send out fresh shoots. But if it be exposed to the action of sulphuretted hydrogen, the leaves, instead of shrivelling, simply begin to look flaccid and droop. This seems, at first sight, to be a less deadly action than that of the sulphurous acid, but when the leaves have once begun to droop in this way the plant is dead, and does not recover when removed from the action of the gas." *

These and other similar considerations that can be adduced appear to the writer to at least suggest caution in applying our knowledge of the action of free Sulphur in explanation of that of Sulphides present in mineral waters; for the evidence—chemical, physiological, and therapeutical—bearing on the question point, not merely to a difference in the effects of these remedies on the organism, but also to the operation of Sulphur on the one hand and

* *Practitioner*, Oct. 1880.

Sulphides on the other following exactly opposite lines.*

When sulphur is applied externally it is apt to act as a stimulant or irritant; and, inasmuch as exanthematous and other eruptions (Poussée) are sometimes developed at sulphur watering-places—Prof. Gubler restricts them to thermal ones—they are believed by some to indicate the stimulant action of the sulphur present in the water.

The writer's observations on this matter lead him to a different conclusion. He has never witnessed *poussée* as the result of merely drinking sulphur-waters; but he has observed an exanthem traceable to bathing in them, only, however, when the baths were of too

* The writer finds he is not singular in his views as to the sedative action of the Sulphides present in sulphur waters: "M. Lambron, expérimentant à Luchon, affirme que l'élément sulfuré des eaux prises en boisson et en bain tempéré exerce une action hyposthénisante tres marquée sur le système circulatoire. Suivant lui, sans que les différences de sexe, d'âge et de constitution changent ces résultats observés à diverses reprises, les contractions du cœur deviennent moins energiques et moins nombreuses; le pouls, pendant plusieurs heures après la bain, baisse de 8, 10 ou 12 pulsations sur le rhythme normal et habitual. Les relevés de M. Armieux à l'hôpital militaire de Barèges, les observations de Gerdy, de M. Doyon, à *Uriage*, et d'autres, tendent à établir l'action sédative des eaux sulfureuses en opposition avec les opinions qui regnaient anciennement sur leur propriétés stimulantes."—*Manuel Médical des Eaux Minérales*, par Eug. le Bret, Paris, 1874.

high a temperature or too frequently resorted to—a result from over-bathing in ordinary water frequently witnessed at hydropathic establishments. He therefore believes Sulphides in the waters should be exonerated from acting on the skin as irritants or stimulants.

Cutaneous eruptions occurring during a course of treatment are harmless and quickly pass away, but they form no necessary part of the cure.

The direct sedative influence of Sulphides on local inflammation is, perhaps, best illustrated by their curative use as baths of pure Sulphur-water in skin diseases, and as an atomized inhalation of the same water in chronic inflammatory affections of the pharynx, larynx and bronchial tubes; and it is maintained by the Sulphides reaching the affected structures by drinking the water at stated intervals.

5. The form in which sulphur is combined in the Harrogate waters, is a matter of great therapeutic importance. As previously noticed, an Alkaline Sulphide holds the principal part of the sulphur in perfect solution. This salt is curatively more valuable than the Gaseous Sulphide; for if broken up by the acids of the stomach, it will furnish a further supply of Sulphuretted hydrogen, and any portion which escapes this decomposition may be readily

carried by the blood to all parts of the system, where it may encounter and reduce an excess of free acids, such as are associated with gouty and rheumatic ailments—*e.g.*, uric acid, sarcolatic, and other acids—Sulphuretted hydrogen being liberated in their place. The Saline Sulphide charge is more definite and stable than Gaseous Sulphuretted hydrogen —the ordinary sulphide of the generality of sulphur waters—and is, moreover, unlike the latter, inasmuch as it may undergo chemical reactions with the acids of the organism, whereby it may effect curative work beyond the range of sulphide gas.*

In the Saline-Sulphur waters the association of Chlorine combinations is therapeutically harmonious; as, for instance, where the object is to remove

* The following passage from M. le Bret's "Manuel Médical des Eaux Minérales" corroborates the writer's views as to the therapeutic superiority of waters charged with Sodium Sulphide over those merely sulphuretted by virtue of Sulphuretted hydrogen: "Il résulte des travaux de M. Filhol que les eaux, dont le sulfure de sodium est le principal élément minéralizateur, sont à la fois les plus stables et celles dont l'action locale se prononce le plus, par rapport aux dermatoses, aux plaies, aux ulcères, aux trajets fistuleux, &c. Les eaux très-altérables, qui dégagent une forte proportion de gaz acide sulfhydrique, agissent à la fois sur la peau et sur les poumons, mais leur action est moins durable, et quant à celles qui blanchissent par la précipitation de sulfre, on sait qu'elles perdent une partie de leur sulfuration, et consequémment de leur énergie."

pathological products—such as residues of gouty or rheumatic inflammation, or scrofulous indurations—chlorides, by improving the extra-vascular circulation of fluids, and the power of the circulation as an absorbent apparatus, may favour the passage of the Alkaline Sulphide into the tissues requiring it, and a quickened lymphatic circulation may the more readily remove the products of chemical destruction. And this therapeutic work may be further advanced by the conjoint use of the Alkaline-Sulphur waters, and the use of warm Saline-Sulphur baths, and of douches of hot Saline Sulphur water, combined with well-directed shampooing—agencies which powerfully stimulate the resolution and absorption of exudations, and favour the release of parts crippled by inflammatory and other adhesions.

The reader may here observe that Harrogate enables the physician to apply, as the needs of cases demand, the simultaneous use of several natural remedies of allied power, which he may concentrate to the cure.

Among the prominent advantages of this Sulphur Spa are those derived from the Saline charge of some of its Sulphur waters, especially for external use. Nearly all Thermal Sulphur springs, *e.g.*, the Pyrenean —whatever their medical value in other respects, are,

as a rule, weak solutions of Sulphides, and contain salts in so small a quantity, that their curative use as baths may be justly ascribed to their temperature and to the adjuvant manipulations.

6. Some other points in the chemical constitution of the Sulphur waters, are doubtless reflected in their therapeutic operations.

(1.) The absence of Sulphate of Lime, and the presence of Carbonate of Lime in small proportion. Both these salts are difficult of digestion, produce constipation, and greatly lessen the medicinal power of accompanying constituents; such as aperient doses of the Chlorides of Sodium and Magnesium, &c. Gypsum is of special ill-repute in this direction—especially when exceeding 6 or 8 grains per 20 ozs.

Chloride of Calcium present in the Old Sulphur Well (gr. $5\frac{1}{2}$), strong Montpellier Sulphur (gr. 10), and the mild Saline Sulphur waters (gr. 4) cannot well come under these chemico-therapeutic considertions; for it may be decomposed by the acids in the digestive tract, and in this respect differs from sulphate of lime, and it has been observed to correct and strengthen digestive power rather than to retard it. (See p. 130).

(2.) Finally, the probable therapeutic gain derived

from Barium and Strontium (see p. 132) should not escape recognition.

The Old Sulphur Spring possesses a charge of Iodine and Bromine, which entitles it to a high position among waters containing them in larger proportion than others (see p. 93). Various writers on mineral waters are fain to regard these constituents as effective remedies, though existing in quantities which all physicians must look upon as impotent. It is said that Iodine in mineral waters resolves hepatitis, chronic ovaritis, engorgements of the spleen and of the uterus, especially when these ailments are combined with a strumous constitution.*

The Old Sulphur Well is of value in all these ailments; but the writer cannot say if its iodobromide charge should be credited with any share in the therapeutic results.

IV. IRON SALTS.

Convenience of arrangement and brevity are secured by deferring comments on the ferruginous salts of the Harrogate waters to a subsequent chapter. (Chap. IV.)

* See *Traité Générale des Eaux Minérales de France et de l'etranger*, par MM. Petrequin et Socquet.

CHAPTER II.

GENERAL THERAPEUTICS OF THE WATERS.

I. *Chemical and Therapeutical Analyses of the waters may only illustrate, but cannot provide, a just conception of their observed effects.*

THE foregoing commentaries on the principal components of the waters, may be viewed as but a few isolated threads, which the reader may trace here and there in their individual colours in the tangled web of practical experience. The chemical analysis of mineral waters may be likened to the scalpel of the anatomist, exposing and separating the tissues of an animal or plant, for it also isolates constituents grouped together by the hand of nature into a living whole, and then attempts to reveal the natural structure. But the tissues of the animal or the plant, or the constituents of the waters exposed and detached by these processes of practical science, require to be vitalized by a knowledge of physiology before a conception of the behaviour of all these elements in the living unit can be conceived; and in each case that conception, at best, will merely be a general one, for

the special and individual experience of what the animal or plant, or the mineral water was before each was subjected to the scrutiny of the anatomist, or of the chemist, is essential. But, while the chemical analysis of mineral waters and the clinical experience of them may run independently of each other, the former often reflects light on the practical ends and aims of the physician who prescribes them; though he cannot build up a true conception of the operation of medicinal springs with his knowledge of the physiology and therapeutics of the constituents used by him or others as separate remedies, he cannot, when they appear in sufficient quantities, ignore them as factors in the unified results, and, when it illumines his experience, the prescription of the waters becomes somewhat more rational and discriminative. And, moreover, chemical and therapeutical analyses may enable others to realize a better notion of the curative properties of mineral waters than can be gleaned from mere statements of results which they have no opportunity of witnessing. And, furthermore, chemico-physiological knowledge and collateral clinical experience—independently formulated—of the principal constituents may enable one here and there to rend the veil of mystery, which it has too commonly been the pride of mineral water thera-

peutists to guard with jealous, if not almost sacred devotion. There is, however, doubtless much more to be learnt respecting the operation of mineral waters as curative agents on the animal economy, but patient clinical observation as well as the application of collateral knowledge equally positive and true to nature, will doubtless shed a fuller and truer light into many dark corners.

II. *The therapeutic principles which underlie the operations of the Waters.*

Clinical observation enables the writer to recognize a fundamental principle, to which most of the obvious effects of the waters may be referred; a principle which appears to group all the springs together into a harmonious series of natural curative agents with the keynote—acceleration of tissue-change. The number and variety of the waters enable the prescriber to vary the combinations according to clinical requirements; he may, for example, maintain an equally balanced increase of building and of unbuilding, or he may cause one of these processes to predominate, or he may render the therapeutic movement of tissue-metamorphosis irregular—now in the ascendant, a quickening of the

production and removal of waste, and now of construction; but throughout, the keynote remains true. The radical action of these natural remedies is exerted on the blood and the tissues; and it is one which stimulates both sides of nutrition—the removal of the out-going and the substitution of the in-going molecule—and is, in fact, the normal operation of Chlorides on disintegration and construction.

But in Harrogate these renovating agents are linked, on the one hand with those which specially favour construction, such as the salts of Iron, Barium, &c.; and on the other with Sulphides, which hasten disintegration.

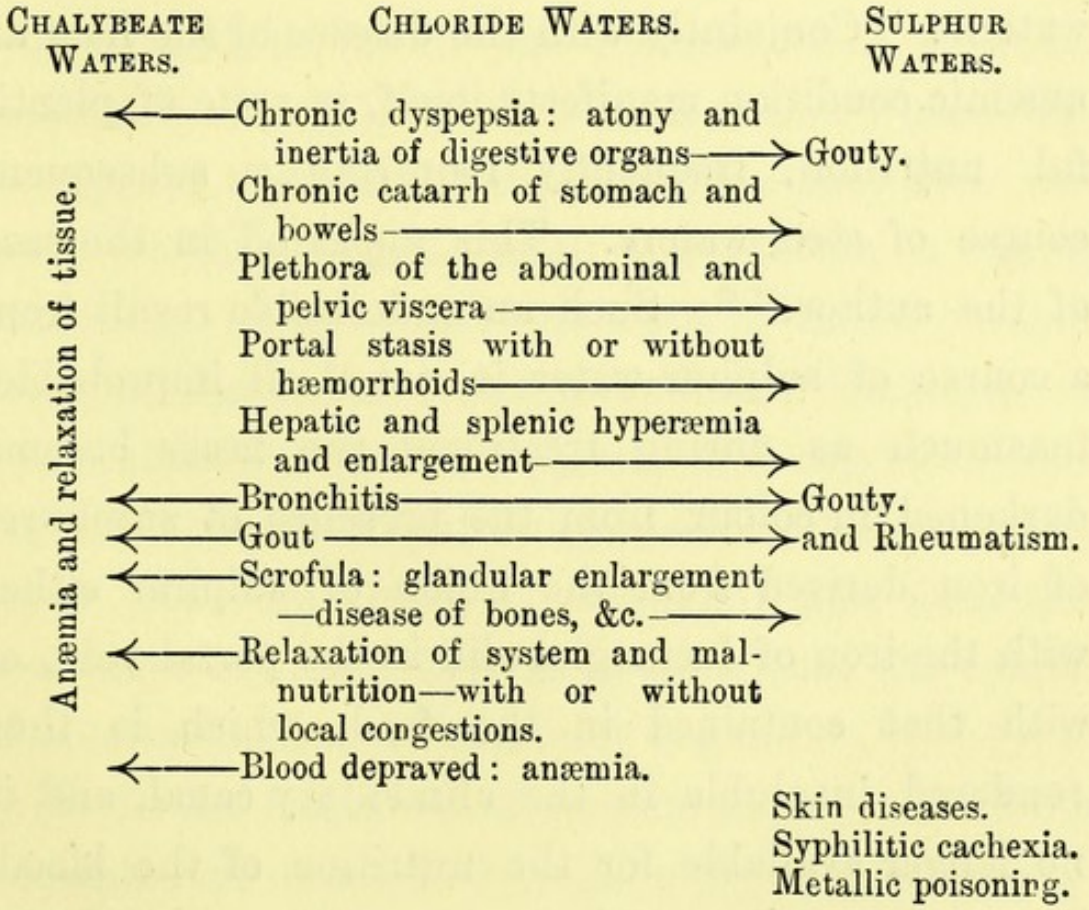
The therapeutic unity of the whole series of mineral waters is a valuable acquisition to Harrogate, and offers several practical advantages in the treatment of cases which resort to it; such as the following.

1. Cases frequently present themselves in which the use of Pure Sulphur or of Chalybeate waters appears to be specially desirable, but is contra-indicated by the state of the stomach, liver, or bowels. Under such circumstances ordinary medicinal treatment of a preparatory nature would perhaps be resorted to elsewhere; but in Harrogate the natural therapeutic resources may be sufficient to meet the

clinical needs, for a preliminary course of the Saline Aperient waters—whether sulphuretted or ferruginous, according to the indications—may afford the necessary correction. Then again, at many Chalybeate or Sulphur watering-places, the bowels, which are apt to become constipated, demand careful attention during the course, and ordinary purgatives or imported aperient waters are resorted to; at Harrogate, however, the Aperient Salines may be used for this purpose, and thus become, not merely complementary to the Chalybeate or Sulphide treatment, but auxiliary to it, because of their allied constitution and curative power.

2. The association of Salines—in suitable combinations for both aperient and diuretic action—with either Sulphur or with Iron, is believed to enforce the action of each. This may explain why in many cases the concerted use of the Aperient Saline-Sulphur, or Iron with absorbable doses of either Sulphur or Chalybeate waters, often succeeds, when the latter alone either completely fail or effect only a partial improvement. This position appears to be corroborated by observing how far the recognized therapeutic indications for the use of Chloride coincide with those of Sulphur and Iron waters. The following table in a general way indicates—by arrows—the harmonious

properties of these different classes of mineral waters; and may enable the reader to readily note the therapeutically valuable association, which, it is presumed, the curative powers of the body of Chlorides in the Harrogate Sulphuretted and Chalybeate salines form with the more special yet synergetic properties of the Sulphides and Iron-salts.



3. But while the special therapeutic properties of the Sulphides are emphasized by their association with Chlorides, the latter appear to serve two useful purposes in the courses of treatment by the Saline

Sulphur-waters which are not apparent when Pure Sulphur-waters are employed.

(*a*) It is believed the integrity of the blood is impaired by sulphur-waters containing little more than Sulphides; for anæmia has been frequently noted as a result of treatment by them. Dr. Braun personally experienced this ill effect after the successful reduction of an enlarged liver by the Weilbach waters: "Conjointly with the disease of the liver an anæmic condition manifests itself, in spite of plentiful nutrition, frequently requiring a subsequent course of steel waters. This appeared in the case of the author." * Such an undesirable result from a course of sulphur-water is not at all improbable, inasmuch as during treatment the fæces become darkened in colour from the presence of sulphuret of iron derived from the union of sulphur either with the iron of hæmoglobulin in the portal vein, or with that contained in the food, which is thus rendered insoluble in the alimentary canal, and is no longer available for the nutrition of the blood. Practical experience, however, of the use of the Harrogate Saline-Sulphur waters, when taken even for long periods, while the clinical indications are appropriate, shows they do not induce anæmia; at

* *Op. cit.*, p. 414.

any rate when—as is the rule in all suitable cases—they stimulate the digestive organs and largely increase the ingestion of food. The only explanation of this difference between the operation of these and of Pure Sulphur waters on the constitution of the blood appears to be the presence of Chlorides in larger proportion than in any other sulphur waters; salts which are well known to invigorate the digestive system, and to favour the restoration of blood in anæmia.* Pure Sulphur waters not only often fail to improve digestion, but sometimes they even depress it; they do not refresh the stomach as Saline waters do. One of the best tests of the favourable action of the Saline-Sulphur waters of Harrogate is a remarkably improved appetite and digestion and the development of real hunger, which declare themselves from the outset of treatment, and form the best index of much benefit in store from the course of treatment thus auspiciously begun.

(*b*) In the treatment of certain phases of chronic ailments the associated Salines are of great therapeutic value. In very chronic cases of eczema sometimes the skin affection fails to be cured, apparently because the local morbid process is sluggish,

* Many observers believe chlorides possess hæmatinic properties (see pp. 209–9).

and the skin does not possess sufficient vitality for the purpose of repair; then the daily stimulation of tissue change by the rich charges of Chlorides in the Sulphur or Iron waters, which accumulate in the tissues (see p. 120),* gradually rouses the morbid dulness of the nutrition of the skin, until even a fresh outburst of the disease may be induced; but this excitation may, however, be the prelude of great improvement, or even of cure.

So again, in some low types of gout, the Saline-ness of the Sulphur waters may stimulate tissue-metamorphosis until at last the disease may honestly declare itself; but this effect also is, as a rule, but indicative of a start towards improved health, and even to partial emancipation from the continued but subdued thraldom of the disease. The writer has rarely observed pure rheumatism amenable to a similar excitation by the Saline-Sulphur waters; consequently, when it occurs in the course of treatment of arthritic cases, in which it cannot be accurately decided whether they should be referred to chronic rheumatism or gout, he is inclined to regard it as solving the obscurity in favour of the latter—the Chlorided waters proving themselves a sort of touch-

* The writer here refers more to the absorbable doses of chlorides than to the aperient ones.

stone between these ailments. Pure Sulphur waters merely taken internally* rarely induce these reactions which, as a rule, mark the road to better health; for they are manifestations of stimulated nutrition which may lead to a higher vitality of the whole system and of the affected parts. The consecutive improvement does not appear to be so much the result of the local excitation—which may be the first to declare itself, because, perhaps, it offers least resistence to the stimulating action of Chlorides—as to the general exaltation of the nutritive processes.

3. Ample choice of springs enables the treatment to be started at any point of the therapeutic scale provided by Harrogate; or, if necessary, typical waters of the whole series may be called in requisition—when, for instance, a patient may begin with a Strong Saline-Sulphur water, and, after being led through intermediate stages, may complete the course of treatment with the Strongest Chalybeate.

It should be here remarked, that though anæmia is not in suitable cases perceptibly induced by the Saline-Sulphur waters, there are many cases which derive further benefit after their sulphuretted course

* Warm bathing, whether at thermal stations or in heated saline waters, likewise exalts local and general tissue changes such as are apt to follow courses of Chloride waters.

is ended, by proceeding to the Ferrated-Salines or the Pure Chalybeates; not, however, so much because it is necessary to restore the blood and the tissues impoverished by sulphur treatment, as for the purpose of consolidating the improvement already gained, and of establishing a firmer general health; so that there may be less probability of a return of the ailment which, in the first instance, suggested the use of the sulphur waters.

III. *Selection of cases.*

As a rule it is unwise to advise the Harrogate waters to patients in whom morbid processes are either active, or though waning from, are still within the limits of a recent disturbance, or are unstable and touchy, with an evident wavering towards activity; in such cases—as in gout and skin diseases—they may now and then, it is true, be exhibited with success; but it is better to avoid the risk of an unhappy hit, and to wait until the pathological action, while subdued, obstinately persists.

Chronic ailments — unassociated with wasting organic diseases—derive most benefit from Harrogate and its waters; such as struma, gout, rheumatism, skin diseases, anæmia and relaxation of tissue,

portal congestion, &c. Among these diseases the treatment, when periodically resorted to, is frequently observed to be of great and permanent value in such cases as have settled into that obdurate state which cannot be impressed by ordinary remedies; cases in which the pathological condition of the tissues reminds one of the compacted soil around the roots of plants, which bars out the life-giving influences of nature—the air, the light, the snow, the rain, the dew and the mineral nourishment in solution—but, when broken up, permits them again to diffuse health and vigour throughout the vegetable tissues.

IV. *Therapeutic methods, &c.*

The fact that Harrogate possesses aperient waters (both of the sulphuretted and ferruginous orders) which have acquired a deeply-rooted reputation as the mainstay of its therapeutic resources, has given rise to an impression that nearly all patients submitted to a course of treatment there must be subjected to continuous purgation; this is, however, a fallacy. The various therapeutic applications of the numerous springs (non-aperient as well as aperient) which the physician can employ in divers ways, both externally and internally, enable him to

cope with the clinical peculiarities of each case, whether they arise from the nature or the individual pathological phase of the disease, or from idiosyncrasies of the patient, or other exceptional conditions patent to the experienced observer. The prescriber of the waters therefore employs them—though natural curative agents—as ordinary remedies, and in the same selective way adapts them to the individualism of the patient and of his disease. The treatment can be so adjusted that the functions of the body may, on the one hand, be controlled by the least disturbing measures, or, on the other, may be impressed with firmness and vigour by the concentrated salines. But the latter are not prescribed in so large a proportion of the cases submitted to treatment by the waters as outsiders are inclined to believe, and great care is exercised by the local practitioners in the selection of suitable cases for their exhibition.

Continued purgation by Chloride waters is, however, less to be feared on the score of lowering the system than by the Sulphated; for the latter more readily excite catarrh of the alimentary canal, more quickly lower the tone of the organism, and cannot be continued for so long a period without interruption as the Chloride aperient waters. The action of

Sulphated waters rests mainly on local irritation: while Chloride waters perform the same local work in a milder manner, and, furthermore, induce widespread effects throughout the tissues; a difference in operation which possibly hinges on Chlorides in aperient doses being normal constituents of the blood, and of all the secretions, and, being merely augmented for the time, their physiological are exalted into therapeutic powers, which not merely operate in the intestinal tract but all through the organism—while Sulphates are far from prominent constituents of the fluids, and act as local irritants. Hence concentrated chloride waters induce purgation in the most natural way attainable by therapeutics, and with the least expenditure of the forces of the organism.

Sometimes, however, the clinical conditions call for Sulphates rather than Chlorides, or a combination of both, which is often better than the former alone; then some of the imported Bitter waters may be added with advantage to the morning draughts of Saline-Sulphur or Saline-Iron water.

When the aperient doses of the concentrated salines fail to disturb the bowels, they are apt to cause temporary discomfort: this statement, however, more especially applies to the Strong Sulphur-

waters, which, when not ejected by vomiting, drain away by the kidneys, when the oppression they induce is relieved. The weaker salines, as a rule, do not act as aperients—per contra, like small doses of the stronger waters, they dispose to constipation, and are valuable aids to the cure of certain forms of diarrhœa—they are digested with comfort, and are valuable and reliable diuretics.

CHAPTER III.

THE THERAPEUTICS OF THE SULPHUR-WATERS.

HARROGATE, possessing both *saline* as well as *ordinary* sulphur-waters, provides exceptional therapeutic advantages as a Sulphur-spa: for, inasmuch as other watering-places are rarely furnished with examples of more than one of these groups of springs, it affords the practitioner an ampler choice of Sulphide waters than can be found in any one locality elsewhere; and, furthermore, as the curative operation of Pure Sulphur-waters is regarded by some as doubtful in certain diseases—such as portal congestion and stasis, gout and scrofula—the more reliable therapeutic range of them is enlarged and emphasized by their charge of salines, which are recognized as valuable remedies in these ailments.

The sulphur treatment generally consists of both the internal and external use of the waters; but frequently it is deemed advisable to confine it merely to one or other of these applications. The curative employment of the Harrogate Sulphur-waters runs in the following clinical directions:—

1. *Disorders of the stomach:* such as are characterized by

(*a*) *Atony and inertia:* when the tongue may be clean, but is indented and flabby; the appetite may be good, but, after only a moderate meal, the patient experiences much fulness and oppression, drowsiness and flatulence; the bowels are constipated; and often there is an irregular outflow of urinary water—now the urine is scanty and loaded with lithates, then pale and abundant.

(*b*) *Chronic catarrh:* when the tongue is loaded or slimy and indented; the breath offensive; flatulence troublesome at all times; the appetite capricious; the bowels generally constipated, or they alternate between constipation and diarrhœa—or, in other words, between sluggishness and irritability; and the urine usually highly-tinted and loaded with lithates.

These digestive disorders are often associated with portal congestion (from over-eating, alcoholic excesses, sedentariness, &c.), gout and struma (p. 194).

The waters are contra-indicated when the dyspepsia is of an irritative form; when the tongue is red and has a stripped or raw look, or is pointed at the tip with injected red papillæ there and on the sides; when great uneasiness is experienced from

about half an hour after eating, and throughout the digestion of each meal; when there is thirst, which is most troublesome at night; and nausea, and sometimes even vomiting of food or of mucus.

2. *Chronic constipation* is often greatly improved by an aperient course of the Old Sulphur Well: the bowels, after the immediate effects of treatment have passed away, becoming much more regular. This desirable result the writer has specially noted in the cases in which, besides an atonic condition of the muscular fibres of the large bowel, there were indications of an unhealthy state of the intestinal mucous membrane—probably of the nature of chronic catarrh—when the habitual constipation was accompanied by the rapid generation of gaseous products in the bowels, and by the appearance of mucus in the evacuations—either enveloping the scybala or coagulated as shreds.

3. *Plethora of the Abdominal and Pelvic organs.*

(*a.*) Engorgement and hyperæmia of the liver from over-eating and from alcoholic stimulants. If the liver be equally enlarged in all directions with signs of bile-pigment abroad in the general circulation—such as a sallow and even slightly jaundiced skin, a sub-conjunctival bile tinge, urine deeply tinted or

even containing traces of bile—with constipation, and the patient mentally dull and indisposed to exertion, the Strong Sulphur-waters—represented by the Old Sulphur Spring—undoubtedly relieve the hepatic engorgement more quickly and more effectually than any other saline treatment with which the writer is acquainted; and, when periodically resorted to by those disposed to this type of hepatic derangement, they not merely alleviate the immediate embarrassment, but may ward off or even prevent the approach of a coming evil which may take the shape of cirrhosis.

Minor disorders of the liver, pathologically akin to this congestive form, are frequently observed to derive great benefit from the strong sulphur treatment: cases, for instance, in which the hepatic derangement is not merely less pronounced, but is of an intermittent type, and such as may be referred to an exaltation of the physiological hyperæmia of the portal system which accompanies digestion—an exaltation which appears to be on the borderland of pathological deviation; then, as a rule, traces of biliary colouring matter—as it is freshly formed—cannot be detected beyond the portal circuit, and the absence of an enlargement of the liver is shown by the edge of this organ failing to be felt beyond

the margin of the thorax,* but for several hours after the principal meals the patient complains of more than usual dulness and oppression, and the urine is apt at one time of the day to be highly tinted and loaded with lithates—without obvious cause in increased exercise or perspiration—and at another clear and normal, and the complexion is apt to be dark sallow, and here and there may be observed—especially about the temples—slight brownish tints or even more distinct liver-stained patches. In such cases one sometimes discovers a history of gout, or this disease is in course of development by sedentary habits and by a too richly nitrogenous diet.

(*b.*) *Portal stasis with hæmorrhoids.* The relief afforded to the portal circulation not merely reaches that part of it connected with the liver and spleen, but extends even to the passive congestion of the hæmorrhoidal veins.

(*c.*) *Congestion of the Uterus and inflammatory induration of the Uterus;* often associated with

* This is undoubtedly a good and ready practical test of enlargement of the liver; but when the margin is found to advance downwards it is still necessary, before deciding as to whether the organ is enlarged, to eliminate from the clinical view dislocation forwards of a liver which may be of normal size.

congestion of the liver and constipation. It is not merely the internal use of the Sulphur-waters which exerts a favourable action on the pelvic organs when affected by passive or inflammatory congestion, but also the topical use of them as douches, especially in uterine cases in which catarrhal and suppurative discharges or indurations are prominent features.

Comments.—The steady daily drain of fluid from the bowels is believed to relieve the overloaded portal system, and is of special service when the liver and spleen are hyperæmic. The aperient sulphur treatment may relieve hepatic and splenic engorgements mechanically by determining an outflow of serum from the portal vein, and may, furthermore, clear away a good deal of abnormal liver-work by sweeping beyond the reach of the intermediary circulation of the liver (p. 125), and thus diverting from this organ the excess of biliary elements which, previously re-absorbed, overloaded that circulation, and tainted the whole system. But whatever the explanation, the benefit derived from a course of the aperient sulphur-waters is unquestionable; for the urine becomes pale and abundant, the fæces darker, the dingy sallowness fades, or the pallid or the congested face acquires a healthier tint, and the patient

becomes more and more cheerful and less irritably nervous or less apathetic.*

4. *Enlargement of the liver or spleen from long residence in tropical climates or from malaria.* The writer has observed in a few such cases a marked improvement in the digestive powers and in the general health from a short course of Sulphur-waters followed by the Kissengen in aperient doses (p. 203) with other Saline-Chalybeates (p. 213).

5. *Imperfect action of the liver and of other chylo-poiëtic viscera not traceable to hyperæmia.* It is not an uncommon medical experience to observe cases in which, from the general assemblage of symptoms, a derangement of the portal system is suspected, but cannot be accurately defined, because the more special and ordinary signs of the recognized disorders of the liver and the allied organs—such as bile-pigment abroad in the tissues, and excess of lithates in the urine, or an alteration in

* The cheering effect of the Sulphur water in all cases of 'liver' which it relieves, did not escape the earlier observers of its operation; for thus wrote Dr. Neale more than 150 years ago: "It opens obstructions of the liver and other viscera: and, though it purges sharply, yet, even during the operation, the drinker may perceive his spirits raised; he is more cheerful, active and vigorous. It resists all corrupt humours, creates a keen stomach and quick digestion."—Quoted by Dr. Short, 1733.

the size of the liver, spleen, &c.—are absent. The cases to which the writer refers are such as are often found among those who have led for long a sedentary indoor life, perhaps in a large town, or who are suffering from the overstrain and worry of these high-pressure times, or who either proceed from a gouty stock or have become themselves gouty, in whom there is, as a rule, a general loss of tone. Inasmuch as it is mainly by addressing the treatment to the portal system in the first instance these patients are emancipated from much mental and physical depression and misery, the writer prefers to believe they illustrate a phase of imperfect liver-work of the nature of exhaustion or debility in advance of that of the whole organism, and which maintains a far-reaching deleterious effect on the tissues, and especially on the nervous system. Doubtless many such cases may be viewed from different sides according to the bias of observers; for the interpretation of them rests on physiological grounds, and, as yet, not on the surer and more definite data provided by pathological demonstration. Year by year has, however, added to a growing conviction of the writer that exhaustion of the liver—physiologically, perhaps, the busiest organ of the body—and of the chylo-poiëtic viscera generally,

induced by causes such as those just referred to, is a very common ailment; and, giving rise to great depression of spirits as well as to real physical exhaustion throughout the organism, leads to mistaken attempts at restoration by alcohol and by plentiful supplies of meat, and essences and extracts of meat, and other proteids which add more and more to the labours of the weakened organs and to their embarrassment. To the surprise of the patients and their friends the weakness intensifies, notwithstanding the high feeding and the absence of organic disease. But the reason of this perplexity is not far to seek: the exhausted liver—for this, doubtless, is the principal organ at fault—becomes more feeble under the increased work which it is pressed to perform, and consequently, perhaps, permits the digestive ferments and the peptones to pass through it—as it would not in health—into the general circulation,* and the sort

* Physiologists are pretty well agreed that peptones absorbed into the portal blood become arrested or transformed—somewhere as yet undetermined—within the portal system, and are thus prevented from reaching the general circulation. When injected into a vein "they greatly depress the circulation, so that the blood-pressure falls very considerably; and when the quantity injected is large, they produce a soporose condition, complete arrest of the secretion of the kidneys, convulsions, and death." (Prof. Albertoni, quoted by Dr. Brunton, *Practitioner*, 1880.) The step between the physiological arrest of peptones by the liver and the pathological deviations, in which this

of self-poisoning already begun is intensified. The accumulation of waste products also advances, and unites with the unassimilated and, therefore, injudicious supplies, until the nervous system and all the tissues are enthralled by a crowd of materials unknown to them in health. Hence the patient becomes more and more gloomy and foreboding, his temper more and more irritable, his mental powers less and less apt, his sleep is either intensified into unrefreshing stupor, or becomes fitful, or he remains irritably wide awake, and his limbs feel like lead and always weary.* As a rule there is no tinting of

normal work is disturbed, may be readily bridged over, *e.g.*, by whatever may alter the complex and naturally feeble circulation of blood through the liver, or by some failure in the cell-work of this organ. Whether the less or more continuous circulation of peptones beyond the liver may lead to disease of distant organs must as yet be left to surmise ; but it does not seem improbable that they may maintain a sufficient irritation of the organs which eliminate nitrogenous waste—the kidneys—as to initiate the pathological changes of Bright's disease, or to determine the development of gout. Even this suspicion has a warning within it that the slightest indications of continued imperfect liver-work should not be neglected, but should be met by careful dieting, and by occasional or periodical courses of mineral waters : preventive measures which may thwart the beginnings of incurable disease.

* Dr. Brunton has furnished the profession with a graphic description of this pathological aspect of imperfect liver work with an accumulation of waste products.—See *Practitioner*, Oct. 1880.

the tissues from bile-pigment—either as such and recent, or transformed. Experience has taught the writer the most successful treatment of cases of this order is obtained by a course of the Harrogate Chloride waters in aperient doses: in the first instance the Old Sulphur Well for a short period, and then the Kissengen for a much longer one (p. 203).

The beneficial effects are indicated by a rise in pulse-pressure, by a feeling of real hunger and by improved digestion, by a return of cheerfulness, and by the sensation of weary weight in the limbs giving place to a healthful desire for exercise, and by a returning ability to take it with less and less exhaustion ensuing.

6. *Jaundice.* Frequently the writer has witnessed, after the failure of other treatment, a happy relief to the flow of bile into the intestines, and the consequent rapid cure of Jaundice, during the daily aperient action of the Saline Sulphur-waters. Now and then a gall-stone has been voided by stool, and the cause of the Obstructive Jaundice has thus become apparent; but more commonly it could not be detected, and then the clinical evidence, supported by the history of the attack, has generally suggested some other explanation of the arrest of bile-flow, such as catarrhal conditions of the lining membrane

of the gall-ducts, swelling of the mucous membrane of the duodenum involving the mouth of the common duct, enlarged glands or collections of fæces in the colon pressing on the latter, or inspissation of bile within the ducts. Some care is necessary to exclude, if possible, from treatment cases of obstructive jaundice induced by organic disease.

After the cure of this ailment by the Sulphur-waters, a periodical course of them in subsequent years is a valuable preventive measure.

7. *Gout.* In nearly all forms of Chronic Gout the Sulphur-waters are valuable, but they are specially so when the disease manifests itself in the following clinical phases :—

(*a.*) *Congestion of the liver* from excess of nitrogenous food and alcoholic stimulants.

Atony and feebleness of the liver and of the stomach with sluggish bowels.

(*b.*) *Skin disease.* The skin dry and toneless ; chronic dry eczema ; psoriasis ; prurigo ; acne.

(*c.*) *Œdematous tissues*—passive swellings—stiffness of joints and general loss of tone following acute or sub-acute attacks of Gout (p. 203).

(*d.*) *Symptoms suggestive of Gout* in those in whom there is a family history of the disease, or in whom it has been long suspected ; such as flying pains

and twinges through the small joints, which are now and then slightly painful and puffed; a liability to irritative states of the mucous membranes, *e.g.*, bronchial attacks, to obscure neuralgic affections, &c.; such symptoms are often met with in women, and sometimes in rather delicate men, in whom they rarely bloom into an attack of Gout.

(*e.*) *Bronchitis* in gouty subjects or in those in whom Gout is strongly suspected from the family history, &c.

(*f.*) *Renal inadequacy*—a condition which has probably some affinity to Gout, in which the kidneys without obvious cause—such as detectable renal disease, excessive perspiration, &c.—excrete daily too little urine, the solids of which are not concentrated in proportion to the scantiness of the urinary water. The writer has found the Magnesia water of great service in this condition.

A renal state somewhat allied to this is frequently met with, in which treatment by the Sulphur-waters generally proves very useful; the urine at one time of the day very scanty, highly acid and loaded heavily with lithates, very quickly alternates with a copious limpid outflow of low specific gravity—these variations far exceeding the normal, and not traceable to the irregularity produced by unusual action

of the skin or the results of exercise; in such cases one not uncommonly discovers a family history of Gout, or some minor traces of the disease in the patients, or symptoms pointing suspiciously to it, or signs of derangement of the stomach and liver—such as may possibly lead to the rapid formation of urates rather than urea from the destruction of the proteids. Perhaps these are cases on the way to Gout—livers halting in that direction—but the kidneys being healthy and eliminating the urates as rapidly as they are formed, they are still preserved from this disease—though the intermittent passing off of dilute urine suggests a temporary failure in renal-cell work, while the vascular tension of the Malpighian corpuscles is at least maintained; but a failure which may become less and less temporary.

Comments. Prof. Garrod having discovered invariably an excess of uric acid in the blood, whether during an acute attack of Gout or in the course of Chronic Gout, has established a positive step in the pathology of the disease—sharply defining it from rheumatism and rheumatic-gout, whence is undoubtedly derived an incalculable gain in the treatment of it. The Harrogate waters do not operate on the gouty blood by directly neutralizing this acid—as is the manner of potash and alkaline waters—

but by relieving disorders of the portal system—that complicated laboratory whence uric acid may largely proceed—and by flushing out the tubules of the kidneys, in which urate of soda is apt to be deposited even in the early stages of Gout, and to obstruct the eliminating function of the renal cells.*

They thus address themselves to the radical sources of Gout; on the one hand to the liver and the spleen, which may generate uric acid in excess, and on the other to the kidneys which, becoming crippled by the deposition of urate of soda within their tubes, thwart the elimination of it. Besides operating on the portal system, they are believed to flush out of the system much uric acid lingering about the tissues as well as the deposits within the tubules of the kidneys.

The mild Pure Sulphur waters, such as the Magnesia and the Starbeck Sulphur—are frequently prescribed to gouty subjects with manifest advantage, when a full course of sulphur treatment—which operates both on the liver and the associated organs as well as on the kidneys and the tissues generally, is not indicated. These mild springs are undoubtedly valuable diuretics, and they probably induce a far-

* The renal deposits of urate of soda are in the first place amorphous and intratubular, and only afterwards become intertubular.

reaching effect throughout the system by stimulating the extra-vascular circulation of fluids; whence may proceed the benefits which the gouty and those having only the beginnings of Gout derive from their use, for it is believed they freely wash out the urates lodged in the tubules of the kidneys and disseminated throughout the tissues. These waters are also invaluable in the treatment of uric acid gravel, and in the prevention of calculi.

As a rule, Gout, both in its active as well as in its subdued forms, is a life-long ailment, which calls for a permanent readjustment of diet and hygiene; and one of the new conditions of existence, which is of no small import in counteracting the progress of the disease, is the periodical resort to a mineral watering-place; where by natural agents urate of soda may be washed from the tissues, in which in the intervals between the visits it has deposited; where the elimination of the uric acid accumulated in the blood may be accelerated; and where, when the course of treatment is ended, the kidneys are left less embarrassed by deposits, and it may be the chylopoiëtic viscera, being corrected and raised in tone are less disposed to generate the superfluous uric acid. Harrogate claims to do all this for the gouty; and, inasmuch as each successful visit means a par-

tial reversion to health which for long outlives the immediate benefit, gouty patients return to this watering-place regularly year by year, and there are many who have done so for long periods, twenty, thirty or forty summers.

8. *Rheumatism.* The form of Chronic Rheumatism which derives more benefit from the Sulphur waters than others is that in which the sheaths and other tendinous structures of the muscles are the seat of pain. It is often associated with great irregularity of the outflow of the urinary water and constituents, and with signs of hepatic derangement, but without obvious enlargement of the liver:—the complexion is generally dark and sallow, the tongue is sometimes loaded and is generally indented, there is often acidity of the stomach, and the bowels are, as a rule, disposed to constipation. The pains are apt to fly about—are rarely stationary for long periods—and there is always stiffness in the muscles —especially in the thighs, legs and hips—after the patient remains awhile in one posture; sometimes the joints are implicated as well as the muscles, but this is not often the case. This ailment when neglected is apt to lead to atrophy of the muscles.

The Sulphur waters soon clear up the urine and maintain an increased and steadier outflow of its

constituents, and correct the digestive organs. Recovery is, however, not generally rapid; but, when the treatment is continued by suitable baths and waters, as a rule it dispels the derangement of the chylo-poiëtic viscera, as well as its apparent outcome—the Muscular Rheumatism.

Chronic Rheumatic Arthritis, or Rheumatic Gout is rarely amenable to the sulphur treatment, except sometimes, when applied in its milder forms, or only externally—as baths and douches. But care requires to be exercised in this ailment, lest the tone of the patient be lowered, either by too much general bathing, or an evacuant treatment to which the system does not respond by improved appetite and digestion (p. 213).

Synovial effusions, left by Acute or Sub-acute Rheumatism, or by Genital Rheumatism, are treated with much success by hot Saline-Sulphur douches with shampooing; and the internal use of the Sulphur waters to induce free action of the bowels and kidneys. *Rheumatic sciatica; rheumatic pains* lingering about the joints after an attack of rheumatic fever; *chronic rheumatic stiffness* of the tendinous structures and of the joints are often amenable to the same treatment; the writer, however, is of opinion that in the management of these external

remnants of rheumatism, the thermal treatment of Buxton or of Bath should be preferred to the Sulphur Waters and Baths of Harrogate; unless they are not merely cripplings, but are accompanied by derangements of the portal system and by imperfect elimination of the kidneys.

Harrogate and Buxton or Bath in the treatment of Chronic Gout and Rheumatism. The writer has frequently witnessed a marked improvement from associating the therapeutic advantages of these watering-places, in certain cases of Chronic Gout, Rheumatic Gout, and Chronic Rheumatism; as when these arthritic diseases had induced much crippling, and were still progressing, and especially when the portal system was deranged, or was suspected to be the source whence pathological products arose which maintained these ailments. He is, therefore, inclined to suggest to his professional brethren this combination of the principal natural remedial resources of this country in the management of these obstinate chronic diseases, which generally defy ordinary treatment: believing that many cases of this type frequently sent to foreign spas—such as Aix-les-Bains and other thermal stations—would obtain more relief at home, without the detractions involved in the fatigue and discomforts of long journeys, and in the

uncongenial elements of life abroad, by resorting in the first place to Harrogate for internal treatment, and then, after a short pause, to Buxton, or, in the winter months, to Bath. In Chronic Gout and Rheumatism these thermal resorts are complementary to Harrogate, and *vice versâ ;* for, while the latter is therapeutically fitted to deal more effectually with the inward ailments, the former are more serviceable in the local treatment—liberating crippled joints, &c.

9. *Scrofula.* The writer has generally found the Old Sulphur Spring of great service in Scrofula, whenever this constitutional deviation maintains a skin affection ; enlargements of lymphatic glands ; an atonic state of the digestive organs, with sluggishness of all the chylo-poiëtic viscera and of the large intestine ; or a form of dyspepsia common in strumous subjects—characterized by foul breath, a loaded tongue, irregular and capricious appetite, constipated or uncertain bowels, and offensive evacuations; after a certain time the sulphur treatment should be substituted by a course of the Chloride of Iron Water—or the latter may be indicated from the first (p. 213).

10. *Skin diseases.* From 1626, when the curative power of the Sulphur waters over Skin diseases, then denominated "Itch, Scab, Morphew, Tettar,

Ringworm," was recorded by Dr. Dean, to the present, Harrogate has not only kept its ground as the principal resort—at least in this country—for cutaneous cases, but has acquired a firmly rooted reputation which, judging merely from his own observations, the writer believes to be well deserved.

(*a.*) In *Chronic Eczema* the Sulphur waters are of signal value when the disease is associated with gout, struma, rheumatism, disorders of the liver and of the abdominal viscera; and in that obstinate form of it which is apt to follow ringworm of the scalp. They are also frequently useful, more especially, however, as baths only, when it appears in the over-worked or the worried, or those whose tissues are impoverished and whose reserve energies are exhausted.

Though the Old Sulphur Well and the Mild Sulphur waters form the mainstay of the cure in a large number of the cases of chronic eczema, they are by no means the only natural agents employed with success in the treatment of this disease; for the Ferruginous Salines are sometimes equally valuable, as when they are indicated by the general conditions which maintain the skin affection (pp. 204 and 214).

(*b.*) *Other skin-affections*, such as Psoriasis, (especially in the scrofulous, gouty and rheumatic),

Prurigo (gouty), Acne, Urticaria and Lichen, also generally improve under the sulphur treatment; particularly when they are associated with derangements of the stomach, liver and bowels, and with imperfect elimination by the kidneys and the skin.

In *some* cases of Chronic Eczema, Lichen, and Psoriasis, the stimulating action of the saline waters and baths is a necessary step towards recovery.

11. *Metallic poisoning.* The deleterious and lingering effects of mercurial and lead poisoning are said to be effaced by Sulphur waters. The writer's experience on this matter has been limited to that of a few cases of lead poisoning in which gout in a low form had declared itself; the Sulphur waters and baths were of benefit to all, but whether because they merely relieved the gout or met the plumbism, it is hard to say. If Sulphur waters counteract metallic poisoning, those of Harrogate—strong in sulphides and withal containing stimulating salines—should rival all others in this property.

12. *Obesity.* There is no doubt in some cases the Old Sulphur Well is very effective in removing superfluous fat. In the ordinary run of cases submitted to the sulphur treatment, the writer, who is in the habit of himself testing the weight of patients during their course, has however, met with some-

what unequal results; for in a large proportion of the cases the body weight was not lessened, and in many of these it progressively advanced, notwithstanding the ordinary active operation of the water. But in obese subjects a reduction of weight is usually effected by a well-adapted course of treatment by the Sulphur waters.

13. *Bronchial affections* in the gouty and in those suffering from disorders of the alimentary organs—congestion of the liver, &c.—and dry bronchitis in which the secretion will not maturate, are sometimes greatly relieved by the sulphur course—baths and waters—and by the atomized inhalation of the Sulphur waters, both saline and pure.

The Sulphur waters are used externally as:

(*a.*) *Baths*, of which there are two principal varieties, viz.: the Saline Sulphur baths of the Victoria Bath, and of the Montpellier Gardens; and the Pure Alkaline Sulphur baths of Starbeck.*

* Within two miles to the eastward (Starbeck and Bilton) and to the westward (Harlow-car and Beckwith) the neighbourhood of Harrogate is richly supplied with Pure Alkaline Sulphur waters comparable to many of the celebrated sulphur spas abroad, but at present—except the Starbeck source—unavailable either for internal or external use. It is much to be regretted the baths at Harlow-car, supplied with one of the best of the Pure Sulphur waters of the district, should be out of use.

The latter is of special value in the irritable forms of Skin disease for which the former prove too stimulating ; and, when stimulation of the skin has been carried sufficiently far by the Harrogate baths and waters, they often usefully complete the treatment. The swimming bath of Starbeck resembles the Piscines of Aix-les-Bains, and is maintained at a uniform temperature like that of the latter ; and from a medical point of view it is a valuable addition to the bathing arrangements. The Sulphur baths of Harrogate are indicated in Gout, Rheumatism, Liver derangements, and Skin diseases which require the stimulating or tonic effects of saline matter side by side with the special sedative action of sulphides (pp. 132 and 148). The writer is not acquainted with any other Sulphur Spa in which these different kinds of sulphur baths can be procured.

(*b.*) *Sulphuretted vapour baths :* the value of which in the treatment of Acne, Psoriasis, and dry forms of Eczema, the writer has proved.

(*c.*) *Hot Saline Sulphur-water douches,* useful in Rheumatic, Gouty and Surgical Contractions, &c., especially when supplemented by skilful manipulation and shampooing. Vaginal douching affords good results in Chronic Congestion of the Uterus, with Leucorrhæa. Douches of warm mild saline

sulphur water are useful in Nasal affections—Chronic Eczema, Ulceration, &c.

(*d.*) *Spray inhalations* of mild sulphur water—of much service in Follicular disease of the Pharynx, Irritability of the Laryngeal mucous membrane and Bronchitis, especially in the gouty.

CHAPTER IV.

THE THERAPEUTICS OF THE IRON WATERS.

During the early part of its medical history, from between 1570 and 1580 when the first spring (the Tewit) was discovered, to the middle of the seventeenth century, the reputation of Harrogate rested almost entirely on the pure chalybeates: the "acid tart Fountain" of Dean, and the "Sweet Spaw" of Stanhope. Then the Sulphur waters somewhat deposed their more agreeable compeers until sixty years ago, when Dr. Hunter discovering a Saline-Chalybeate (the Cheltenham), inaugurated a departure from the somewhat exclusive sulphur treatment of Harrogate—a departure which, culminating in the discovery of the Kissengen Water and of the presence of Chloride of Iron in the Cheltenham Saline Chalybeate (1865), brought up the Chalybeate abreast with the Sulphur resources of Harrogate; so that now both may be said to possess an equally balanced name.

The therapeutics of Iron are so well-known to the

profession, that even a passing glance at them is here out of place.

The ferruginous salts present in the Harrogate Waters are the following:—

1. *Proto-carbonate* in the Pure chalybeates, and in the Saline chalybeates—the Kissengen, the Alexandra, and the Chloride of Iron waters.

2. *Chloride of Iron* (*proto-salt*), in the water of that name.

3. *Proto- and Per-Sulphates* in the aluminous chalybeate.

It may be asked: what curative advantages do these natural solutions of the salts of iron possess over those artificially prepared?

Whatever they are, practical experience of ferruginous waters frequently shows them to surpass the ordinary pharmaceutical preparations of iron, and to succeed when these fail. Moreover, there is ground for believing that Nature is a wiser chemist than the best of us, and, as a rule, arranges her ingredients in wonderful conformity to our therapeutic aims; and as yet we know but imperfectly how she links together the constituents of a mineral water; for our chemistry, advanced though it be, and so searching that when combined with its pioneer in subtlety, spectrum analysis, it seems to compass every atom

of matter—can but give a rough cast of the original, with its features broken and robbed of their true symmetry and proportion. It is, therefore, almost idle to speculate how far these natural combinations are better adapted to therapeutic work than ordinary medicines. It may, however, be suspected they may more readily enter into organic union with the tissues of the organism—a suspicion suggested by the side-light of chemistry; for instance, Ferrous Chloride is known to unite with Alkali Chlorides, and to form therewith crystallizable double salts: may not this true chemical association exist in the Chloride of Iron Water, and if so, may not such a union of constituents surpass for therapeutic purposes the ordinary preparations of iron, or any attempts to combine the latter with other substances declared by the chemist to be components of the Chloride of Iron Water?

From the therapeutic standpoint the chalybeate waters may be conveniently viewed as APERIENT; HÆMATIC and TONIC; and ASTRINGENT.

I. APERIENT CHALYBEATE.

The Kissengen is the only chalybeate possessing aperient properties.

The writer has observed this phase of the thera-

peutics of the water useful in the following conditions.

1. *Anæmic subjects* with torpor of the digestive organs; atonic dyspepsia, feeble appetite, &c.; signs of sluggish or feeble liver; constipation; amenorrhæa or leucorrhæa. As a rule, other Chalybeates may be taken with advantage concurrently with the course of Kissengen; and the latter often proves a useful and appropriate aperient for occasional use when the former—which are apt sometimes to constipate—are prescribed as hæmatics and tonics.

2. *Portal congestion* with general atony and tissue-exhaustion, as when arising from alcoholic excesses; from sedentary habits, as from office life, &c.; residence in tropical climates and malaria.

3. *Debility of the liver* and of the chylo-poiëtic viscera (p. 181), either after a short course of the Saline-Sulphur water has been resorted to, or without the latter.

4. *Gout* in asthenic forms: marked by feeble circulation; coldness and dryness of the skin; anæmia and atony; debility of the liver and sluggish bowels; progressive degenerative changes and signs of retarded tissue-metamorphosis. After an attack of acute gout—and perhaps after rather active treatment—a patient is apt to remain debilitated and

feeble; the circulation may continue poor and the appetite bad; the skin may be kept warm with difficulty; and the swelling of the foot or feet does not subside, though there are no signs of active inflammation. In these circumstances the Kissengen water, as a rule, proves most useful; for after the prescription of it the œdema rapidly disappears, and the digestive organs and the circulation soon regain their lost tone and vigour.

5. *During the menopause* there is great proneness to derangements of the liver—possibly from disturbance of the circulation of this organ from the instability of the vaso-motor nerves—associated with general relaxation of the tissues. The author has repeatedly observed cases of this type to derive much benefit from a course of the Kissengen.

6. *Leucorrhœa* in anæmic and relaxed subjects with constipation and sluggish liver.

7. *Rheumatism* in the debilitated; especially Muscular Rheumatism associated with torpor of the liver.

8. *Skin diseases* of sluggish type where there is some exhaustion of the tissues and of the blood, and where the digestive organs are toneless—constipation, &c.

9. *After a course of the Sulphur waters* the sulphur

treatment may be changed at a certain point with great advantage; when the Kissengen may take the place of the morning doses of Sulphur water, and a Chalybeate that of the Mild Sulphur usually taken during the day. But this is a matter which should be left to the special guidance of the local practitioner.

Summary.

Nearly all the clinical indications may be epitomized as sluggish or deranged states of the abdominal organs—and especially the chylo-poiëtic viscera—associated with such loss of tone and impoverishment of the blood and the tissues generally as contra, indicate the prescription of the Sulphur waters; the appropriate cases may be roundly described as such as need correction, because the functions of the liver and the kidneys are imperfect or embarrassed, and at the same time require tonic treatment. The obstructed function and lowered tone of such cases suggest that they should be approached by treatment similar to that which should be applied to a slumbering fire with ashes clogging the lower part and preventing oxidation of the fuel above them; when, while the barrier to better combustion is cleared away and the burning

embers are handled with care, more fuel is added. And just as it is known in this illustration how much more successfully the fire can be revived by gently removing the unoxidizable and oxygen-excluding ash *before*, and *not after* fresh supplies of oxidizable wood or coal are added, so, in these cases, in which the Kissengen water is of the greatest service, it is preferred, because it is found to be an agent which will clear away the products of oxidation lingering about the fluids and solids, and obstructing their nutrition, with the least strain on their resources, and will thus prepare the way for the better ingestion and assimilation of food, both for the reconstruction of the impaired blood and tissues, and—as fuel—for the production of the various forces of the organism. It may be said to liberate—without exhausting—toneless and debilitated organs from the oppression induced by the presence of the products of oxidation, from which they cannot without similar aid extricate themselves, and thus to clear the ground for a higher vitality.

The Iron present in an ordinary aperient Saline-Chalybeate, is, perhaps, of little avail to the system as a tonic. The chalybeate charge of the Harrogate Kissengen is, however, large—exceeding that of the Ragoczy spring of Kissengen and of the Hom-

burg waters (p. 100)—and should not be lost sight of as a probable coadjutor of the curative powers of the waters when used as an aperient. But it should be noted that this water in absorbent doses, and other valuable Chalybeates—such as are not to be met with at Kissengen and Homburg—are often prescribed concurrently with the morning draughts; and thus a much more decidedly tonic course of treatment combined with aperient action is available at Harrogate than elsewhere.

II. Tonic Chalybeates.

These embrace—

The Chloride of Iron.
The Kissengen in non-aperient doses.
The Alexandra water.
The Pure Chalybeates.

I. The Chloride of Iron Water.

The remarkable constitution of this Spa viewed both from a physiological and therapeutic standpoint —for here experimental physiology appears to join hands with therapeutics—so definitely illustrate the clinical experience of it, that the writer cannot

refrain from pointing out some of its salient characteristics.

1.—*The saline constitution of the water.*

The experiments of Zabelin and Woronichin* showed that Sodium Chloride is the agent which affects the absorption and storing up of iron in the blood; and that which robs the iron-holding tissues of this metal and eliminates it from the organism is Chloride of Potassium; it may therefore be inferred that the former, when accompanying the ingestion of Iron-salts, will favour their well-known properties in building up hæmoglobin and in filling the white corpuscles with this all-important constituent of healthy blood, and, moreover, will maintain the integrity of the newly-generated red blood discs; and, on the other hand, Potasium Chloride, when similarly associated with Iron, may either retard the process of the construction of new red corpuscles, or may hasten the disintegration of others. On referring to the analyses of Professors Muspratt and Miller (1865–6), and to those just completed by Professor Thorpe, F.R.S., these chlorides are presented in the average dose of the water (4 oz.) in the following proportions:—

* *Wiener Medizinische Jahrbuch*, 1868, II.

	Grains.	
	NaCl.	KCl.
Muspratt, 1865	5·16	·046
Miller, 1865	5·15	·090
Muspratt, 1866	5·21	·120
Thorpe, 1880	6·93	·074
Thorpe, 1881	6·94	Not estimated.

From these remarkably uniform results, embracing a period of sixteen years, the reader will note that the salt which has been proved by physiological experiments to assimilate iron into the blood and the tissues has all along remained, and is still present in full force; while that which expels it from the organism has never exceeded gr. $\frac{1}{8}$, and is now as low as gr. $\frac{1}{14}$—an amount so small that it may be justly regarded as absent or inoperative. Sodium Chloride, forming sixty per cent. of the total contents of the water, may therefore be looked upon as an auxiliary to the hæmatinic properties of this valuable Chalybeate; and, moreover, a coadjutor which cannot be thwarted in its operation by only a half per cent. of its antagonist.

Most writers on mineral waters believe Chlorides, apart from their association with Iron, to be therapeutically anti-anæmic; for Anæmia is often cured by Common Salt springs after the failure of Chaly-

beates. Surely, therefore, a saline constitution purely Chloride and, moreover, in accord with the results of experimental physiology, linked with Iron-salts, not merely in large proportion, but more than half also Chloride—cannot well fail to fulfil certain therapeutic requirements with great force and certainty.

2. *The Proto-Chloride of Iron.* The presence of this ferrous salt in a medicinal water is not merely a rarity, but is probably therapeutically an apt preparation of Iron ; for it may be inferred, nature has here done outside the body that which the hydrochloric acid of the gastric juice does when it meets with the ordinary Proto-Carbonate of Iron present in steel waters ; and, furthermore, this Ferrous Chloride may exist in the water in chemical union with an Alkali Chloride (p. 200), and the compound salt thus formed may be the natural arrangement by which Chloride of Sodium may assist the absorption of Iron into the organism. This is, however, but surmise. The charge of Manganous Chloride is therapeutically noteworthy ; for it is only exceeded by that of two other springs, at Pyrmont and Marienbad, both celebrated as hæmatinics.*

* The writer's experience of Manganese as a hæmatic is not, however, assuring.

On turning to the results of clinical observation, there is no discord discoverable between them and the suggestions of a theoretical character derived from the chemical and therapeutical analyses of the water; the same harmonious note is struck by all—namely, the blood and tissue-building properties of this Spa.

The writer's favourable experience may be thus briefly stated.

1. *Chlorosis.* This Chlorided Chalybeate is invaluable in bringing up the hæmoglobinic value of the blood of chlorotic girls to the standard of health. It is difficult to form a trustworthy opinion as to whether this therapeutic work is more rapidly or more effectually performed by this concentrated water than by equivalent doses of the ordinary preparations of iron. The writer can, however, remark, he has not unfrequently found the latter, even in the most approved formulæ, to fail in advancing the development of hæmoglobin beyond a certain sticking point, and then the water has carried it onward; and in other cases, in which the hæmatic power of Iron as usually prescribed has not been apparent, he has observed the combination of aperient doses of the Kissengen with the Chloride of Iron water to restore the impoverished blood.

Though chlorotic cases are often rapidly improved by large doses of Iron, or by such a strong Chalybeate as this, they require prolonged treatment before the cure can be trusted; but in attaining this goal the writer is convinced this Spa is one of the most helpful means at the disposal of the physician. Its curative power is best shown when the digestive organs are toneless, and irritability of the stomach is not a prominent symptom.

2. *Anæmia.* Besides that form of Anæmia induced by imperfect evolution of the blood—Chlorosis—there are others in which this concentrated Chalybeate Saline is a valuable remedy; they are such as may be caused by hæmorrhage; by excessive secretion (lactation, &c.,) and exhausting discharges—such as the suppurations of the strumous, and leucorrhæa in lax-fibred women; by acute febrile disease, such as rheumatic fever; by long residence in tropical climates and by malaria; by gout—when there is no suspicion of renal disease, albuminuria, &c., absent; by syphilis; by lead poisoning; by long continued treatment by potash, iodine, and other tissue-exhausting remedies. It is also of signal service in the Anæmia which is often associated with nervous disorders, such as chronic forms of chorea, of neuralgia, &c.; and in anæmic subjects

free from renal disease—in whom there are signs of hyp-albuminous blood and relaxation of the solids—such as, œdema of the feet, &c., and a liability to quasi-erysipelatous inflammations.

3. *Its general tonic properties* are of great service in the treatment of various phases of *debility of the tissues:* such as in retarded convalescence; too rapid growth; imperfect evolution and the disorders —*e.g.*, sexual debilities—of puberty and adolescence; the tissue exhaustion of chronic ailments, such as diabetes, rheumatic gout, enlargements of the spleen or liver from malaria or residence in the tropics, women over-taxed by child-bearing, &c.

4. In *diseases of the Lymphatic system* experience pronounces emphatically in favour of this water. It is indicated in all the clinical phases of the Strumous diathesis; but especially when the patient is pasty-pale and flabby; with a tongue large, moist, and indented; tonsils flabby, anæmic and enlarged; lymphatic glands everywhere lumpy, while some are specially so; and the muscular and mental energy small. After the foul state of the digestive organs, now and then observed in the scrofulous, has been corrected by the Saline-Sulphur waters (p. 194), a course of this Ferruginous Chloride is frequently invaluable.

5. *Amenorrhœa* in the chlorotic or the anæmic or the strumous is often met successfully by a course of this water, especially when in conjunction with it the warm Kissengen is prescribed in the early morning.

The writer has also observed encouraging results in the following clinical conditions :—

6. *Feeble Heart* and *Heart-Disease.* The value of Iron in the treatment of the failing heart muscle is now duly recognized by medical observers. The formula presented by nature in this water appears to the writer to be one which promises valuable aid to cardiac asthenia and degeneration.

7. *Skin diseases* in the strumous, anæmic, and over-worked ; boils under similar conditions, and not associated with derangement of the chylo-poiëtic viscera.

8. *Wounds* which remain unhealed without obvious cause ; except, perhaps, there be some exhaustion in the construction of tissue which ordinary tonics fail to rouse.

9. *Atonic Dyspepsia* in lymphatic and anæmic subjects. The concurrent use of the Kissengen is indicated when the bowels and liver are sluggish.

10. *Atonic Chronic Diarrhœa* with relaxation of the solids and impoverished blood : clinical con-

ditions, in which in ordinary practice Per-Nitrate of Iron may be prescribed.

Summary.

It will be observed, the clinical applications of the Chloride of Iron water turn mainly on its remarkable blood and tissue-restoring properties. As a helper to the re-construction of partially broken down tissues, and to the constructive forces when languid or enfeebled during the period of growth and development; as a toner of the loosely-built and imperfectly consolidated elements of the organism; and as a renovator of the blood—when exhausted of its Iron and Saline constituents either from imperfect assimilation or from undue expenditure of them—experience proves this water to surpass, as a rule, any pharmaceutical preparation hitherto devised by physicians to fulfil these important indications.

But while this natural hæmatic may be employed as the central axis of treatment, there are among the curative resources of Harrogate other agents which, during the course, may be called into requisition to correct deviations from it induced by the special clinical conditions in which it may operate; such as a disposition to constipation, to biliary disturbance, and the like, which may be met by the synergical

operation of thermal doses of the Kissengen in the morning, while the Chloride of Iron water may be continued without interruption: and it is the duty of the local practitioner in other ways to preserve the therapeutic movement of this powerful hæmatic as much as possible from departures apt to arise from the individualism of the patient and of his disease.

2.—*The Kissengen and the Alexandra Waters.*

These saline-chalybeates in absorbent tonic doses occupy a useful position among the therapeutic resources of Harrogate. In the quantities usually prescribed (table, p. 218), they are less charged with Iron than the Chloride of Iron, but more so than the Pure Chalybeates; the Kissengen, besides being strongly Chalybeate, and containing nearly three times the amount of Chlorides present in the other Saline-Chalybeates, is selected for tonic medication when fairly good doses of Iron as well as of Salines are indicated: and the Alexandra water, with Chlorides nearly on a par with those of the Chloride of Iron, but with one-third less Iron, is usually preferred when the larger Chalybeate charge of the Chloride appears to be contra-indicated or uncalled for.

The proportions in which Sodium and Potassium Chlorides exist in both these waters—as in the Chloride of Iron—conform to the results of the experiments of Zabelin and Woronichin as to the agency by which Iron is stored up (NaCl) or expelled (KCl) from the system: the Sodium salt being abundant and the Potassium Chloride in only fractional quantity (table, p. 218). Experience, moreover, proves these waters to be valuable tonics and renovators of the blood and the tissues. The diseases in which they are indicated are, therefore, usually marked by general debility and anæmia. They are perhaps more frequently prescribed than is the Chloride of Iron water in tonic doses concurrently with the thermal aperient draughts of the Kissengen. The writer regards them—and especially the absorbent doses of the Kissengen—as more diuretic, and as less liable to counteract the aperient properties of the warm Kissengen than the Chloride Spa: and hence, perhaps, why they appear to be of greater service, when thus administered, than the latter, in many cases of Gout, Rheumatism, and derangements of the Portal system in somewhat anæmic and debilitated subjects.

When prescribed apart from the aperient doses of the Kissengen, and therefore exclusively as tonics,

they are found to be of less value than the Chloride of Iron in the treatment of Anæmia, Chlorosis, and Struma; but when the Chloride, otherwise desirable, cannot be exhibited—because contra-indicated, for instance, by an irritable and catarrhal state of the stomach, or an inability to bear large doses of iron, &c.—they often prove useful substitutes. The Kissengen, acting more freely on the kidneys than the Chloride of Iron water, is indicated rather than the latter when the poverty of the blood is less pronounced than debility of the tissues, with indications of imperfect elimination of waste products—as in the slighter forms of Anæmia in the gouty and rheumatic; but they are less useful than the Chloride in Rheumatic Gout.

The proportions in grains of the chlorides and of the salts of iron in the ordinary tonic doses of the leading Harrogate chalybeates:—

	Quantity.	NaCl.	KCl.	Total Chloride.	Iron Salts.
Chloride of Iron . .	4ozs.	6·94	·07	10·97	·836*
Kissengen	6ozs.	25·29	·80	31·88	·359
Alexandra	6ozs.	6·61	·04	6·83	·217
Tewit	10ozs.	—	—	—	·136

* The Chloride of Iron calculated as crystallized according to the formula $FeCl_2$, $4H_2O$.

3.—*The Pure Chalybeates.*

Those who are accustomed to prescribe Iron in large or even ordinary doses are apt to underestimate the curative power of Pure Chalybeate waters, which are but weak solutions of Carbonate of Iron; for they cannot readily conceive how the small quantities of Iron thus administered can be really effective in the treatment of anæmia, and of the various forms of debility in which these waters are prescribed. Pure Chalybeates, however, occupy a useful place in mineral hydro-therapeutics: for, there are many patients in whom Chalybeate treatment is indicated by Anæmia and Debility, who cannot take a course of the Stronger Iron waters—such as the Chloride of Iron, the Kissengen, and the Alexandra—without suffering from gastric disturbance and headache, even though the Kissengen as an aperient is concurrently prescribed with a view to the prevention of these accidents; but who, nevertheless, derive great hæmatic benefit from the Pure Chalybeates; and there are some patients so peculiarly sensitive to Iron in any form that, unless these weak solutions are available, they must shun the remedy entirely.

It is true in many cases of impoverishment of the

blood there is great aptness on the part of the organism to assimilate Iron rapidly; as, for instance, when in Chlorosis it may in a few weeks raise the hæmoglobinic value of the blood 50 per cent. or even more.* In such cases the hæmatic value of the strong ferruginous waters, *e.g.*, the Chloride of Iron, is unquestionable, and is demonstrated by all the clinical signs indicative of the development of new blood. But the curative place and power of the Pure Chalybeates are of a somewhat different order; their therapeutic rôle lies more in the direction of the stimulant and tonic properties of Iron on the digestive organs and on the tissues generally, than in that of directly supplying this essential element of the highly complex organic molecule of hæmoglobin—though they doubtless also contribute to the building up of this important constituent of the blood. They invigorate the stomach, improve the appetite and digestion, and stimulate the distal circulation; they thus favour the ingestion of new materials, and the distribution of nutrient fluid to the tissues. Their power to disturb the vaso-motor nerves is indicated by the general flushing and the

* Dr. Sidney Coupland records a case in which "the percentage of hæmoglobulin was doubled within ten days."—*Gulstonian Lectures on Anæmia*, 1881.

agreeable diffusion of warmth throughout the body frequently witnessed after each draught by sensitive patients—especially women.

The writer regards the Tewit spring as by far the best of the Pure Chalybeates; and he believes its charge of Ferrous Carbonate, as recorded by Professor Hofmann in 1854, is decidedly below that which is now ordinarily present, for several estimations of it during the past ten years show that it is at least 50 per cent. greater than it was twenty-seven years ago. This spring is well aërated and most refreshing to the palate and the stomach.

It is frequently resorted to as a tonic by those who visit Harrogate a little below par, jaded or overworked, with flagging appetite and digestion, but without definite ailments: and there is little doubt it generally proves a valuable auxiliary to the bracing qualities of the climate—harmoniously aiding the latter in invigorating the digestive powers and in restoring vigour. It acts well on the kidneys, and may thus carry away much tissue waste and the residua of work, while at the same time the small chalybeate charge, presented in the most agreeable form, will stimulate re-construction and brace the whole organism.

The writer has proved this Spa of service in the following classes of cases:—

1. A toneless and relaxed state of the tissues—

tissue exhaustion—without obvious derangement of the liver, kidneys or other organs; with slight anæmia, but insufficient to call for a course of the Strong Iron waters; an atonic state of the digestive organs and loss of appetite—part of the general lowness of tone; and nervous and muscular exhaustion not altogether traceable to the retention of excretory products. Such a condition is not uncommon when convalescence from some acute disorder is retarded; when men—and women also—are exhausted and worn down by worry or by the incessant over-work of years, or are the victims of the depressing influences of town-life; and when the nutritive changes begin to flag in the elderly. A course of this Pure Chalybeate is frequently of great service to those advancing in years whose tissues are undergoing a change of life, and also to women suffering from general debility associated with uterine disease. Many of the cases in which it is prescribed with benefit are such as require relief from home duties and from the cares of business, and should be left to enjoy a comfortable and refreshing reprieve from accustomed thought and labour in a bracing tonic climate.

2. The Anæmia of atonic Gout with Albuminuria—a condition in which the strong Saline Chalybeates in non-aperient doses are, as a rule, contra-indicated.

3. This spring is frequently found to be a valuable tonic adjunct to an aperient course of the Kissengen water when the strong Saline Steel waters are inadmissible; and it often forms a more appropriate after-course than the latter when the portal system has been duly corrected by the aperient salines.

III. Astringent Chalybeate.

The Sulphated Chalybeate or Alum Well.

The writer's observations have been mainly directed to the external use of this powerfully astringent water; and they have enabled him to recognize gratifying results in the following classes of cases:—

1. *Relaxation and loss of tone of the Pharynx and Larynx; Chronic Congestion of the Pharynx.* The water was used as a spray inhalation.

2. *Profuse Phthisical Perspiration.* The undiluted water was sponged or sprayed over the skin: the latter process was more grateful to the patient, and was perhaps more efficacious.

3. *Leucorrhœa; relaxation of the Vagina.* Other applications promisingly useful may be further noted. In relaxed and debilitated conditions of the skin the addition of this strong Aluminous Chalybeate to the bath-water—*e.g.*, the spray or needle-bath or the ordinary sponge-bath—may prove adjuvant to the

valuable chalybeate and other courses of treatment; and as a dressing or lotion in certain obstinate Skin diseases (*e.g.*, chronic eczema, the vegetal parasitic diseases), and chronic indolent Ulcers, this stimulating and astringent water may play a useful part in the local treatment.

The author's limited experience of the internal use of the water does not enable him to draw any definite conclusions as to its therapeutic force or range. He is, however, persuaded that it may prove beneficial in some cases of chronic Diarrhœa and Dysentery and other chronic discharges—whether hæmorrhagic, mucous or purulent. His few observations suggest the commencing dose should be small—a table spoonful or even less, well diluted, an hour after meals, and not on an empty stomach.

Such medicinal virtues as the water possesses appear to depend mainly on the acid and astringent properties of the Persulphates and the rich charge of Iron salts—both Proto- and Per-Sulphates.

It should be noted that, unlike some allied waters —*e.g.* Sandrock, Isle of Wight; Vicar's Bridge, near Dollar; Strong Chalybeate of Moffat—it is not too concentrated for convenient use; and, though a strong chalybeate, its constituents are in perfect solution, and not in suspension like some of the muddy mine-washes which have been dignified as mineral waters.