MOUTH-WASHES IN HEALTH AND DISEASE.

BY

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SINCE writing a short paper in collaboration with M. Moseley³ on certain parasites of the mouth in cases of pyorrhoea, I have been asked so often about the prophylaxis and treatment of this disease that possibly a few notes on my observations in these directions may be of general interest.*

In every mouth left undisturbed for some hours—for example, during sleep—a varying amount of white substance accumulates round the teeth. This is no new discovery, the substance having been noted by Leeuwenhoek in the seventeenth century, and called by him "materia alba." When examined microscopically it is found to consist of salivary corpuscles, epithelial cells, and various organisms, but chiefly the thread-like leptothrix which, if allowed to remain undisturbed, will grow rapidly and calcify to form hard masses of tartar or calculus.

There has been plenty of time for this plant leptothrix (*L. buccalis*, Robin, 1853) to become thoroughly adapted

A powder or paste is only necessary once a day for polishing the teeth, but, if hard tartar has already formed, it is essential to have it removed by a skilful dentist. Great care should be taken to prevent the gums being injured by hard brushes, etc., and, if any trauma be present, mouth-washes should be used even more often than usual until healing takes place. There is no doubt that the use of mouth-washes is much neglected by people in general; and this is in great part due, I think, to the quite unnecessary expensiveness of those put before the public. It was with a view to discovering a satisfactory antiseptic mouth-wash that the following experiments were made.

Experiments to Test the Action of Certain Liquids on the Common Organisms of the Mouth.

1. The resistance of motile organisms, such as amoebae, spirochaetes, spirilla, fusiform bacilli, etc., was tested directly *in vitro* by mounting them in the liquid on a slide and observing the length of time during which the organism retained its motility. Such experiments were repeated with different strengths of the liquids, which exhibited some specificity in their actions. However, as a rule, the movement of the fusiform bacilli was most easily arrested, followed quickly by that of the spirochaetes and then the amoebae.

2. The resistance of the ordinary cocci and bacilli of the mouth, which are easily grown in artificial media, was

FIG. I.—1, Control; 2, 3, and 4, saturated aqueous solution of thymol for one, one-half, and one-quarter minutes respectively (2 and 3 are sterile; in 4 three colonies have grown); 5, 6, saturated aqueous solution of boracic acid for one and one-half minutes respectively; 7, 8, and 9, patent mouth-washes A, B, C used undiluted for one minute.

to its parasitic life, for it apparently inhabited the mouth of paleolithic man, not to mention the comparatively recent Egyptian mummies who were afflicted with tartar and pyorrhoea. Moreover, it occurs also in other mammalia which are subject to this disease. Some closely related algae live a free life in warm calcareous springs—a habitat somewhat similar to the saliva in the mouth.

Now the ideal to be aimed at in oral hygiene is the prevention of this growth of leptothrix altogether, there being good reason to believe that it is the cause of pyorrhoea.³ Approximation to this ideal can be attained with a little trouble. It is obvious in the first place that there must be friction of some kind. Much should be accomplished by the tongue and lips. The tongue, if allowed to lie idle, not only fails to keep the lingual sides of the teeth free from accumulations, but also itself acts as a "forcing ground" for young colonies of leptothrix, a fact which can easily be verified by examining scrapings from a part of the tongue which does not usually rub against the teeth. Such young colonies were figured by Robin so early as 1853.⁴ However, the use of a soft brush is also necessary, and with a suitable mouth-wash should be used as often as possible. It should especially be passed vertically up and down the teeth so that the bristles penetrate between them.

* The pyorrhoea work and also the experiments described here have been carried out in the Radcliffe Infirmary, Oxford; in a laboratory which the authorities of that institution have kindly placed at my disposal.

FIG. II.—Each antiseptic had been allowed to act for one minute. 1, Control; 2, saturated aqueous solution of thymol; 3, saturated aqueous solution of boracic acid; 4, saturated solution of boracic acid in a mixture of equal volumes of water and glycerine; 5, chloramine-T 3 per cent. aqueous solution (the dots shown here are due to a defect in the block); 6, zinc sulpho carbolate 10 per cent. aqueous solution; 7, 8, and 9, proprietary mouth-washes A, B, C.

tested as follows: A single loopful of an emulsion or vigorous broth culture was spread out to form a thin film on a sterile coverslip of standard size and allowed to dry. The coverslip was then immediately placed film downwards on the surface of the antiseptic to be tested for a definite time. It was then washed in sterile tap water and either dropped into a tube of broth or pressed film downwards on to agar and removed from the latter after some minutes. After incubation at 37° C. for twenty-four to forty-eight hours the results were read and compared with the control, in which the film on the coverslip was washed in sterile tap water only. Two plate results (x 3) are represented in Figs. I and II. Both had been incubated for approximately twenty-four hours when photographed.

It will be observed that B and C, which are much advertised and generally used mouth-washes, give very poor results. I have tested them many times up to five minutes, and the only time there was an approach to sterility was once with C, when there were only three colonies after five minutes. Diluted with water in equal parts the results were of course far worse, and diluted as recommended by their proprietors these fluids must be practically useless.

Mouth-wash A is much better, though with half and quarter minute experiments it showed inferiority to pure thymol, and when diluted rapidly lost its efficacy.

Boracic acid gave very poor results, as will be stated more fully below.

The experiments were made with pure and mixed cultures of organisms from pyorrhoea pockets and contained, among other bacteria, streptococcus, pneumococcus, pneumobacillus, staphylococcus, and *B. coli*. It is not desirable here, however, to go into details as to specificity of the antiseptics, especially as their actions *in vivo* are, of course, liable to be different from their actions *in vitro*. All that I wish to point out is that in every case there was a growth from the control and almost as invariably none after the action of a saturated thymol solution for half a minute or more (one or two exceptions being attributed to the presence of spore-forming bacteria). After only a quarter of a minute's action of the thymol there were always two or three colonies. This record was not attained by any other liquid tested except 2 per cent. chloramine-T and dilute iodine solutions, which are unsuitable as mouth-washes for general use, as will be explained below.

Thymol.

These experiments show that a saturated aqueous solution of thymol is a very good antiseptic for ordinary mouth bacteria, and it is the most satisfactory mouth-wash that I have been able to find. In cases kept under observation (some for more than a year) in which this solution has been used at least every night, the growth of leptothrix, as well as the bacteria which can easily be cultivated artificially, has been very much diminished, so that there is practically no accumulation of tartar. In cases of pyorrhoea where the gums are too sore for even a soft brush to be used, they should be massaged with the fingers and then well washed with the solution, some of which should be retained in contact with the gums for some minutes. An antiseptic solution is much to be preferred to a paste or powder. These latter, owing to the necessary presence of some gritty substance, such as chalk, tend not only to injure the gums but also to clog the "pockets"—a most undesirable result.

The saturated solution of thymol has a pleasant taste, causing a temporary burning sensation, and stimulating a flow of saliva. It is a stronger antiseptic and less irritating than carbolic acid, to which it is closely related, being also a monohydric phenol (monohydroxycymene or paramethylisopropylphenol). It is not acid, and is free from the corrosive action of phenol. It may be used as a gargle as well as a mouth-wash, since it is harmless if swallowed, large doses being sometimes given as an intestinal antiseptic. According to most standard works on organic chemistry and pharmacology, one part of thymol dissolves in 1,500 of cold water (others give the solubility as 1:1,200 or even 1:1,000). According to the first, a saturated solution would contain only 0.06 per cent. of thymol. Notwithstanding this it is a remarkably good antiseptic, a fact which has, of course, long been known, though practically no use has been made of it by the general public. For ordinary use, a saturated solution may easily be prepared by putting a lump of thymol into a bottle of cold or warm tap water; the water must not be hot, for thymol melts at 51.5° C. It should be allowed to stand for some hours, and should preferably be shaken occasionally. As the solution is used, the bottle may be filled up with water.

According to the solubility (1:1,500) given above 1 gram of thymol is enough to make 1½ litres of solution, or 1 oz. as much as 9 gallons. In 1914 the price of pure thymol was 8d. an ounce. Owing presumably to the fact that its extraction from the common wild thyme is not carried out in this country the price of it just now is abnormally high. Still, even at the present price of thymol (3s. 6d. an oz.), the cost would be less than 5d. a gallon. Such a mouth-wash should be within the reach of every one. As a matter of fact, thymol forms the active part of many dentrifices or mouth-washes, including A, B, and C (see Figs. I and II, 7, 8 and 9). A fourth dentrifice tested gave quite good results, and was found to contain a saturated solution of thymol according to the prescription on the label. All of these proprietary mouth-washes are sold at approximately 5s. a pint. In travelling, and especially on active service, nothing more convenient as a dentrifice or mouth-wash can be imagined than a lump of thymol in a small bottle to be filled with water as occasion offers. If more generally used, it would do much to put an end to the

distressing gingivitis and pyorrhoea so often following neglect of the teeth during a sojourn in the trenches.

Thymol is much more soluble in glycerine than in water (1 part dissolves in 190 glycerine), so that if glycerine be added to the tap water used a stronger solution of thymol may be obtained, without, however, increasing its antiseptic power. The presence of glycerine may be desirable, especially if there be any soreness of the mucous membrane, and of course the solution can always be diluted with more water should it be found to be irritating. As a general rule, the aqueous solution, undiluted, will be found to be a suitable strength. There are no official preparations of thymol in the *British Pharmacopoeia*, but several non-official ones are used to some extent—for example:

Liquor thymol: 1 part thymol in 100 parts 90 per cent. alcohol,* the resulting solution to be diluted in the proportion of ½ pint to a gallon. This gives the final concentration of thymol as 1 in 1,700, or 0.058 per cent. This preparation therefore contains slightly less thymol than a saturated aqueous solution (0.06 per cent., taking the lowest solubility 1:1,500). Experiments showed that a saturated solution of thymol had more effect in one minute than a half-saturated one had in four minutes (inverse squares of concentrations). It is therefore very necessary to have the solution as concentrated as possible, that is to say, saturated.

Boracic Acid.

Boracic acid has given disappointing results. A saturated solution must act for more than two minutes to be effective, and was by no means always satisfactory in five minutes. If used, care should be taken to obtain a really saturated solution by leaving excess of the crystals or powder in contact with the water until no more will dissolve. Such a saturated solution contains 4 per cent. of boracic acid; by adding glycerine to the water more may be made to dissolve, but the antiseptic power of the solution is still unsatisfactory (Fig. II, 4).

Emetine Hydrochloride.

Unfortunately Bass and Johns, believing the amoeba of the mouth (*E. gingivalis*) to be the cause of pyorrhoea, recommended the use of a dilute solution of emetine as a mouth-wash.

E. gingivalis is certainly not the cause of pyorrhoea, and is quite easily killed by ordinary antiseptics so long as it is not sheltered too much by large accumulations of tartar, into which, as already explained,³ it tends to burrow. Thymol solutions kill the amoeba very rapidly. The well-known amoebicidal properties of emetine are due to indirect action on the parasite, and yet one still finds preparations with emetine, or ipecacuanha containing it, prescribed for direct use in the mouth.† The uselessness of this drug for the purpose is well shown by experiments *in vitro*. On several occasions I have kept *E. gingivalis* under observation in 1 per cent. and 0.5 per cent. solutions of emetine and found specimens alive and putting out pseudopodia after twenty to forty minutes. Consequently solutions many thousand times more dilute, such as those recommended by Bass and Johns, could hardly have any effective action during the few minutes they are likely to be retained in the mouth. Strong solutions could not be used owing to the great toxicity of emetine. As an ordinary germicide emetine gave very poor results, even a 1 per cent. solution being no better than a saturated solution of boracic acid.

Harmine Hydrochloride.

This was tested in the first place for its action on amoebae, at the suggestion of Captain Gunn.² A 0.5 per cent. solution was found to have a much greater amoebicidal action *in vitro*, the amoebae being killed instantly, but the germicidal effect was approximately the same as the 1 per cent. solution of emetine. The poisonous

* When a prescription has to be rapidly dispensed it is desirable to dissolve the thymol in a little alcohol, in which it is readily soluble (8 parts dissolving in 3 parts 90 per cent. alcohol), and then to dilute it.

† The use, too, of emetine injected or given internally in cases of pyorrhoea cannot, I think, be too strongly condemned at a time like this when all the emetine procurable is required for the treatment of amoebic dysentery patients and carriers among the troops. All the evidence tends to point to the fact that the amoebae of the mouth do not invade the tissues of the gums; therefore they are not likely to be affected to any extent by absorbed emetine, and the results of the small number of satisfactory tests made point in the same direction.

character of this alkaloid, however, apart from other reasons, makes it undesirable for general use in the mouth.

Iodine.

Even in such weak solutions as 1 in 3,000 iodine is a splendid antiseptic, but its destructive action on the tissues is well known, and it would obviously not make a satisfactory mouth-wash for general use. It is, however, useful to dental practitioners, not only owing to its antiseptic properties, but because it stains the leptothrix and so facilitates its removal.

Hypochlorite Solutions.

Even if hypochlorite solutions do not attack the teeth, as is claimed,¹ they are still not suitable for general use owing to their instability.

Chloramine-T (toluene sodium sulphochloramide), which has given such good results when used in solution as a spray for the nasopharynx of meningococcus carriers, was tested in 2 per cent. and 3 per cent. solutions. No growth occurred after submitting films of mouth bacteria to them for any time over fifteen seconds. However, the solutions have an unpleasant chlorinous taste, and this, in addition to possible action on the teeth and their stoppings, at present makes their general use undesirable.

Oxidizing Agents.

Hydrogen peroxide solutions are too readily reduced to be successful in the hands of an ordinary patient. *Potassium permanganate*, another oxidizing agent and deodorant, is sometimes used as a mouth-wash. It is by no means ideal, being only a weak antiseptic, and, in addition to staining the teeth, has an unpleasant taste.

Other Antiseptics.

Zinc sulphocarbolate (zinc phenol parasulphonate) has been recently recommended to be used in 4 per cent. solution as a "gum-wash" in cases of pyorrhoea. In my experiments I have used chiefly a 10 per cent. solution, and out of nine bacterial films submitted to this strong solution for half to two minutes, I have never once obtained complete sterility. In most there were many more colonies than the thirteen shown in Fig. II, 6.

Flavine and other dyes with antiseptic properties are obviously unsuitable for general use in the mouth owing to their tinctorial properties.

To sum up: in health as well as in cases of oral disease, antiseptic mouth-washes should be used as often as possible, and a really satisfactory mouth-wash, both cheap and effective, is a saturated aqueous solution of thymol.

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THE TREATMENT OF FRACTURES BY SPLINTS;

WITH SPECIAL REFERENCE TO THE TREATMENT OF FRACTURES OF THE FEMUR IN CIVIL AND MILITARY PRACTICE.

BY

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In order that we may determine the right method of treating a fracture by splints, it is necessary that we should first try and answer the question, Is it desirable that the fragments should be immobilized? and then, if this seems to be essential, we should further consider whether it is necessary to fix the joints on each side of the fracture to obtain this immobility. Lucas-Championnière taught¹ that not only did a slight amount of movement at the seat of fracture do no harm, but that it actually aided union. But we must consider not only the effects of movement on the reparative process, but the risk of disturbing the position of the fragments by such movement.

In a transverse fracture in which there has either been no displacement, or it has been reduced, and there is no tendency to its recurrence, the risk of slight movement at the seat of fracture might be ignored; but on the other hand, if we had only succeeded with much difficulty, under an anaesthetic, in correcting marked deformity at the seat of fracture, and we found that unless the parts were most carefully and thoroughly fixed the displacement tended to recur, obviously any movement at the seat of fracture would be most undesirable. Now with movement of a neighbouring joint there must be a risk of displacement of the fragments, and this is, of course, in proportion to the nearness of the joint to the seat of fracture. For instance, in that very troublesome fracture of the femur just below the trochanters, in which there is such marked riding upwards of the lower end of the upper fragment, as well as other forms of displacement, there must be considerable risk of displacing the fragments with movement at the hip-joint, after they have been placed in the best possible position we can obtain under an anaesthetic. Or take another example—fracture of the lower end of the femur just above the condyles. If after much difficulty in reducing the backward displacement of the lower fragment under an anaesthetic, and fixation of the limb on a double inclined plane, we move the knee-joint, we must run a risk of again displacing the fragments.

I have lately had a very striking instance of the way in which movement of the neighbouring joint may disturb a fracture. I treated a soldier with a very comminuted gunshot fracture of the middle of the femur in the Military Hospital with the splint I am about to describe, which fixed the hip-joint. After the splint had been applied for several weeks, and the fracture was slowly uniting, he asked to be allowed to sit up more. I thought this might be done without harm, at the stage of union then reached, and I altered the splint so as to allow of it. When I next saw him I expected him to express satisfaction at the greater freedom of movement, but I found he had not been able to take advantage of the possibility of raising his body into the sitting position, as it caused pain at the seat of fracture. Later on, after further union had taken place, he was able to do so.

There can, of course, be no doubt of the value of movement of the joints above and below the fracture, to prevent them becoming stiff, but it seems to me we ought not to perform such movements at the risk of disturbing the position of the fragments when there is considerable liability to recurrence of displacement of a serious character. I am fully aware that, when it can be carried out without risk of disturbing the fragments, passive movement of the joints above and below the seat of fracture is greatly to be recommended; but I fear there is a tendency to recommend it without laying due stress on the risk of disturbing the position of the ends of the fractured bone. It is sometimes said that if considerable extension is maintained, the risk of displacing the fragments by movement of the neighbouring joint need not be seriously considered. No doubt if extension is acting powerfully, it will to a large extent reduce the risk, but it seems to me very doubtful if it really removes it.

I do not believe that in every fracture a really perfect anatomical position of the fragments is essential to good function. Indeed, I feel sure it is not. But gross deformity must obviously be corrected, and the fragments so fixed in the corrected position that serious displacement does not recur. I do not think that in some cases we can expect to maintain this improved position, which we may have only obtained with much difficulty under an anaesthetic, if we move the neighbouring joint. Not only is movement conveyed to the seat of fracture by moving the articular end of the bone, but every movement of the joint moves the muscles which are attached to the bone, and may be attached just at the seat of fracture. No doubt movement of the joint remote from the fracture—the hip-joint, for instance, in fracture of the lower end of the femur—is not nearly so likely to disturb the position of the fragments by direct movement of them as would movement of a neighbouring joint, but there might be just as much muscular movement produced in the limb. Even if the joint movement is only performed by the surgeon, it is apt to excite some involuntary active movement on the part of the patient, even if he is cautioned against making them.

When a fracture is close to a joint the liability to stiffness of the joint is of course increased, and the surgeon in