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ON DEODORISATION AND DISINFECTION.

BY

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CHAPTER I.

Definitions of Disinfection and Disinfectants. Classifications of Harris and Richardson. Author's Classification.

FEW chapters in the history of medical science would be more interesting than one on the history of Deodorisation and Disinfection, and the various agents that have been used for these purposes. Whether such a history would be profitable as well as interesting, is a matter of doubt; and I should hardly think, under any circumstances, that the labour required to be bestowed upon it would be repaid by the result. However that may be, it is a chapter which cannot be written here; because, in fact, to do justice to it, the whole twenty-four pages of the JOURNAL placed at my command would require to be devoted to the subject. I shall, therefore, strike the word history out of the programme, in order to concentrate my attention solely on the question, according to its modern reading, in the present development of science.

Deodorisation is a term that needs no definition; but disinfection is a term which, up to the present time, has been very vaguely defined and applied. Vulgarly, any substance that removes a bad smell, is called a disinfectant. By some, this word disinfectant is used synonymously with the word antiseptic; by others, the terms disinfection and disinfectants are applied only to such purposes and agents as remove completely bodies which are supposed to infect; that is to say, which destroy contagion. Hence it has become a practice to speak of heat as the only perfect disinfectant.

Concerning the first two definitions here referred to, they are manifestly out of date, and deserve no consideration. The third is definite, and to an extent correct; but it is too limited in its meaning, and it does not afford, therefore, a basis on which all that is now known with regard to disinfection may be placed. In these respects, it contrasts—and, perhaps, on the whole, favourably—with other definitions, which enter too minutely into detail, and which

convey to the mind theories of absolute processes, which are, as yet, not perfectly satisfactory. Thus, Dr. Elisha Harris, in his Report prepared for the New York Sanitary Commission, classifies disinfectants under four heads.

1. As absorbents of moisture and of noxious effluvia.
2. As oxidisers (ozone the most active) and de-oxidisers.
3. Other chemical agents that break up noxious compounds.
4. Agents that form indestructible compounds with putrescent materials, or that destroy cell-life and the cryptogamic and infusorial organisms.

As regards this classification, it is open to objection on various grounds. Thus, the first head is incorrect, because a body that would only absorb moisture and noxious effluvia is not a permanent disinfectant at all, inasmuch as the injurious agent would remain still undestroyed, although it were for a time locked up.

Next, as regards oxidisers: ozone, although very powerful, is certainly secondary to extreme heat, which is purely an oxidiser. Then, under the third and fourth heads of Harris, we have actually but one class of disinfectants, inasmuch as chemical agents that either enter into combination so as to form new compounds, or that break up compounds, act, in so far as the process is concerned, in the same way; that is to say, they destroy the deleterious agent, by setting up new forms of chemical action.

A definition differing from that laid down by Harris has been made by Dr. Richardson. He divides all disinfectants simply into two classes; viz., those which oxidise noxious matter and break it up by oxidation, and those which arrest action of all kinds. His two classes of agents may, therefore, briefly be considered as oxidisers or destructive agents on the one hand, and as antiseptics or preservative agents on the other. In this sense, he would place extreme heat at the head of the destructive, and extreme cold at the head of the preservative class. For instance, heat, ozone, the permanganates, nitric acid, iodine, bromine, and even chlorine, represent the destructive class; while cold, alcohol, the coal-tar compounds, ammonia, and acetic acid, with others similar in kind, represent the preservative group. There can be no doubt that this classification is exceedingly simple, and that it explains a great many apparent paradoxes.

Any one who takes up a book on hygiene, such as the compendious and accurate work recently published by Dr. Parkes, will be at once struck by reading the number of different agents noted by various observers as disinfectants. Take one fact in illustration of these differences. Sulphurous acid has been recommended as a disinfectant in sick rooms, and

chlorine has been placed in the same position. Here, then, are two bodies, the very opposites of each other in a chemico-physiological point of view. Can they both be disinfectants? It may be that they are. For chlorine would destroy—that is to say, break up—the organic poison; while sulphurous acid would hold it in abeyance, in the same way as it preserves animal tissues from decomposition. I do not think we can dispute the fact, that the best and readiest disinfectants do in the main belong to one or the other of the two classes described by Richardson. But, in considering the question in its wholeness, it must be conceded that there are certain other agents which may be almost said to act mechanically, rather than chemically, in the process of disinfection. Under this head I should include substances which, in contact with organic matters, remove water or desiccate. Of these I shall give examples in the sequel.

To resume: my definition of disinfection is as follows.

Disinfection is a process by which noxious agents are either destroyed, suspended in action, or fixed. In accordance with this view, I shall classify disinfectants under three heads:—

1. Agents that chemically destroy the noxious body.

2. Agents that hold the noxious body inactive (antiseptics) by arresting chemical change.

3. Agents that physically restrain the action of the noxious compound, whereby its poisonous properties are neutralised.

CHAPTER II.

A brief Description of the Method of Research pursued.

There are two methods by which a writer who has some experience in the use of deodorants and disinfectants may put forward his knowledge. He may adduce his experience of disinfectants, as derived from his observation of their action in the sick-room; or he may follow an experimental research, and draw the conclusions therefrom. For many years past, I have followed out various lines of inquiry by the first of these methods; but the results, although at times apparently very decisive, have not in the main been satisfactory—not such, certainly, as a man of science ought to put forward as definite. The fact is, that the sick-room is not sufficiently under the control of the scientific observer; and many social considerations prevent him from using it, even to a limited extent, as a centre for scientific inquiry. This is right; for we enter the sick-room to treat the patient, not to carry out any investigations which do not fall naturally into the course of treatment.

In order, therefore, to obtain more perfect data than have yet been placed before the profession, I have chosen to rest mainly on the second, or experimental basis of research; that is to say, I have taken organic matters, and, subjecting them to processes of decomposition under various and varying conditions, have endeavoured, by the use of deodorising and disinfecting agents, to find the readiest means of removing or destroying the decomposing products, or of holding the process of decomposition itself in abeyance. The objection that may be made to the form of inquiry may be, that the same organic substances were not experimented on as are present in

the emanations from the sick; that I have not, for instance, been dealing with the poisons of scarlet fever, typhus, typhoid, or small-pox. I admit the objection to the full extent of its worth; and I would willingly have met it, if it had been possible. It will be seen at once that such process was impossible; because, even if the poisons named could be isolated and subjected to chemical agents, we have no means by which to show that their specific action was destroyed, inasmuch as we could not subject susceptible human beings to the test of experiment. I have, therefore, taken a course which is practicable, approximative at all events, and I think, upon the whole, satisfactory. Assuming that animal organic matter varies not greatly, whether it be in the form of decomposing blood and animal tissue, or excrete from the organic poisons to which reference has been made, I have subjected decomposing animal structures to deodorising and disinfecting processes, and have marked the results.

In following out the inquiry, the organic matters operated upon have been treated in the solid state, in the fluid state, and as they exist in fine particles floating in air.

In trying various deodorants and disinfectants, they have been used according to their applicability. Some have been employed in the solid form; others in the fluid; and a third class in the state of gas or vapour. In all cases, the experiments have been conducted leisurely, and, in every series, under the same circumstances and conditions, all of which have been noticed and rendered in the sequel. Thus the natural conditions of the air, in respect to its pressure, moisture, temperature, ozone, and direction of wind, have been registered from day to day, as the inquiries have proceeded. This will be seen in the chapters in which the results of experiments are recorded. In the record of experimental research which is now to follow, I have taken the various deodorants and disinfectants into my hands quite irrespectively of any theory of their action—I mean irrespectively of the classification drawn out in the first chapter. For this reason, and for the purpose of simplicity in narration, I have made no attempt, in describing the agents, to place them under the classification above named. At the same time, in regard to each substance under discussion, I have added a paragraph to the description of its action, stating the class under which it may be most fairly grouped.

Lastly, I have arranged the experiments in such manner as to render them of largest service for various purposes in a sanitary point of view. Thus certain of the processes referred to have relation to the principle of rendering innocuous dead animal matter, and might, therefore, be employed in the temporary preservation of human remains; others have a bearing on the deodorisation and disinfection of fluids; and others on the deodorisation and disinfection of impure air.

CHAPTER III.

Experimental Inquiries into the Deodorising Properties of various Substances used in the Solid Form, or as Fluid mixed with Solid.

In the present chapter, I am about to describe the effects of various substances used commonly for deodorisation, when placed in contact with solid organic matter, either in the fresh state, or after it has

undergone decomposition. After observation as to the organic matter which would yield products of decomposition most speedily, I fixed on the intestines of oxen as most effective for use. Weighed quantities of fresh intestines were obtained, and were buried in the substances employed for deodorisation. The organic matter, with the deodorising agent, was placed in a box open at the top, and freely exposed to the air; and all the substances in each series were placed, side by side, on the same spot and at the same periods of time. They were carefully examined on alternate days, and were reported upon at the moment.

During the whole time, meteorological observations were taken; and the following table describes, for each day, the mean pressure of the air, the mean temperature, the degree of humidity, the amount of ozone, and the quantity of rain.

TABLE.—Meteorological Elements.

Date. 1865.	Mean of Barome- ter.	Mean Tempera- ture.	Degree of Humidity, Complete Saturation=100.	Ozone.	Rain.
May 15 ..	29.517	55.3	84	2	0.01
" 16 ..	29.688	48.3	87	0	0.05
" 17 ..	29.726	51.8	87	2	0.00
" 18 ..	29.955	52.8	80	0	0.00
" 19 ..	30.223	52.5	58	0	0.00
" 20 ..	30.190	57.0	58	0	0.00
" 21 ..	29.949	63.5	81	0	0.01
" 22 ..	29.859	68.0	68	2	0.15
" 23 ..	29.856	68.0	64	2	0.00
" 24 ..	29.529	64.8	67	8	0.57
" 25 ..	29.943	58.3	64	0	0.00
" 26 ..	29.882	60.8	58	0	0.00
" 27 ..	29.769	65.3	65	0	0.00
" 28 ..	29.722	61.8	65	6	0.02
" 29 ..	29.741	61.8	59	3	0.04
" 30 ..	29.675	63.3	60	5	0.00
" 31 ..	29.795	57.3	67	2	0.00
June 1 ..	29.790	59.0	67	4	0.00
" 2 ..	29.525	58.3	74	10	0.21
" 3 ..	29.790	56.8	77	1	0.30
" 4 ..	30.089	60.0	65	0	0.01
" 5 ..	30.150	61.3	77	0	0.00
" 6 ..	30.169	66.3	67	0	0.00
" 7 ..	30.222	66.0	69	0	0.00
" 8 ..	30.284	59.0	61	0	0.00
" 9 ..	30.241	66.3	64	0	0.00
" 10 ..	30.049	67.5	64	0	0.00
" 11 ..	30.098	59.3	63	4	0.00
" 12 ..	30.273	51.8	58	6	0.00
" 13 ..	30.263	59.0	61	0	0.00
" 14 ..	30.264	63.8	69	0	0.00
" 15 ..	30.250	61.0	67	4	0.00
" 16 ..	30.269	63.0	71	8	0.00
" 17 ..	30.250	59.0	73	9	0.00
" 18 ..	30.184	59.4	75	9	0.00
" 19 ..	30.195	54.0	67	10	0.00
" 20 ..	30.220	57.7	49	0	0.00
" 21 ..	30.164	55.8	39	0	0.00
" 22 ..	30.172	63.4	67	4	0.00
" 23 ..	30.051	69.0	67	0	0.00
" 24 ..	30.054	69.8	50	0	0.00
" 25 ..	29.992	60.0	56	3	0.00

FIRST SERIES OF EXPERIMENTS. In the first series of experiments, two pounds of intestines were buried in a mixture containing given and equal quantities of deodorising substance, mixed up with two pounds of sawdust. The idea of using sawdust in connection with a deodoriser was derived from the process invented by Falcony, in which a chemical agent mixed with sawdust was applied, with great effect, to the preservation of the dead. I have in my possession the facts of an experiment made with Falcony's powder, in which the dead body of a man

was buried for four weeks; but was partially uncovered for some minutes, every day, for examination. In this case, the body retained its sweetness during the whole period, although the weather was hot, and decomposition in the air, with the production of offensive compounds from organic matter, was set up in a few hours. The result was so good, that I thought the experiment was worthy of being imitated with regard to other agents for disinfection. The experiments were commenced on the morning of the 15th May, and continued until the 24th June.*

Observations on the Decomposition and Deodorisation of 2 lbs. weight of Intestines from an Ox, buried in 2 lbs. of Sawdust with the Substances described; with Observations on a similar weight of Intestines exposed to common Air. (Commenced May 15th; ended June 24th.)

EXPERIMENT 1. *Two Pounds of Intestine of Ox in Air.*—May 17th. No change.—19th. Slight odour; is softer.—21st. Offensive and softened.—23rd. Very offensive and soft, containing maggots.—25th. Quite putrid.—27th. Completely disorganised (thrown away.)

EXPERIMENT 2. *One Pound of Sulphate of Zinc.*—May 17th. Darker and somewhat hardened.—19th to 29th. Fresh, sweet, and firm.—31st to June 4th. Slight odour.—6th and 8th. Slight odour; good colour; firm.—10th. The odour gone; exsiccated externally.—12th. Sweet and quite dry externally.—14th. Sweet, dry externally, and slightly moist within.—16th. Sweet; remained so on 24th (last day of observation.)

EXPERIMENT 3. *One Pound of Chloride of Zinc.*—May 17th. Darker and somewhat hardened.—19th. Fresh, dry, and of a dark green colour.—21st and 23rd. Sweet, darkened, and hardened.—25th to June 4th. Sweet and still firm.—6th and 8th. Sweet, of good colour, and still firm.—10th and 12th. Sweet, and dry externally.—14th. Sweet and dry externally, but slightly moist within.—16th. Sweet; remained so on 24th (last day.)

EXPERIMENT 4. *One Pound of Chloride of Sodium.*—May 17. Slightly darker in colour.—19th. Fresh, and of light green colour.—21st. Sweet, slightly darkened, and hardened.—23rd. Sweet, and moderately firm.—25th. Sweet; but slight odour when moved.—27th. Sweet on surface; slight odour in interior.—29th. Moderately sweet and firm.—31st. Slight odour.—June 2nd. Slightly offensive and soft.—4th. Yields a slight odour.—6th and 8th. Yields a slight odour, and is dark and soft.—10th. Slight odour; soft.—12th. Slight odour; good colour; soft. 14th to 22nd. Briny odour; soft.—24th. Offensive (thrown away.)

EXPERIMENT 5. *One Pound of Lime.*—May 17th. Is swollen.—19th. Yields a slight odour.—21st. Offensive, soft, and distended with gas.—23rd. Offensive, and more distended with gas.—25th. Less offensive, but distended.—27th. Slightly offensive externally, with strong odour internally.—29th. Yields a slight odour; less distended, and harder.—31st. Slight odour.—June 2nd. Slight odour; soft and dark.—4th and 6th. Is strongly ammoniacal, and contains maggots.—8th. Ammoniacal, soft, and powdery; contains maggots.—10th. Less ammoniacal, and somewhat dried.—12th. Less ammoniacal, and very dry.—14th. Slightly ammoniacal, and very dry.—

* For the purpose of conciseness, Dr. Barker arranged his observations in tables. As, however, it has not been possible to print these in pages of the size of the JOURNAL, we have altered his narrative to the form in which it is here given, taking care to preserve every record of fact contained in the Tables.

16th. Yields no odour.—18th. Yields no odour; is desiccated (thrown away).

EXPERIMENT 6. *One Pound of Charcoal.*—May 17th. Is swollen.—19th. Yields a rather putrid odour.—21st. Offensive, soft, and distended with gas.—23rd. Offensive; colour in interior quite fresh.—25th. Offensive, but of fresh colour; contains maggots.—27th. Offensive internally; colour fresh.—29th. Offensive, and contains maggots.—31st. Putrid; contains maggots.—June 2nd. Very putrid (thrown away).

EXPERIMENT 7. *One Pound of Alum.*—May 17th. Slightly darker in colour.—19th. Fresh, and not discoloured.—21st. Yields a slight odour; is not discoloured, and firm.—23rd. Slight odour; colour good; moderately firm.—25th. Slight odour; fresh colour.—27th. No smell externally, but an odour internally; good colour.—29th. Moderately sweet; good colour; firm.—31st. Slight odour.—June 2nd. Slight odour externally; putrid within.—June 4th. Slight odour externally; is offensive internally, and contains maggots.—6th. Offensive internally, and contains maggots.—8th. Offensive, and contains maggots.—10th. Less offensive.—12th. Not at all offensive.—14th. Very slightly offensive within, and still moist; contains maggots.—16th. Remains the same.—18th. Slightly offensive; surface dry; moist internally; contains maggots.—20th. Very slightly offensive.—22nd. Not offensive.—24th. Remains the same.

EXPERIMENT 8. *Half an Ounce of Creasote.*—May 17th and 19th. Smells strongly of creasote.—21st. Is sweet.—23rd. Moderately sweet.—25th. Is sweet.—27th. Sweet externally, but has some odour internally.—29th and 31st. Yields a slight odour internally.—June 2nd. Yields a strong odour.—4th. Is offensive externally and soft.—6th. Offensive and soft.—8th and 10th. Is offensive.—12th. Is offensive and soft.—14th. Is offensive, dark-coloured, and soft.—16th to 22nd. Remains the same.—24th. Very offensive (thrown away).

EXPERIMENT 9. *Two Ounces of Tincture of Iodine.*—May 17th. No change.—19th. Slight putrid odour.—21st. No odour.—23rd. Rather offensive, and distended with gas.—25th. Slightly offensive; but less distended.—27th. Slightly offensive externally, and more so internally.—29th. Slightly offensive.—31st. Offensive; particularly internally.—June 2nd. Offensive, and contains maggots (thrown away).

EXPERIMENT 10. *Half an Ounce of Carbolic Acid.*—May 17th and 19th. Smells strongly of carbolic acid.—21st to 29th. Is sweet.—31st and June 2nd. Has a very slight odour internally.—4th. Is fresh looking and somewhat soft.—6th. Is fresh looking, sweet, but soft.—8th to 12th. Is sweet.—14th to 18th. Is very slightly offensive.—20th and 22nd. Very slightly offensive; contains maggots.—24th. Offensive (thrown away).

EXPERIMENT 11. *Two Ounces of Vinegar.*—May 17th. Yields an odour of vinegar.—19th. Has a slight putrid odour.—21st. Rather offensive, soft, and gaseous.—23rd. Slightly offensive, dark-coloured, soft, and distended with gas.—25th. Not more offensive, but dark and soft.—27th. Yields an odour internally, and is of dark colour.—29th. Not very offensive, but very dark; and contains maggots.—31st. Offensive, very dark, and soft.—June 2. Quite putrid; contains maggots (thrown away).

EXPERIMENT 12. *Buried completely in Sawdust alone.*—May 17th. No change.—19th. Fresh and sweet.—21st. Very slightly offensive.—23rd. Rather offensive; somewhat softened.—25th. Rather offensive; contains maggots.—27th. Entirely decomposed (thrown away).

From these observations, made with every possible

care and with the utmost possible precaution for preserving uniformity of result, I gather the following inferences.

1. Chloride of zinc and sulphate of zinc are the best deodorisers in combination with sawdust. Practically, there is no difference between the two salts—a fact of considerable importance, inasmuch as chloride of zinc costs four shillings a pound, and sulphate of zinc five pence per pound.

2. After the preparations of zinc, carbolic acid stands best in the list of deodorisers, and next to it chloride of sodium.

3. Lime, when combined with sawdust, can scarcely be considered a deodoriser at all. In it, organic matter becomes offensive in four days, and remains so for fifteen days; then the odour becomes distinctly ammoniacal. Ultimately, the organic matter dries, and odour is lost; but this does not occur until after exposure for a month.

4. Charcoal, contrary to what ought to be expected, is, comparatively, a feeble deodoriser, even when used quite fresh. This was stated by Falcony; and the correctness of the remark is confirmed by the observations I have made.

5. One remaining fact is of considerable interest; namely, that a putrid odour is not always sustained in accordance with the time during which the organic matter has been dead; but that the putridity, as evidenced by the sense of smell, alternates in its stages. Thus, in the case where sulphate of zinc was used as a deodoriser, there was no odour from May 15th to May 29th. On the 31st, there was slight odour, which continued up to June 8th; while, on June 10th, the odour had entirely ceased, and the tissue continued sweet. The same observation was made with regard to other substances; but we may keep to the sulphate of zinc for illustration. The question arises—What is the cause of this alternation? If we turn to the temperature, we find that the first evidence of putridity to the sense of smell occurred on May 31st, when the temperature was lower than it had been for the five preceding days of observation. Again, we find that the day when the odour of putridity disappeared was the 10th of June, when the mean temperature was 67° Fahr.—a higher temperature than had prevailed on any preceding day. This is the only fact of meteorological import which is brought out; for there is the same odour on two days, on one of which there is no ozone, and on another of which the ozone marks ten degrees.

From all the facts, taken collectively, I infer that the alternation of temperature determines putridity, and this to an extent which has been presumed, but not carefully ascertained. It would seem that, when organic matter is undergoing slow decomposition, the products of decomposition are evolved, for the first time, so as to be sensible to the nose, when the temperature is moderately low; but that the odour will disappear altogether with a sudden elevation of temperature. The process of change depends, most likely, on loss of water—the higher temperature producing a quick desiccation and, therewith, an inodorous condition.

SECOND SERIES OF EXPERIMENTS. In a second series of inquiries, another class of substances was used, in combination with sawdust, for deodorisation. The results were as follows.

Observations on the Decomposition and Deodorisation of 2 lbs. weight of Intestines from an Ox, buried in 2 lbs. weight of Sawdust with the Substances described. (Commenced June 1st; ended June 24th.)

EXPERIMENT 13. *Half a Pound of Carbonate of Ammonia.*—June 4th. Yields an ammoniacal odour; slightly offensive internally.—6th. Yields an ammoniacal odour.—8th. Yields an ammoniacal odour; internally and externally is of fresh colour. Sawdust is much darker in colour.—10th. Yields a strong ammoniacal odour.—12th. Yields a strong ammoniacal odour, and is softened.—14th and 16th. Yields an ammoniacal odour, and is softened.—18th. Offensive.—20th and 22nd. Offensive; contains maggots.—24th. Very offensive (thrown away).

EXPERIMENT 14. *One Pound of Nitrate of Lead.*—June 4th. Slightly distended, but of good colour.—6th. Sweet and of good colour.—8th and 10th. Slightly offensive and soft.—12th—16th. Sweet externally; rather offensive internally. Surface dried; interior soft.—18th. Slightly offensive.—20th and 22nd. Offensive; contains maggots.—24th. Very offensive (thrown away).

EXPERIMENT 15. *One Pound of Nitrate of Potash.*—June 4th. Gives out a very slight odour internally.—6th. A slight odour internally.—8th. Gives out a slight odour; soft in structure.—10th. Very slightly offensive; and soft.—12—16. Slightly offensive externally; internally offensive and soft.—18th. Slightly offensive.—20th and 22nd. Offensive and red.—24th. Very offensive (thrown away).

EXPERIMENT 16. *One Pound of Chloride of Ammonium.*—June 4th and 6th. Is of dark colour, and offensive internally.—8th and 10th. Offensive, and soft in structure.—12th—16th. Sweet externally; offensive internally, and soft.—18th—22nd. Rather offensive.—24th. Slightly offensive.

EXPERIMENT 17. *One Pound of Sulphate of Magnesia.*—June 4th. Is of dark colour, offensive internally, softened, and distended.—6th. Offensive externally; very offensive internally, dark, and soft.—8th. Offensive, of dark colour, and soft.—10th. Offensive, dark, soft, and distended.—12th—16th. Offensive externally and internally; soft.—18th. Rather offensive.—20th and 22nd. Offensive; contains maggots.—24th. Very offensive (thrown away).

EXPERIMENT 18. *One Pound of Brown Sugar.*—June 4th. Sour smell developed internally; structure distended with gas.—8th. Offensive internally, soft, and distended.—10th. Offensive, soft, and distended.—12th—16th. Offensive externally; very offensive internally.—18th. Very offensive.—20th—24th. Offensive; contains maggots.

EXPERIMENT 19. *One Pound of Chloride of Potassium.*—June 4th. Slightly offensive internally.—6th. Offensive internally.—8th. Offensive, dark, and soft.—10th. Offensive and soft.—12th—16th. Yields a faint odour internally; offensive externally.—18th—24th. Rather offensive.

EXPERIMENT 20. *Two Ounces of Turpentine.* June 4th. Yields a turpentine odour; is sweet internally, and reddened.—6th. Slightly offensive internally.—8th—10th. Slightly offensive.—12th. Slightly offensive externally; offensive internally.—14th—16th. Remains the same, and contains maggots.—18th—24th. Yields an ammoniacal odour; structure disintegrated.

EXPERIMENT 21. *Two Ounces of Benzole.*—June 4th. Yields a benzole odour; is sweet internally, and of dark colour.—6th. Yields benzole odour; slightly offensive internally, dark, and soft.—8th. Offensive, dark, and soft.—10th. Slightly offensive, dark, and soft.—12th—16th. Offensive externally

and internally; soft.—18th. Rather offensive.—20th. Offensive, and contains maggots.—22nd. Offensive, very black, and soft; contains maggots.—24th. Very offensive (thrown away).

EXPERIMENT 22. *One Pound of Sulphate of Copper.*—June 4th and 6th. Slightly offensive internally.—8th and 10th. Slightly offensive and soft.—12th—22nd. Slightly offensive externally and internally.—24th. Offensive (thrown away).

EXPERIMENT 23. *One Pound of Plaster of Paris.*—June 4th and 6th. Offensive internally.—8th and 10th. Ammoniacal and soft.—12th and 14th. Ammoniacal externally; offensive internally.—16th. Ammoniacal externally, and dried; offensive internally.—18th. Ammoniacal and disintegrated.—20th—24th. Ammoniacal; contains maggots.

EXPERIMENT 24. *One Pound of Sulphate of Zinc.*—June 4th. Rather offensive internally; of dark colour.—6th. Offensive internally; of dark colour.—8th. Ammoniacal, dark, and soft.—10th. Ammoniacal and soft.—12th and 14th. Sweet externally; ammoniacal internally.—16th. Slightly ammoniacal externally; more so internally.—18th. Ammoniacal.—20th and 22nd. Ammoniacal; contains maggots.—24th. Offensive (thrown away).

EXPERIMENT 25. *One Pound of Silicate of Alumina (porous clay).* June 4th and 6th. Slightly offensive internally.—8th. Slightly offensive, dark, very soft, and pulpy.—10th. Ammoniacal and soft.—12th—16th. Ammoniacal externally; offensive internally, soft, and disintegrated.—18th. Slightly offensive.—20th and 22nd. Strongly ammoniacal; contains maggots.—24th. Offensive (thrown away).

EXPERIMENT 26. *One Pound of Sulphate of Iron.*—June 4th and 6th. Offensive internally; of dark colour.—8th. Offensive and very dark.—10th. Offensive, dark, and soft.—12th. Offensive externally and internally, like rancid tallow hardened.—14th and 16th. Rather less offensive.—18th. Offensive.—20th—24th. Very offensive (thrown away).

From the facts here supplied, we are driven to the conclusion that none of the substances named are to be considered as deodorants. In the first experiment, where the carbonate of ammonia was used, the animal tissue retained its character for twelve days, when it softened; and it was not offensive for six days later. Then it became offensive and putrid—the putrefaction going on rapidly after it first commenced. It is worthy of remark, that all the preparations of lime, as well as porous clay, caused a rapid evolution of ammoniacal gas to take place from the organic substance.

THIRD SERIES OF EXPERIMENTS. In order to institute comparison, experiments were made with the substances annexed mixed with sawdust, and also with sawdust alone.

Observations on the Decomposition and Deodorisation of 2 lbs. weight of Intestines from an Ox, completely buried in 2 lbs. weight of the Substances described. (Commenced May 15th; ended June 2nd.)

EXPERIMENT 27. *Fresh-burned Vegetable Charcoal.*—May 17th. No change.—19th. A putrid odour emitted through the charcoal as well as from the substance.—21st. Offensive.—23rd. Slightly offensive; interior of good colour.—25th. Rather offensive, but of fresh colour.—27th. Yields a strong odour internally, but is of good colour.—29th and 31st. Offensive; but still has fresh colour.—June 2nd. Very offensive and entirely decomposed (thrown away).

EXPERIMENT 28. *Earth-mould.*—May 17th. No

change.—19th. Putrid odour emitted through the mould.—21st. Offensive.—23rd. Very offensive, and contains maggots.—25th. Extremely offensive, and full of maggots.—27th. Entirely decomposed (thrown away).

EXPERIMENT 29. *Wood and Coal Ashes.*—May 17th. No change.—19th. Fresh and sweet.—21st. Very slightly offensive.—23rd. Slightly offensive.—27th. Yields no odour externally, but very slight odour internally.—29th. Slightly offensive internally, and somewhat softened.—31st. Rather offensive.—June 2nd. Offensive (thrown away).

With regard to the above series we learn, as the experiments in the first series have already indicated, that charcoal, used quite fresh, possesses a very limited deodorising power in comparison with other substances. I confess, indeed, that I was quite surprised at the result; and I imagine that, in some experiments where charcoal has been used apparently with much advantage, there must have been either a very low temperature, so as to give time for desiccation, or an extreme heat leading to quick desiccation. I afterwards, on June 23rd, in order to be quite satisfied, placed two pounds of intestines in roughly powdered charcoal, and another two pounds in powdered charcoal, changing it every day. The result was, that decomposition proceeded without interruption, and the intestines were very offensive on the fourth day.

I also placed two pounds of decomposing and offensive intestines of an ox in roughly powdered charcoal, and another two pounds in powdered charcoal. The result was that, on the following morning, the intestines were as offensive as when first buried in the charcoal, and went through all the stages of decomposition, unchecked in the least. The offensive emanations were also perceptible externally, before disturbing the charcoal each day. No difference was observable between the effects of the powdered and of the roughly powdered charcoal.

I further buried two pounds of intestines in fine unburned coal-dust; other two pounds in coarse coal-dust; and another two pounds in soot. The results were as follows. On the fifth day, decomposition had fairly set in (and the odour was very offensive) in the coal-dust, whether fine or coarse; but was delayed till the seventh day in the soot.

I also buried two pounds of decomposing and offensive intestines in fine coal-dust, in coarse coal-dust, and in soot. The results were as follows. The offensive odour was not in the least checked or modified by the fine or by the coarse coal-dust. The odour was perceptible externally as well as internally. In the soot-experiment, there was no odour externally; and, on removing the soot, the decomposing mass was certainly less offensive on the surface than internally.

The series of experiments also shows that fresh earth-mould possesses rather less power as a deodoriser than charcoal. It further indicates that wood-ashes possess a very decided deodorising property; being, in fact, little inferior to carbolic acid. Lastly, for some days, sawdust alone acts exceedingly well; but putrefaction, when it once commences in sawdust, is developed with great rapidity.

FOURTH SERIES OF EXPERIMENTS. In this series of experiments, the organic matter, after it had become putrid and intolerably offensive, was buried

in those compounds for deodorisation which had proved to possess the best properties as deodorants. The results are subjoined.

Observations on the Preservation and Deodorisation of 2 lbs. weight of Intestines of an Ox, buried in 2 lbs. weight of Sawdust with the Substances described, after complete Putrefaction had been developed. (Commenced May 31st; ended June 24th.)

EXPERIMENT 30. *One Pound of Sulphate of Zinc.*—June 2nd—4th—6th. Sweet externally, with very slight odour internally; of dark colour; contains maggots in abundance.—8th. Sweet and hard.—10th and 12th. Yields a very distinct odour, like that of tallow.—14th. Odour of tallow less distinct.—16th. Odour still less distinct.—18th—24th. Scarcely any odour.

EXPERIMENT 31. *One Pound of Chloride of Zinc.*—June 2nd. Sweet externally, with very slight odour internally; of greenish colour; no live maggots on the outside, but some in the inside.—4th and 6th. Sweet externally; very slight odour internally.—8th. Sweet and hard.—10th and 12th. Very slightly offensive.—14th to 24th. Yields a distinct odour, like that of pickled walnuts.

EXPERIMENT 32. *Half an Ounce of Creasote.*—June 2nd. Has a strong odour of creasote; an ammoniacal odour internally; of dark colour and rather dry; contains maggots in abundance.—4th. Sweet externally; has no offensive odour, but contains many maggots.—6th. Sweet outside, dried, and of dark colour.—8th—12th. Yields no odour; structure desiccated (thrown away).

EXPERIMENT 33. *Half an Ounce of Carbolic Acid.*—June 2nd. Strong odour of carbolic acid; structure dry, of dark colour; contains maggots in abundance.—4th. Yields no offensive odour; but contains maggots in abundance.—6th. Sweet externally; structure of dark colour and dried.—8th—12th. Yields an odour; structure desiccated (thrown away).

From this series we learn that, for the deodorisation of putrescent organic matter, as well as for the preservation of fresh matter, chloride and sulphate of zinc are by far the best agents. It is also worthy of remark, that the processes of change in the decomposed tissue induced by these salts differ very considerably. The sulphate of zinc gives rise to the evolution of a volatile body resembling a fat-acid; the other to a volatile substance resembling that evolved from a vegetable product partially preserved. There is here a wide field of inquiry suggested in relation to the products of decomposition of organic bodies, under varying circumstances; and I shall hope, on a future occasion, to present a new series of facts bearing on this point.

CHAPTER IV.

Experimental Inquiries into the Deodorising Properties of Various Substances used in the Liquid Form.

FIRST SERIES OF EXPERIMENTS. In the experiments now to be noticed, organic matter was placed in liquids of various kinds, and a comparison was struck between the changes induced by these liquids and by simple distilled water. On this occasion, the fresh liver of an ox was cut up into ounces and used. The liver was selected because, for these experiments, it was more convenient than intestine; and at the same time was almost as easily subject to decomposition. The results were the following.

Observations on the Preservation and Deodorisation of Structure of Liver (one ounce) in various Solutions (eight ounces of each). (Commenced June 2nd; ended June 24th.)

EXPERIMENT 34. *Distilled Water*.—June 4th. No odour detected; structure pale and distended; sinks.—6th. Faint odour of decomposition.—8th. Rather offensive.—10th. Offensive; surface mouldy.—12th—24th. Very offensive (thrown away).

EXPERIMENT 35. *Alcohol*.—June 4th. Odour of alcohol perceived; structure firm; sinks.—6th and 8th. Is sweet.—10th. Alcohol nearly evaporated; liver fresh.—12th—20th. Sweet, but very hard.—22nd. Dry, hard, and sweet (thrown away).

EXPERIMENT 36. *Sir W. Burnett's Fluid*.—June 4th. Much shrunken, solid, and swims.—6th. Sweet.—8th. Sweet, and much contracted.—10th. Sweet; and remained so till the 24th (last day of observation).

EXPERIMENT 37. *Saturated Solution of Sulphurous Acid Gas*.—June 4th. Odour of sulphurous acid; liver pale and swollen; sinks.—6th. Sweet; and remained so until the 24th (last day).

EXPERIMENT 38. *Beaufoy's Liquid*.—June 4th. Liver white; swims.—6th. Sweet; and remained so until the 24th (last day).

EXPERIMENT 39. *Peroxide of Hydrogen*.—June 4th. No odour; pale and swollen; swims.—6th and 8th. Sweet.—10th. Sweet and softened.—12th and 14th. Sweet.—16th. Faint odour.—18th. Offensive and soft.—20th and 22nd. Very offensive and soft (thrown away).

EXPERIMENT 40. *Tincture of Iodine*.—June 4th. Is shrunken, and sinks.—6th—10th. Sweet.—12th—20th. Sweet and hard.—22nd. Tincture evaporated; liver dry, hard, and sweet (thrown away).

EXPERIMENT 41. *Condy's Fluid*.—June 4th. No odour; sinks.—6th and 8th. Slightly faint odour.—8th and 10th. Offensive.—12th. Very offensive and soft.—14th and 16th. Exceedingly offensive (removed).

EXPERIMENT 42. *Liquor Ammoniac*.—June 4th. Ammoniacal, firm, and shreddy around; sinks.—6th and 8th. Ammoniacal.—10th. Offensive and softened.—12th and 14th. Very offensive.—16th. Exceedingly offensive (thrown away).

EXPERIMENT 43. *Saturated Solution of Sulphate of Magnesia*.—June 4th. No odour; swims.—6th—10th. Sweet.—12—16th. Slightly offensive.—18th. Sweet.—20th and 22nd. Has a faint odour.—24th. Offensive.

EXPERIMENT 44. *Solution of Permanganate of Lime*.—June 4th. No odour; sinks.—6th. Sweet.—8th and 10th. Rather offensive.—12th and 14th. Offensive.—16th. Very offensive (removed).

EXPERIMENT 45. *Saturated Solution of Chloride of Sodium*.—June 4th. No odour; swims.—6th—10th. Sweet.—12th—20th. Sweet and hard.—22nd. Yields a briny odour.—24th. Slightly offensive.

EXPERIMENT 46. *Saturated Solution of Sulphate of Iron*.—June 4th. Has no odour; swims.—6th. Sweet; and remained so till the 24th (end of observation).

EXPERIMENT 47. *Saturated Solution of Nitrate of Lead*.—June 4th. No odour; shrivelled and pale; swims.—6th. Sweet; and remained so till the 24th (last day of observation).

EXPERIMENT 48. *Saturated Solution of Nitrate of Potash*.—June 4th. No odour; sinks.—6th and 8th. Sweet.—10th. Yields faint odour; softened, and mouldy on surface.—12th. Faint odour.—14th and 16th. Faint odour; very mouldy.—18th. Sweet, very red, and soft.—20th and 22nd.—Faint odour.—24th. Offensive.

EXPERIMENT 49. *Saturated Solution of Chlorine*.—

June 4th. No odour; sinks.—6th and 8th. Sweet.—10th—16th. Yields a faint odour.—18th. Yields faint odour; very soft.—20th. Very offensive.—22nd. Very offensive, soft, and rotten (thrown away).

EXPERIMENT 50. *Saturated Solution of Sugar*.—June 4th. No odour; dark, smaller; swims.—6th—10th. Sweet.—12th. Sweet, dark-coloured, and firm; remained so on 24th (last day of observation).

EXPERIMENT 51. *Pyroligneous Acid*.—June 4th. Has an acetic odour; pale; sinks.—6th to 10th. Sweet. 12th. Sweet and soft.—14th. Sweet; remained so on 24th (end of observation).

EXPERIMENT 52. *Saturated Solution of Chloride of Potassium*.—June 4th. No odour; swims.—6th. Sweet; and remained so on the 24th (last day of observation).

EXPERIMENT 53. *Saturated Solution of Chloride of Ammonium*.—June 4th. No odour; sinks.—6th and 8th. Faint odour.—10th to 14th. Sweet.—16th. Faint odour.—18th. Sweet; remained so on 24th (last day of observation).

EXPERIMENT 54. *Saturated Solution of Alum*.—June 4th. No odour; sinks.—6th—18th. Sweet.—20th and 22nd. Faint odour.—24th. Slightly offensive.

EXPERIMENT 55. *Turpentine*.—June 4th. Has turpentine odour, is pale, and sinks.—6th. Turpentine odour.—8th. Turpentine odour; sweet. Remained so on 24th (last day of observation).

EXPERIMENT 56. *Saturated Solution of Chlorate of Potash*.—June 4th. No odour; sinks.—6th. Faint odour.—8th. Faint odour; white mould on surface.—10th. Faint odour; mouldy.—12th—16th. Faint odour; very mouldy.—18th. Slightly offensive and mouldy.—20th and 22nd. Offensive.—24. Very offensive.

In reviewing these experiments, we learn that alcohol, Sir W. Burnett's fluid, the saturated solution of sulphurous acid, Beaufoy's liquid, tincture of iodine, solution of sulphate of magnesia, solution of chloride of sodium, solution of sulphate of iron, solution of nitrate of lead, solution of sulphate of copper, solution of sugar, pyroligneous acid, solution of chloride of potassium, solution of alum, and turpentine, were all nearly equally good in preventing decomposition. Solution of peroxide of hydrogen, containing ten volumes of the peroxide, was good for sixteen days; then decomposition commenced, and went on with great rapidity to complete disorganisation. Permanganate of potash (Condy's fluid) was bad, decomposition commencing in it on the sixth day. Permanganate of lime is also bad; but preserves sweetness until the eighth day. Solution of ammonia is indifferent; decomposition commencing on the tenth day. Solution of nitrate of potash is indifferent; decomposition commencing on the tenth day, and mould forming on the organic structure. Chlorine water holds good until the tenth day, or six days less than the peroxide of hydrogen; but, in the former, the change afterwards is not so rapid as in the peroxide. Solution of chloride of ammonium is nearly as good as the solution just named, but it is variable in its action. Solution of chlorate of potash is bad from an early period.

SECOND SERIES OF EXPERIMENTS. In this series, one ounce of liver of ox was allowed to become offensive from decomposition, and was then placed, separately, in precisely the same solutions as are given in the preceding table. The results were, briefly, as follows. On the following day, the offensive odour was readily perceptible in water, peroxide

of hydrogen, liquor ammoniæ, solution of sulphate of magnesia, solution of nitrate of lead, solution of nitrate of potash, solution of chloride of ammonium, solution of alum, and solution of chlorate of potash. The offensive odour somewhat diminished in alcohol, in Condry's fluid, in chlorine water, in solution of sugar, in solution of permanganate of lime, in solution of chloride of sodium, in solution of sulphate of iron, in solution of sulphate of copper, and in solution of chloride of potassium. The offensive odour was destroyed in pyroligneous acid, in Sir W. Burnett's fluid, in solution of sulphurous acid, in Beaufoy's liquid, in tincture of iodine, and in turpentine.

It is a point of some practical importance to the practitioner of medicine, to observe the influence of these various solutions in checking the process of decomposition; inasmuch as it is valuable to know what solutions would be most rapid and effective in their action, when used as injections into cavities containing decomposing matter—such as the cavity of the uterus during organic disease or puerperal fever. Some of these would, of course, be objectionable on account of their poisonous properties; but others would be quite simple, as, for example, peroxide of hydrogen well diluted, tincture of iodine well diluted, solution of sulphurous acid well diluted, solution of sulphate of magnesia well diluted, solution of chloride of sodium diluted, solution of sulphate of iron diluted, solution of sugar, and solution of alum. I therefore place these solutions in order according to their respective merits. These remarks with reference to injections would apply also to gargles.

CHAPTER V.

On the Preservation of Animal Fluids by various Deodorising Substances used in Solution.

FIRST SERIES: EXPERIMENTS WITH DEFIBRINATED BLOOD. In this series the blood of the ox, after having been defibrinated, was divided into quantities of a fluid-ounce each, and treated in the open air, with quantities of a fluid-drachm of each of the deodorants employed. The results are subjoined.

Observations on the Preservation of Defibrinated Blood (one ounce) in various Deodorising Substances in Solution (one drachm). (Commenced May 31st; ended June 24th.)

EXPERIMENT 57. One Ounce of Defibrinated Blood in Air alone.—June 2nd. No change of colour; slight separation of brown precipitate in a thinner fluid.—4th and 6th. Yields a slight odour; is dark.—8th.—12th. Offensive.—14th and 16th. Very offensive.—18th.—24th. Has an odour of sulphuretted hydrogen.

EXPERIMENT 58. Liquor Ammonia.—June 2nd. Has a smell of ammonia; bright colour; liquid.—4th. Ammoniacal; darker, and liquid.—6th and 8th. Sweet.—10th.—14th. Yields a faint odour.—16th. Offensive.—18th. Slightly offensive.—20th and 22nd. Offensive.—24th. Very offensive.

EXPERIMENT 59. Pyroligneous Acid.—June 2nd. Slight odour of acetic acid; dark colour; solid.—4th. Sweet, dark, and solid.—6th. Sweet; and remained so to end of observation.

EXPERIMENT 60. Carbolic Acid.—June 2nd. Strong odour of carbolic acid; brick colour; solid, with small quantity of liquid on surface.—4th. Odour of carbolic acid; otherwise as before.—6th. Sweet; remained so to end of observation (24th).

EXPERIMENT 61. Creasote.—June 2nd and 4th. Strong odour of creasote; light brick colour; con-

sistence of treacle.—6th. Sweet; remained so to end of observation (24th).

EXPERIMENT 62. Bromine.—June 2nd and 4th. Faint odour of bromine; dark colour; solid and expanded, filling the bottle.—6th. Sweet; remained so till end of observation (24th).

EXPERIMENT 63. Tincture of Iodine.—June 2nd and 4th. Faint odour of iodine; dark colour; liquid.—6th. Sweet.—8th. Has faint odour; remained so till end of observation (24th).

EXPERIMENT 64. Saturated Solution of Nitrate of Lead.—June 2nd and 4th. Peculiar faint odour; vermilion colour; solid.—6th.—10th. Sweet.—12th. Faint odour; remained the same till end of observation (24th).

EXPERIMENT 65. Sir W. Burnett's Fluid.—June 2nd. No odour; dirty brown colour; consistence of syrup.—4th. Faint odour; otherwise as before.—6th. Sweet.—8th. Faint odour; remained the same till end of observation (24th).

EXPERIMENT 66. Turpentine.—June 2nd and 4th. Odour of turpentine; dark colour; gelatinous.—6th and 8th. Sweet.—10th. Turpentine odour; sweet.—12th. Sweet; remained so till end of observation (24th).

EXPERIMENT 67. Alcohol.—June 2nd. Slight odour of alcohol; bright vermilion colour; liquid.—4th. Faint odour; otherwise the same.—6th. Sweet.—8th. Faint odour.—10th. Slightly offensive.—12th.—18th. Offensive.—20th.—24th. Very offensive.

EXPERIMENT 68. Benzole.—June 2nd and 4th. Strong odour of benzole; dark colour; semiliquid.—6th and 8th. Sweet.—10th. Benzole odour; sweet.—12th. Faint odour.—14th and 16th. Slightly offensive.—18th.—24th. Faint odour.

On looking over these observations, we find that the substances which prevent entirely the decomposition of blood for a period of twenty-five days are pyroligneous acid, carbolic acid, creasote, bromine, and turpentine. Ammonia is less effective; and tincture of iodine, solution of nitrate of lead, Sir W. Burnett's fluid, chloroform, and benzole, stand in the same category. Alcohol is very inferior; probably from its gradual escape by evaporation.

SECOND SERIES: EXPERIMENTS WITH MILK. In this series, new milk was divided into quantities of a fluid-ounce each, and treated in the open air with a fluid-drachm of each of the deodorants employed. The results are annexed.

Observations on the Preservation of Milk (one ounce) by various Deodorising Substances in Solution (one drachm of each). (Commenced May 31st; ended June 24th.)

EXPERIMENT 69. One Ounce of New Milk in Air alone.—June 2nd.—6th. Sour; creamy on surface; and semisolid.—8th and 10th. Sour and curdy.—12th and 14th. Sour.—16th. Sour; mouldy odour.—18th.—24th. Mouldy odour.

EXPERIMENT 70. Liquor Ammonia.—June 2nd and 4th. Ammoniacal; semitransparent; gelatinous below; surface creamy.—6th. Ammoniacal.—8th and 10th. Sweet.—12th. Faint odour.—14th. Sour.—16th to 20th. Very sour, and somewhat offensive.—22nd and 24th. Very sour.

EXPERIMENT 71. Pyroligneous Acid.—June 2nd and 4th. Acid smell; curdy.—6th. Sweet.—8th. Sour and curdy.—10th.—14th. Sour.—16th. Acid smell; remained the same to end of observation (24th).

EXPERIMENT 72. Carbolic Acid.—June 2nd and 4th. Odour of carbolic acid; opaque; liquid; creamy on surface.—6th and 8th. Sweet.—10th. Sweet;

liquid; opaque; and homogeneous.—12th. Sweet; remained the same to end of observation (24th).

EXPERIMENT 73. *Cresote*.—June 2nd and 4th. Odour of *cresote*; very opaque; surface creamy.—6th and 8th. Sweet.—10th. Sweet; liquid; opaque; and homogeneous.—12th. Sweet; remained the same to end of observation (24th).

EXPERIMENT 74. *Bromine*.—June 2nd—10th. Bromine odour; thick spongy light yellow film on surface; bright gold coloured liquid below.—12th. Sweet.—14th. Bromine odour; sweet; remained the same to end of observation (24th).

EXPERIMENT 75. *Tincture of Iodine*.—June 2nd and 4th. Iodine odour; creamy bright yellow film, covering opaque lighter yellow fluid.—6th—12th. Sweet.—14th—22nd. Slight iodine odour; sweet.—24th. Sweet.

EXPERIMENT 76. *Saturated Solution of Nitrate of Lead*.—June 2nd and 4th. No odour; thick and curdy.—6th. Sweet; remained the same at end of observation (24th).

EXPERIMENT 77. *Sir W. Burnett's Fluid*.—June 2nd and 4th. No odour; thick and curdy.—6th—16th. Sweet.—18th—24th. Faint odour.

EXPERIMENT 78. *Turpentine*.—June 2nd and 4th. Odour of turpentine; creamy surface; quite opaque below.—6th. Turpentine odour.—8th. Sweet; greenish yellow film on surface.—10th. Turpentine odour; forms a firm clot in semitransparent liquid.—12th. Sweet; remained the same at end of observation (24th).

EXPERIMENT 79. *Alcohol*.—June 2nd and 4th. Slight alcoholic odour; surface creamy; colour below "skyblue".—6th and 8th. Sweet.—10th—14th. Sour. 16th—24th. Sour; yields mouldy odour.

EXPERIMENT 80. *Chloroform*.—June 2nd and 4th. Odour of chloroform when shaken; surface creamy; layer of opaque white precipitate at bottom.—6th—22nd. Sour; odour of chloroform when shaken.—24th. Sour, whether shaken or not.

EXPERIMENT 81. *Benzole*.—June 2nd and 4th. Strong benzole odour; opaque and gelatinous.—6th. Strong benzole odour.—8th. Sweet.—10th. Strong benzole odour.—12th—18th. Faint odour.—20th—24th. Mouldy odour.

On reference to the preceding observations, it will be seen, that carbolic acid and *cresote*, bromine, tincture of iodine, solution of the nitrate of lead, turpentine, and chloroform, are the best preservatives from decomposition. Ammonia keeps off decomposition for twelve days; pyroligneous acid is less definite in action; alcohol fails on the tenth day, and benzole on the twelfth.

CHAPTER VI.

Experiments on Ozone as a Deodoriser.

For some years past I have observed, in a general way, that the effect of ozone is to produce purification of air containing foetid matter. Thus when, in my observations, the presence of ozone was well marked, there was always diminution, as I thought, of emanations detectable by the nose from the cess-pool and drain. This, however, might be only imaginary or coincidental; that is to say, the absence of smell might be due to some error of mine, or, presuming that I was right in my impression, it might be that some other agent than ozone produced the change. I therefore thought it worth while to make a series of inquiries relative to the effect of ozone on matter that had undergone decomposition.

In order to test the deodorising effects of ozone, I suspended pieces of liver in advanced stages of de-

composition in bell-jars of various sizes, and introduced dishes of a very foetid liquid. Phosphorus and water were arranged as in one of the processes for making ozone artificially; and its presence was proved abundantly by Schönbein's tests. The results are subjoined.

Observations on the Effects of Ozone upon Decomposed Animal Tissues and Fetid Solutions. (Commenced June 16th; ended June 24th.)

EXPERIMENT 82. *Decomposed Liver placed into a three-quart Bell-jar for making Ozone; suspended within four inches of the bottom.*—June 17th. Very slight odour.—18th—20th. Sweet.—22nd and 24th. Slight musty odour.

EXPERIMENT 83. *Six drachms of Fetid Solution in a Florence Flask introduced into a three-quart Ozone Bell-jar.*—June 17th. Very slight odour.—18th. Not offensive unless shaken.—19th. Less offensive.—20th. Less offensive.—22nd and 24th. Scarcely any odour perceptible.

EXPERIMENT 84. *Decomposed Liver placed into a two-quart Ozone Bell-jar; suspended within six inches of the bottom.*—June 17th. Slight odour.—18th—20th. Sweet.—22nd and 24th. Perfectly sweet.

EXPERIMENT 85. *Decomposed Liver placed into a pint Ozone Bell-jar; suspended just below the neck, eight inches from the bottom.*—June 17th. Slight odour.—18th and 20th. Very slight odour.—22nd and 24th. Slight musty odour.

EXPERIMENT 86. *Watch-glass containing Fetid Solution introduced into a pint Ozone Bell-jar.*—June 17th. Slight odour.—18th. Much less offensive.—19th—24th. Very slightly offensive.

It will be seen that the most marked effects were produced upon the decomposing animal matter in a short time. The experiments were commenced at 8 o'clock in the evening; and at 9 o'clock on the following morning there was but little odour in the solid animal matter, and the offensive odour in the liquid was considerably diminished, and scarcely perceptible, unless the liquid were shaken. The effect was less decided in the smallest bell-jar in so short a time. On the following day, in two cases the odour was lost altogether in the solid substance, and was greatly reduced in the liquid. On the following two days, the solid substance which had been rendered sweet continued so, while the fluids were very much less offensive. On the fifth day, one portion of the solid matter remained perfectly sweet, while the other was slightly musty; and the fluids were nearly deodorised. These facts relate to the experiments numbered 82 and 83. In the case of experiment 84, there was a very slight odour throughout; but so slight that it would have escaped notice if it had not been specially sought for.

It is worthy of remark, that the ozone produced purification of the solid much more quickly and perfectly than of the liquid substance; probably from the circumstance that the continuous changes from decomposition are more actively progressive in the fluid than in the solid form.

As bearing on this subject, I may mention the particulars of experiments with ozone on blood that had undergone decomposition. One experiment was performed by my friend Dr. ———, and is described as follows.

Some blood which was drawn from an ox in the year 1856 was placed in a wide-mouthed bottle. It was allowed to coagulate, and then to decompose. When it had become distinctly offensive from alkaline

decomposition, a stopper was placed in the bottle, and it was set aside, being simply shaken once or twice a week. In the course of time the clot underwent resolution; and at the end of two years there was no clot at all, but a thin dark fluid. The stopper was now so firmly fixed in the bottle that it could not be removed; and so the fluid remained until 1863. In December of that year, the neck of the bottle was filed, and the fluid was drawn off. It was quite free from clot. The corpuscles were dissolved to a great extent—although some small white irregular bodies like corpuscles remained; and an ammoniacal putrescent odour was evolved. An ounce of this fluid was now subjected to a current of ozonised air—the air being saturated with the ozone. In from two to three minutes, the blood was entirely deodorised, and underwent the most natural coagulation; serum exuding, in the course of time, from the clot that was formed. Exposed also to air at 75° Fahr., the clot became of red colour, was quite sweet, and looked precisely like blood that had been drawn immediately from the body.

CHAPTER VII.

The Deodorisation and Disinfection of Air.

In connexion with the inquiries as to the best means of deodorising solid and liquid substances, I carried out another series of inquiries in respect to the deodorisation of atmospheric air. The object which I had in view was to compare the relative deodorising powers of

- a. Fresh air, freely supplied;
- b. Air charged with chlorine;
- c. Air charged with iodine;
- d. Air charged with ozone;
- e. Air charged with nitrous acid;
- f. Air charged with sulphurous acid;
- g. Air charged with ammonia.

To make the inquiry as exact as it could be, a small model was constructed like the ward of a hospital. The model was made exactly to hold two cubic feet. It was provided with four windows facing each other, with a central window on one side, with a long chimney furnished with an Arnott valve, and with a roof in which was fitted McKinnell's ventilator. The ventilation was tested most carefully by burning within the model (which, by the way, was constructed of wood and glass) weighed tapers of wax; and it was determined that the most perfect combustion took place when two of the windows were open at the top and two at the bottom, with McKinnell's ventilators open. The ventilation was very fair, as evidenced by the combustion when the middle window to which I have referred was alone open and McKinnell's ventilator was in play; but the most perfect ventilation was achieved under the conditions named previously. My friend Dr. Richardson, who obliged me with this model, also supplied me with a description of the ventilating capacity of the windows, chimney, and other parts of the model. This was determined by the combustion, by a most simple and accurate process; which might, by the way, be extensively applied. The description is too elaborate to be fully entered into here. I may, however, briefly state what is sufficient for my purpose; that, when the four windows were open and McKinnell's ventilator was open, the combustion of wax in the chamber, for twelve hours, was the same as in open air.

Furnished with this model, I proceeded to test the

deodorising effects of various substances in the following manner.

A glass vessel, capable of holding one thousand cubic inches of air, and fitted up like a Woulfe's bottle, was filled for one-fourth with a compound foetid mass, consisting of cesspool matters, decomposing egg, decomposed urine, decomposed liver and intestine, decomposed vegetable matter (cabbage-leaf), and some decomposed fluid removed from an ovarian cyst. The mixture was allowed to stand for ten days; and a more atrocious compound than the air over it cannot be conceived.

To test the power of the deodorants, eight ounces of this fluid were placed in a shallow dish and put into the chamber. The deodorising powers of the various deodorants employed were tested by the smell, and by Angus Smith's permanganate test. The permanganate was used by making a standard solution of Condry's fluid, as the best known and easiest of access. Two minims of Condry's permanganate of potassa were added to one pint of distilled water. A beautiful rose-coloured solution was thus afforded.

Before proceeding to the inquiry with foetid air, a preliminary step was taken. The standard solution was carefully tested with ordinary air. Then it was tested with the deodorants, to determine whether they would themselves decolorise the permanganate solution. The result was that the air, ozone, chlorine, iodine in vapour, and ammonia, were entirely negative. Nitrous acid and sulphurous acid, when in the pure state, changed the colour; but, diluted to the extent I wished, they, too, were inert in the presence of decomposable matter. These preliminaries determined, the following series of experiments was instituted.

Experiments on Foetid Air.

EXPERIMENT 87. Eight ounces of the foetid liquid were placed in a glass dish six inches in diameter. The dish was then put in the centre of the floor of the model; and the model was closed entirely, all ventilation being cut off, for forty-five minutes. At the close of this period, two drachms of the permanganate solution were placed in the chamber in a wide-mouthed test-tube, which was carefully agitated in the air of the chamber.

The colour of the solution was discharged in four minutes.

EXPERIMENT 88. The chamber was next ventilated as freely as it could be, by opening the windows, the chimney, and the ventilator in the roof. The offensive odour soon sensibly diminished, but it could always be detected. After waiting thirty minutes, two drachms of the permanganate fluid were placed in the test-tube, and agitated as before in the air of the chamber.

The colour was discharged in twenty-five minutes.

EXPERIMENT 89. The windows and other openings of the chamber were closed; and the air in the chamber was allowed to become charged with the foul air as in experiment No. 87. Then, into the chamber, one cubic inch of chlorine was introduced. Almost immediately, all odour had disappeared, and the smell of chlorine alone prevailed. The chlorine odour remained for nearly sixteen minutes; then a faint foetid odour was again perceived.

The colour of two drachms of the permanganate solution remained unchanged. Seven minutes later, it was discharged. The colour, in fact, remained perfect, so long as the odour of chlorine could be detected.

EXPERIMENT 90. The chamber was purified, then

closed, and charged, as before, from eight ounces of the fetid fluid, until the foul air was thoroughly diffused. Three grains of iodine, calculated as practically representing one cubic inch of chlorine, were next diffused in vapour through the chamber, by being dropped upon a heated plate in the chamber. The iodine vapour was unequally distributed; and the iodine deposited in patches on the sides and roof. For four minutes the odour of the iodine prevailed; then the impure smell began to return.

The permanganate solution, used as in the previous experiment, was discharged of colour in *nine* minutes.

EXPERIMENT 91. The chamber was closed, and charged, as before, with foul air; then ozone, made by the action of phosphorus—the phosphoric acid being thoroughly removed—was introduced into the chamber until the foul air was replaced by an odour of ozone. On this, the ozone was withdrawn. The offensive odour remained absent for five minutes.

The permanganate, in the same quantity and dilution as before, was deodorised in *sixteen* minutes, at a temperature of 75° Fahr.

EXPERIMENT 92. The chamber was cleansed, and afterwards charged with the offensive smell, as in preceding experiments. One cubic inch of binoxide of nitrogen was now introduced into it. The vapour was at once transformed into nitrous acid fumes; and in *four* minutes the air in the chamber was nearly deodorised.

The permanganate, used as before, was deodorised in *twenty-one* minutes.

EXPERIMENT 93. The chamber was cleansed and charged once more with fetid vapour, precisely in the same manner. One cubic inch of sulphurous acid gas was now introduced. As the gas was diffused, the odour of the fetid matter was destroyed in *seven* minutes; and a faint trace of sulphurous acid could be detected at the upper aperture of the chamber.

The permanganate, introduced into the chamber precisely in the same manner as in the foregoing experiments, was deodorised in *twenty-two* minutes, at a temperature of 75° Fahr.

EXPERIMENT 94. The chamber having been charged with fetid vapour in the usual way, one fluid-drachm of strong liquor ammoniac of the *Pharmacopœia* was introduced and diffused. Within *two* minutes, the ammonia was easily detected by its odour; and the odour of the fetid matter was disguised or removed for three or four minutes more.

The permanganate test, applied in the usual way, was discharged of colour in *eighteen* minutes, at a temperature of 75° Fahr.

In the performance of experiments such as the above, the greatest nicety is required in the method of conducting the research; and, what is more, the greatest care is required in commenting on the results obtained. The researches which I have narrated were carried out with as much regard to every minute detail as I and two scientific friends who were present could devise; and, speaking upon them with as much precaution as was used in conducting them, I think that the following inferences are fair and correct.

1. The most powerful deodoriser, and—if Angus Smith's test be taken as faithful in respect to the destruction of organic matter—the best disinfectant, is chlorine. But, when the odour of chlorine is lost, its efficacy may be considered as having ceased.

2. Next to chlorine is thorough ventilation; which in its turn has this advantage over chlorine, that it continues in action, while chlorine only deodorises,

and destroys while it remains to act upon the deleterious body.

3. After ventilation, nitrous and sulphurous acids stand next in order. Both of them preserved the permanganate from decolorisation for nearly the same period of time. The sulphurous acid had one minute the advantage, and it certainly removed the odour more effectually.

4. Ozone appears to be less active, in so far as the permanganate is concerned, than either chlorine, nitrous acid, or sulphurous acid. It, however, destroys the odour as effectually as the others, and almost as rapidly as chlorine, which, in action, it closely resembles. It possesses, again, in its turn, an advantage: it can be employed permanently, by a simple process, with ventilation. The air that ventilates, in fact, may be ozonised as applied, chemically and mechanically, at one and the same time.

5. Iodine in vapour, used in the same quantity as chlorine, is equally effective with chlorine in removing the offensive odour, when the vapour is freely distributed. The difficulty in using iodine lies in securing its free diffusion. The vapour is deposited unequally in various parts of the chamber: hence the iodine does not remain so universally in action on the offensive substance that is suspended in the air as organic particles, or diffused through the air as a gas.

6. Ammonia acts in a peculiar manner on air containing organic and fetid matter. It possesses, unquestionably, some action, by which for a time odour is modified and the permanganate is prevented from change. But I may observe that there is a difference in the action of ammonia from that displayed by other substances; viz., that, if a given and limited quantity of fetid air be used, the chlorine, iodine, ozone, nitrous acid, sulphurous acid, and pure air in current, destroy the odour altogether, while the ammonia only produces a suspension of the action. This fact sustains the theory to which I referred in my chapter on the definition of a disinfectant; viz., that all disinfectants are either deodorisers or antiseptics. But it is, at the present time, fair to observe that the fact relates to ammonia alone as an antiseptic; for sulphurous acid is in truth an antiseptic, and meats preserved in it have, as I know, been kept sweet and fit for eating for six months; but, as a gas in contact with gas or with solid organic matter in a state of fine division, it is itself decomposed, and towards the substances with which it is in contact it becomes a destroyer, instead of being a preserver.

From what has now passed before us, we learn that chlorine, pure air in current, nitrous acid, sulphurous acid, ozone, iodine, and ammonia, stand as disinfectants in the order in which they are placed in this sentence. I thought it worth the trouble to determine whether chlorine, ozone, iodine, and ammonia would produce any analogous action in preventing the decomposition of the permanganate, if the fetid substance were used in the liquid instead of the gaseous form. Nitrous acid and sulphurous acid were excluded from this inquiry, in consequence of the circumstance that they themselves in liquid destroyed the colour of the test. I made several efforts to overcome this objection, but failed in all.

In the experiments to be related, the solution of permanganate was made of a much deeper colour than when gases were employed. The solution contained twenty minims of permanganate in a pint of distilled

water. It was, however, easily acted on. One fortieth of a grain of dried poison from the rattlesnake sufficed to decolorise one ounce of the solution in one minute and fifteen seconds. The experiments with the fetid solution are given below.

EXPERIMENT 95. Ten minims of the fetid solution were introduced into a very large test-tube, holding four ounces of a solution of permanganate made by adding twenty minims of Condry's fluid to a pint of distilled water. The fetid solution was shaken with the permanganate, and set aside at a temperature of 75° Fahr.

The colour of the permanganate was discharged in five minutes.

EXPERIMENT 96. Four drachms of the fetid solution were poured into a glass vessel containing thirty-four cubic inches of pure chlorine. The vessel was immediately closed. The fluid became white, and the fetid odour was entirely destroyed at once; but a new chlorinated odour was established. The fluid was kept in contact with the chlorine for fifteen minutes at 75° Fahr., and was then withdrawn.

Ten minims of the chlorinated solution discharged the colour of four ounces of the permanganate in thirty-three minutes.

EXPERIMENT 97. Four drachms of the fetid solution were placed in thirty-four cubic inches of air charged with ozone to saturation. The vessel was then closed. The solution was slightly bleached; and in five minutes the odour, though not entirely removed, was much reduced. After fifteen minutes' contact with the ozone at 75° Fahr., the fluid was withdrawn, and ten minims were added to four ounces, as before, of the permanganate solution.

The colour of the permanganate was discharged in nine minutes by the ten minims of ozonised fluid at 75° Fahr.

EXPERIMENT 98. Four drachms of the fetid solution were placed in a vessel measuring thirty-four cubic inches, and charged with vapour of iodine. The fluid was left in contact with the vapour for fifteen minutes. The fetid smell was removed in two minutes; and, after exposure for fifteen minutes, the smell was absent, and an iodine smell alone was present. Ten minims of the solution thus treated with iodine were now added to the solution of the permanganate.

The colour of iodine solution was thus imparted; but this colour did not obscure the pink colour of the original solution. The pink colour remained for nearly nine minutes, when it subsided into a greenish brown, which remained for many hours.

Solution of iodine in spirit acted on the permanganate precisely in the same manner; so that it is difficult to state the precise period of discoloration, or the actual value of iodine in preventing discoloration of the permanganate in solution in the presence of decomposing matter.

EXPERIMENT 99. Four drachms of fetid solution were placed in a bottle capable of holding thirty-four cubic inches, and one fluid-drachm of strong liquor ammoniæ was added. The mixture was allowed to stand for a quarter of an hour, being thoroughly shaken during the time. The odour of the fetid solution was not destroyed, but was obscured to a certain extent by the ammonia.

Ten minims of the ammoniated fetid solution were now added to four drachms of the solution of permanganate.

The colour was discharged within a minute after the addition.

The suddenness of the change led me to test the effect of ammonia by itself, and again of the fetid

solution by itself. The result was, that the ammonia produced no change; while the fetid solution caused discharge of colour in five minutes, as before.

Respecting the relative value of these substances—chlorine, iodine, ozone, and ammonia—for the deodorisation of decomposing sewage containing organic matter, chlorine and iodine hold nearly equal positions. If anything, iodine has the preference; for the effect of the chlorine was limited in its duration, the gas being all rapidly applied, while the iodine, as I found by an after experiment, remained in action for four days, the iodine vapour condensing, admixing with the fetid fluid undergoing slow decomposition, and long yielding evidence of its own presence.

Ozone is less effective than either chlorine or iodine on fluid decomposing matter; a fact explainable on the ground that ozone does not combine readily with bodies in solution, whatever its affinity for them may be. If ozone is to be used at all for the deodorisation of fluid matter, it must be employed in the form of permanganate (Condry's fluid); but in that form it is, as I found by comparison, very inferior to iodine and chlorine.

Ammonia does not bear comparison with the other substances in respect to the deodorisation of fluid matters. It does not, in fact, deodorise; and, tried by the permanganate-test, it seems to intensify the action of the decomposing body. I say "seems" to intensify; because the phenomenon observed, of rapid discharge of colour in the permanganate on the addition of a fetid solution containing ammonia, while it favours the view that ammonia intensifies the action of the decomposing bodies, does not prove it true. Some other explanation of the phenomenon observed may, perhaps, present itself on further reflection.

CHAPTER VIII.

On Deodorisation and Disinfection in Medical Practice.

In the short space that remains at my disposal, I have thought it best, avoiding many points of singular interest, to confine myself to the consideration of the best methods of deodorising and disinfecting, in accordance with their application in the daily practice of the medical man.

DEODORISATION AND DISINFECTION OF THE SICK-ROOM. Let us turn first to the sick-room or hospital-ward, and consider what shall be done there.

In the sick-room, the object of the practitioner should always be either to remove or to destroy the offending matter in the air; it should never be, by the use of antiseptic gases or vapours, to suspend action. Under such a process, deodorisation becomes a mere cloak for evil. The reasons for this line of argument are sufficiently simple and satisfactory; for they accord with that which is beneficial to the patient himself—that is to say, a true disinfectant works side by side with good air. Further, it works side by side with warmth. Thus, in the sick-room, when air is freely admitted without chill, when temperature is sustained, and when any one of the oxidising agents is being employed, there are three agencies at work all tending to one specific end—the removal and the destruction of the poison.

In many cases, we may determine that it is most advisable to trust to the ordinary influence of air alone, and warmth alone, for disinfection. When, for example, the temperature of a room can be sustained at 65° Fahr., with free and equal ventilation, the use of any disinfectant is hardly demanded; or, at all events, is only demanded at peculiar times, as when the excreta are being removed. But when the room is confined and the ventilation indifferent, then bodies that quicken oxidation of organic matter supplement the deficient oxidation of the air, and, at an adequate temperature, perform the work which ventilation, if it were effective, would itself perform.

Bearing, then, on this point, I would suggest that, for a sick-room charged with an organic poison, all disinfectants that may be used should belong to the class that assist oxidation; that the action of disinfectants thus employed is accelerated by ventilation; and that their action, to be of service, must be quickened by temperature.

An oxidising disinfectant being determined upon, the next point to consider is the nature of the agent. We are limited in this matter by the agents themselves; for the most active are not always the most ready. We may say, however, that we have chlorine, ozone, iodine, nitrous acid, and sulphurous acid. I believe that these are the five representative deodorants and disinfectants, and that, with these in his hands, the medical man need wish for nothing more.

In applying these agents, however, respect must be paid to temperature. An elevation of temperature increases their action; but the necessities of the sick-room demand that the temperature be kept at a moderate degree and steady in regard to its range. If this be not carried out, the patient suffers. I believe that, in this country, a mean temperature of 60° to 65° Fahr. is the proper average for the sick-room. This temperature is generally easily sustained; and for ventilating, disinfecting, and deodorising, is always ready and practicable.

USE OF CHLORINE. I have already shown that chlorine is the most active destroyer of the offensive emanations from decomposing matter. But our use of chlorine in the room in which a patient lies is, in my opinion, much less impracticable as an useful means, than is generally supposed. Solutions of chlorine, indeed, in every form, are objectionable. They cause the distribution of a large quantity of water through the air of the room. They require brisk and sharp currents of air to produce distribution, which causes a reduction of temperature; and, after all, they are but partially effective. Presuming that chlorine is used, it is best to distribute it from very small bottles—half-ounce phials—which may be emptied, at properly restricted intervals, into a room containing 3000 cubic feet of air, and may be distributed through the air by placing the bottle at as great a distance as possible from the patient and slowly removing the stopper. In this way, the whole of the air of the room, small as is the quantity of chlorine, becomes slightly odorous of chlorine; but sometimes—owing, probably, to the chlorine being wafted by a current of air—it is necessary for a short time to open the window of the apartment, in order to avoid the irritation produced, in some parts of the room, from inhalation of the chlorine. Experience soon teaches how far a room will bear the introduction of chlorine in this way; and it is, at once, an

easy, simple, and effective plan of using chlorine, as by having bottles with glass stoppers, and not exceeding half an ounce in size, a measured quantity of the gas can be set free by the attendant, at intervals, according to the directions of the physician, while the bottles of chlorine can be sent, as medicines, from the surgery, or from the druggist. An intelligent nurse is necessary to carry out this mode of using chlorine; but when it is carefully done, there is no comparison as to its efficiency by the side of solutions of chlorine.

USE OF IODINE. Iodine, first suggested as a solution in application to decomposed matter from wounds and sores by Dr. Williams of Carmarthen, was afterwards used in the form of simple iodine in boxes, as recommended by Mr. Hoffman of Margate, for removing the smell arising from bed-sores. Later it was applied and brought into use as a general deodoriser and disinfectant by Dr. Richardson of London; and I hear that it has recently been employed with great effect in Calcutta in cases of small-pox.

Iodine may be used by merely exposing it in cups or glass-vessels in the air. It may be exposed as a tincture; or it may be poured, in the form of hydriodic acid, upon bibulous paper, the iodine by this process being left, after decomposition of its compound, in a state of minute division and distribution. When a slow and continuous process of deodorisation is required, iodine, used in this manner, maintains an excellent effect. In water-closets, it acts exceedingly well, keeping the air pure at all times, or charged with a faint and agreeable odour of iodine.

When required for more active service, iodine must be evaporated from a heated plate. In this way it acts well, but with less rapidity and uniformity than chlorine. In fact, as in my experimental chamber, the iodine is deposited about the chamber and there exercises a local action only, instead of a general action, or, at most, a feeble general action. At the same time, iodine is to be accepted as a steady and valuable deodoriser; and the practitioner who may prefer chlorine for an extreme case, will do well to combine iodine with it—i. e., he will do well to have iodine exposed in the room in the solid form, while the chlorine is diffused. Then, after the effect of the chlorine has ceased, the iodine continues to carry on its part of the work.

It may be useful to know that one drachm of iodine-scales placed, in a common saucer, on the mantelshelf of a room of two thousand cubic feet measurement, is diffused, at a mean temperature of 62° Fahr., in four weeks and two days.

NITROUS AND SULPHUROUS ACIDS. Nitrous and sulphurous acids are excellent deodorants; but they are not, in medical practice, so convenient as iodine, or even chlorine. Nitrous acid is most easily managed by using a round earthenware jar, like those employed in one of Bunsen's cells. In this nitric acid is placed, and into the acid a plate of copper coiled as a hollow cylinder plays up and down, precisely as the zinc plate of the battery. The evolution of binoxide of nitrogen can thus be regulated at pleasure by raising or depressing the copper plate; and the production of nitrous acid, as the binoxide rises into the air, is abundant. But, after all, this is a clumsy process, compared with the liberation of chlorine in measured quantities, and is less effective.

The remarks made in reference to nitrous acid are also applicable to sulphurous acid, which, indeed, is open to even graver objections, inasmuch as heat is required for its liberation, and because in the presence of water it becomes inert.

USE OF OZONE. The last deodoriser and disinfectant to which I shall refer is ozone. Ozone may be applied on a large scale by the use of Siemens's cylinder; the air driven through the cylinder being ozonised by sparks from Ruhmkorff's coil. This method might be adopted in hospitals with great advantage, as one apparatus would suffice for several wards; but in private practice it is quite impracticable. Skilled hands are required for the management of the battery and the coil; and one hand must always be at work to drive the air along the tube. Fortunately, we have a means of generating ozone from phosphorus, which I have used for years, and which is ready for use at any moment and with little trouble. Two sticks of phosphorus—each two inches in length—made very clean by scraping if covered with oxide, and half covered with water, will yield, in an hour, sufficient ozone, in a room of three thousand cubic feet, to be detectable by Schönbein's test in every part, and this even when there is good ventilation.

In order to meet any difficulties in this method of using ozone, I have invented an instrument, of which an accompanying sketch is given, and by which the

air of an apartment can be kept at pleasure charged with ozone. The instrument, made of glass, resembles a large wine-glass in shape, and is covered with a perforated glass lid. Within the vessel is a perforated glass box, and at the lower part is a water-tap. Into the perforated glass box, phosphorus is placed. When it is required to use the vessel, water is allowed to enter the glass until the phosphorus is half covered. Ozone now becomes developed over

the phosphorus, and is diffused through the room. The degree of evolution may be tested by a slip of Moffat's or Schönbein's ozone-paper. When not required for use, it is only necessary to cover the phosphorus entirely with water and replace the cap on the top of the cup. When, at any time, the water is surcharged with phosphoric acid, it is easily removed by means of the tap.

Ozone, applied in this manner, acts like iodine in the solid state, but more decisively. For this reason, it removes the necessity for the diffusion of chlorine. Indeed, I have never known a room impure through the air of which ozone was thus distributed in sufficient quantity to influence the test-paper. The test-paper left in the room becomes, moreover, a test of the purity of the air, and tells the attendant when the ozone apparatus may be closed, if it be considered desirable, from any circumstances, to limit the diffusion.

The only objection to which this method of purifying is open is, that a little phosphoric acid escapes from the vessel. I may add, in reply to such an objection, that experience supplies no evidence of mischief or danger from this cause. By removing the fluid through the tap, when very acid from its absorption of phosphoric acid gas, and replacing it by pure water, the quantity of phosphoric acid gas escaping into the room will be considerably diminished.

When there is fair ventilation, the ozone apparatus is amply sufficient; and it has this advantage that, being once set going, the action is maintained for several hours; and as in an apartment several of the apparatuses may be used at one and the same time, I prefer it, as a general means, to all others.

VENTILATION. In suggesting these various means of disinfection, the value of ventilation must never be lost sight of. Indeed, all measures must be considered supplementary to that; and I have no hesitation in stating, from experiment as well as from large experience, that, when thorough ventilation with pure air can be secured with an equable temperature, no foreign substance need be resorted to for purification. But to remove the danger of ventilation from the sick, the utmost care is necessary to sustain the heat of the room. When doors and windows are suddenly thrown open to let in air, the sudden change of temperature of the entire volume of air is, I believe, often, in some cases, a worse evil than a close room. Hence the natural and almost instinctive dread of ventilation by the sick. Hence iodine and ozone, in many cases, where the temperature of the room can only be kept up by having the windows closed, become indirectly of curative value; for they purify the atmosphere without necessitating the exposure of the patient to alternations of heat and cold, which inevitably tell on the invalid as so many shocks, unseen but not the less effective for injury.

DOES THE INHALATION OF DISINFECTANTS INJURE? In considering the introduction of disinfecting agents into the sick-room, it is fair to open the question, Whether the sick person himself is likely to be injured by the exposure and consequent inhalation of the substances that may be employed? In the case of ozone, I have every reason to believe that it has often done good to the patient, especially in cases of fever; and I have never seen reason to believe that any bad result has arisen either from it

or from iodine. Indeed, it is a fair inference, if not a proved fact, that the introduction into the system of a substance which would destroy the organic emanations evolved from the subject, would tend to hasten the process of elimination within the body.

Chlorine, nitrous acid, and sulphurous acid, are, however, not so satisfactory. I have seen the respiration accelerated by all these agents; and I know a gentleman on whom nitrous acid, even when so diluted that to me it is quite inert, produces pain and constriction of the chest, with great difficulty of getting in the breath, or of performing the inspiratory act. These cases may be exceptional, but they ought not to be forgotten.

PURIFICATION OF EMPTY ROOMS. For the purpose of purifying rooms or houses in which infected people have been confined; that is to say, in cases where no one is exposed for a time to the influence of the gas, chlorine is, doubtless, the best disinfectant; although iodine freely diffused in vapour is very effective and very easily applied. In an asylum with which I am acquainted, the rooms in which paralytics are kept become, after a few days, even with fair ventilation, exceedingly offensive. In these, the iodine is invariably used at intervals when the patients are removed, and with admirable effect. Half an ounce, or even an ounce, of the iodine is placed on an iron plate and gradually heated until driven into vapour. The rapidity with which the disinfection is carried out is well marked; and, as some of the iodine, in fine particles, condenses, as we have seen already, the effect remains even for some time after the room is inhabitable.

I have seen the permanganate of potass in solution used in sick-rooms; but the effect is negative in so far as the air of the room is concerned, for the simple reason that nothing is given off from the solution at ordinary temperatures. This may be proved by the use of Moffat's or Schönbein's ozone-papers, which show no activity in the air at ordinary temperature, however much of the solution may be present in the room.

PURIFICATION OF CLOTHING. I have spoken thus far of the principle of disinfection, when air only is to be subjected to the process. When organic matters in the solid state are deposited on clothing, the exposure of the infected articles to great heat, as to steam or boiling water, is the readiest, the easiest, and the most effective method. It is quite unnecessary to dwell on any other special means of disinfecting solid substances, which will bear exposure without injury to boiling water; or, if not to boiling water, to an equivalent temperature of air in a heated chamber or oven.

DEODORISATION AND DISINFECTION OF FLUID OR SEMI-FLUID MATTERS IN A STATE OF DECOMPOSITION. My researches have, I think, afforded the means of pointing out, in simple language and with some precision, the best methods of deodorising fluid and semi-fluid matters, such as the excretions of the sick man and the fluid refuse of the sick. I shall dismiss at once all agents for this purpose except two; they are iodine and carbolic acid. I fix on these, first because they are better than all the rest, and next because they are most convenient. For the ordinary chamber utensil, iodine may be used, either in the solid form or as tincture. Half a

drachm of the former or half an ounce of the latter is sufficient. The tincture made with methylated spirit is all that is required.

Carbolic acid may be used in the same way in quantities of from one to four drachms. It answers well as a deodoriser; but it leads to the diffusion of an odour of its own, and it does not destroy the organic decomposing mixture. I consider it, therefore, less valuable than iodine; and I do not think that, for the purpose, anything better than iodine could be desired. It destroys like chlorine; it is slower and more continuous in action; and as a mere deodoriser, it is as rapid as carbolic acid.

DEODORISATION AND DISINFECTION OF SOLID DECOMPOSING ORGANIC MATTER THAT IS NOT TO BE DESTROYED AT ONCE. In cases where solid organic matter, such as a dead body waiting for burial, requires to be deodorised, there cannot, I think, be the shadow of doubt as to the selection of a salt of zinc, with sawdust, as the best substance. Carbolic acid, with sawdust, certainly acts very effectually; but it distributes an odour of its own, and on the whole is less ready. The proportions of the zinc salts and the sawdust are given in a previous chapter, so that the mixture can at once be made. The only question will be as to the selection of the preparation of zinc. The chloride is a little the better, the sulphate is much the cheaper; and, balancing one point against the other, I should usually select the sulphate.

In the case of a dead body, it is merely necessary to cover it, after it is placed in the shell, with the sawdust and zinc compound. It is not even necessary to screw the shell down when this is done. Should zinc not be at hand, and should carbolic acid be employed as a substitute, it is necessary only to cover the body with sawdust, and then to spread over it from two to three ounces of the acid. After this, the coffin should be at once closed.

For the deodorisation of animal substances that require to be identified—such as decomposed organs or tissues—no plan is better than that of placing them in a jar of air which is strongly ozonised; or they may be buried for a short time in a mixture of chloride of zinc and sawdust. If, when they are purified, they require to be kept in preservation, they may be placed in closed jars, charged either with ammonia, or vapour of chloroform, or vapour of bromine.

For the deodorisation of vegetable matters or offal that cannot immediately be disposed of, the zinc and sawdust mixture would answer perfectly. In its absence, or in the absence of carbolic acid—and they are not likely to be ready in all cases—wood-ashes afford by far the best substitute. Wood-ashes act far better than pure charcoal; and, after them, coal-ashes, well pounded, stand next in efficiency. I am sorry to throw discredit on so popular a deodorant as charcoal; but I am obliged to write from experiment, uninfluenced by prejudice, either professional or popular.

DEODORISATION AND DISINFECTION OF SUBSTANCES THAT MAY BE DESTROYED. Whenever a substance that is offensive admits of being destroyed, there is but one scientific course to take; namely, to destroy; and there is but one means of destruction; namely, fire. I need not dwell on this point a moment longer.

CHAPTER IX.

Summary.

The propositions which follow from the perusal of the preceding pages, may be summarily placed in the following order.

1. For the sick-room, free ventilation, when it can be secured together with an even temperature, is all that can be required.
2. For rapid deodorisation and disinfection, chlorine is the most effective agent known.
3. For steady and continuous effect, ozone is the best agent known.
4. In the absence of ozone, iodine exposed, in the solid form, to the air is the best.
5. For the deodorisation and disinfection of fluid and semi-fluid substances undergoing decomposition, iodine is best.
6. For the deodorisation and disinfection of solid bodies that cannot be destroyed, a mixture of powdered chloride of zinc or powdered sulphate of zinc, with sawdust, is best. After this, a mixture of carbolic acid and sawdust ranks next in order; and, following on that, wood-ashes.
7. For the deodorisation and disinfection of infected articles of clothing, etc., exposure to heat at 212° Fahr. is the only true method.
8. For the deodorisation and disinfection of substances that may be destroyed, heat to destruction is the true method.

A MEDICAL CORONER. Mr. Bennett, a surgeon, has been appointed medical coroner for the Shaftesbury division of Dorsetshire, beating Mr. Chitty, a man of law.

MR. GAMGEE AND THE CATTLE-PLAGUE. The disease spreads more rapidly, and destroys much faster, than such means of cure as are known can follow; and therefore it is of more profit to kill, than to try to cure. This is the simple and serviceable ground which has been all along held by Professor Gamgee; and to this the farmers are rapidly coming. There is in Scotland at least a conviction that had Professor Gamgee's energetic counsels been taken at first we should not have been in these alarming circumstances. It has been the fate of Mr. Gamgee to see a little too clearly, and to speak a little too soon, for the class in whose interests he labours. He declared the disease imported; after much controversy, that is admitted on all hands. He urged the suspension or rigid supervision of the import of foreign cattle; the commissioner and the farmers have practically recommended the stoppage of the entrance of live cattle from abroad. He strenuously prescribed isolation and slaughter, as the sole effectual cure; and for the "killing cure" many of the farmers are now only too willing. He has long, almost if not quite alone, insisted on the necessity and advantage of a National Cattle Insurance Association, as a safeguard against the ravages of this and other epidemics; and the most influential meeting of agriculturalists that has been held on the subject of the plague has taken up the idea, and resolved in favour of just such a system of insurance. It is something for any man to have been right, and to have pointed the way, in a time of emergency and tumult of opinion—to have silenced and convinced opponents, and to have led those who have laughed at him. This Professor Gamgee has done, and it is but just that the credit he deserves should be given to him. (*Scotsman*.)

Original Communications.

THE CATTLE-PLAGUE AN ERUPTIVE FEVER.

By ROBERT CEELY, Esq., Aylesbury.

In his admirable Biography of Jenner, as well as in his Report of the Vaccination Section of the Provincial Medical and Surgical Association (*Transactions*, vol. viii), Dr. Baron has recorded several striking facts and referred to the observations of many high authorities for others illustrative of the pestilential and eruptive fevers of domestic animals.

He particularly alludes to Dr. Layard in England, and, long before him, to Fracastorius, Lancisi, Lanzoni, Ramazzini, and others in Italy. These references are certainly but brief, and intended chiefly to support his proposition "that cattle and other animals have for centuries been known to be affected with variola."

On this account, from the difficulty of access to the works of the authors above named, and with the view of comparing the facts and descriptions given by them of the epizootics prevalent in their times, with the terrible epizootic now unhappily raging in this country, I may be excused referring to these authors more in detail, and quoting one or two others whom he has omitted; particularly as the subject has been forgotten by some and is new to many.

Lanzoni thus describes the disease which prevailed in the duchy of Ferrara in the years 1713 and 1714 (*Lanzoni, Observationes*):—"Correpti boves cibum respuebant, aures subito collapsæ procidebant, pili erigebantur, tremor penè universalis aderat, oculi lacrymabant, per nares multa lymphæ copia exibat, alvus solvebatur, in aliquibus pustulæ sub cute prodibant, ita ut variolis boves ipsos affici crederent, tandemque septem dierum brevi spatio, magno cum cruciatu (ut ex mugitu apparebat) moriebantur."

Lancisi, describing the disease as it was introduced into Italy from Hungary in 1711, says:—"Neque vero quin febris affectos boves ureret dubitandum erat; namque non modo Veterinarii Medici, sed ipse ego in illorum arteriis carotibus et axillaribus summam semper, ac statim ab initio celeritatem, ac frequentiam deprehendi. Præterea quanquam ob nimiam cutis crassitiam neque exanthemata neque carbunculi in externâ boum superficie erumperent; singulis tamen, ubi teneriores sunt membranæ, scilicet in ore et faucibus phlogosæ, pustulæ, ulcera, et maculæ e vestigio apparebant. In super plerique boves hoc malo tentati peribant intra diem septimum, quod in peste frequentissimum est; pauci vero per abcessum, ac decubitu at mox dicemus, evadebant." (*Lancisi, De Bovillâ Peste*.)

Dr. Layard, in his *Essay on the Contagious Distemper among the Horned Cattle*, published in 1757, says:—"All are not equally affected. The first appearance of the infection is a decrease of appetite; a poking out of the neck, implying some difficulty of deglutition; a shaking of the head, as if the ears were tickled; a hanging down of the ears and deafness; a dulness of the eyes, and a moving to and fro in a constant uneasiness. All these signs, except the last, increase till the fourth day. Then a stupidity and unwillingness to move, great debility, a total loss of appetite, a running at the eyes and nose, a husky cough and shivering. The fever, which was constant the three first days, now rises and increases towards evenings, pulse quick and contracted, a constant