Original Articles.

THE VALUE OF CORROSIVE SUBLIMATE AS A PRACTICAL DISINFECTANT.¹

BY WILLIAM B. HILLS, M.D., OF CAMBRIDGE.

It is only within a comparatively few years that the exact nature of infectious material has been determined with any approach to certainty. Previous to this time, our knowledge of the relative value of disinfectants was necessarily very inexact, and their mode of action, although the occasion for numerous theories, entirely unknown. It was assumed, however, that infection had its origin in putrefactive processes. Any substance, therefore, which arrested such processes, or destroyed their chemical products, was considered to possess more or less value as a disinfectant. The only known test of the efficiency of these was their power to arrest decomposition, and this was determined by the presence or absence of odor.

Investigations of recent years, however, have proved as exclusively, perhaps, as is possible that certain infectious diseases are caused by micro-organisms. Consequently, all processes of disinfection are now based on the view that all such diseases are caused by micro-organisms, or by poisons which are produced by the vitality of such micro-organisms. In the present state of our knowledge, therefore, we consider as disinfectants those substances only which have the power of destroying the vitality of micro-organisms.

When the various substances formerly employed as disinfectants were measured by this test, it was found that nearly all of them are much less valuable than was formerly supposed; while some, including ferrous sulphate and the salts of zinc, which had for some years been considered of inestimable value, are absolutely worthless. The hypochlorites, which have always occupied a prominent place in the list of disinfectants because of their power to destroy organic matter and the chemical products of putrefaction, were found to be in fact very efficient; though it is probable that, as they had been hitherto employed, they were more often inefficient than otherwise, owing to a lack of any definite knowledge regarding the proper amount to be employed. With this exception, however, the only metallic salt found to have distinct value for practical disinfection was corrosive sublimate. This salt had been recognized for many years as an efficient antiseptic, and had also been included in the list of supposed disinfectants; but it had not been shown, by the tests employed previous to 1880 or thereabout, to have a superiority over other metallic salts of its class, sufficient to compensate for its expense and poisonous properties.

Our knowledge regarding the relative value of disinfectants as measured by their power to destroy micro-organisms dates from the researches of Robert Koch, published in 1881. Koch found that most micro-organisms are destroyed by a solution of corrosive sublimate of the strength of 1:5000; while a solution of the strength of 1:1000 is fatal to all. He also found that corrosive sublimate has a decided superiority over all other substances as an antiseptic. A solution of the strength of 1:1000000 had a marked restraining power on the germination of the spores of the *B. anthracis*, for example, while a solution of the

strength of 1:300000 prevented their development. The results of other investigators, while showing that its antiseptic and disinfecting powers are possibly not quite so great as claimed for it by Koch, still confirm the latter so far as to show that they are considerably greater than those of any other known substance, with the possible exception of one or two other salts of mercury, which for one reason or another are not so available.

As a result of these investigations, and more directly following the recommendations of the Committee on Disinfectants of the American Public Health Association, published in 1885, corrosive sublimate has taken the place, to a large extent, of all other disinfectants, for nearly every purpose excepting aerial disinfection. Every State Board of Health, to whose reports, for the past four or five years, I have been able to obtain access, has published the recommendations of this committee, thus giving them a wide circulation, and nearly every one has distinctly endorsed them as representing the best methods of disinfection known to us. The Board of Health of Maine alone objects to corrosive sublimate, on account of its poisonous properties, and because it forms an insoluble compound with albumen. Figures showing the exact extent to which it is used, can be obtained, if at all, only through local Boards of Health, and the reports of these are not easily accessible. There were used, however, in the city of Boston, according to the reports of the Board of Health, in 1884, 850 pounds; in 1885, 1,550 pounds; in 1886, 1,400 pounds; and in 1887, 2,250 pounds of corrosive sublimate for purposes of disinfection.

The value of corrosive sublimate, as measured by its power to destroy micro-organisms in aqueous solutions, is not denied. But the efficiency of a disinfectant, and the amount required for certain disinfection, vary with the nature of the material to be disinfected. The disinfecting power of corrosive sublimate for instance, is greater in an aqueous solution than it is in an albuminous solution; for in the latter case a part or the whole of the disinfectant unites with the albumen, forming a compound which has little or no disinfecting power. Thus Klein² found that one and the same kind of blood bacillus was completely killed by an aqueous solution of corrosive sublimate of the strength of 1:25000, whereas it remained unaffected by a solution in nutrient gelatine of the strength of 1:20000 of fluid, — or even by a solution in broth of the strength of 1:10000. In all processes of disinfection with chemical disinfectants, we should therefore take into consideration the chemical changes which the disinfectant undergoes when it is added to the material to be disinfected. If we act upon germs in the presence of material which is capable of forming, with the disinfectant employed, inert compounds, it is clear that the germs are likely to escape unharmed, unless we add such a quantity of the disinfectant that it shall be in sufficient excess after the chemical change is complete. Even then we do not attain perfect disinfection, if the inert compounds are such as are able to protect the germs in any way from the action of such excess. This is the case when we employ corrosive sublimate, or any other substance which coagulates albumen, for the disinfection of albuminous material. Under these conditions a coagulum is formed, and germs included within such solid masses may escape

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² Report of the Local Government Board, London, 1885-6, page 155.

destruction and develop later when the material is thrown into the vault or other similar receptacle; for the excess, if any, is in turn converted to inert compounds by the albuminous material, ammonia, sulphuretted hydrogen or other substances with which it there comes in contact, or it is so far diluted as to become inefficient.

Considering corrosive sublimate in connection with these facts, we see no reason for denying that it is an efficient practical disinfectant for certain of the purposes for which it is recommended by the committee on disinfectants, and employed in this and other countries; bearing carefully in mind, however, that its use is for obvious reasons unjustifiable unless we can dispose of it in some other manner than through lead pipes. But for the disinfection of the excreta, vomited matters, sputum, etc., of persons sick with diseases known or suspected to be infectious, or for the disinfection of clothing or bed-linen soiled with such material, it is wholly unreliable, and is so recognized by sanitarians abroad. Yet a solution of the strength of 1:500 is recommended for these purposes by the committee on disinfectants, and following them, by most of the Boards of Health in this country.

An examination of the report of this Committee fails, however, to bring to light the slightest particle of evidence upon which such a recommendation could have been based. The statements made relative to corrosive sublimate are very contradictory and confusing; the biological tests recorded are few in number and very unsatisfactory; and the report, as a whole, shows evidence of hasty preparation, and is not at all creditable to the Committee. A brief review of the alleged evidence presented by this Committee in favor of corrosive sublimate will, I think, prove the correctness of this criticism.

It is to be observed, first, that the Committee recognize the fact that the quantity of disinfectant required for perfect disinfection depends upon the nature of the material in which the germs are contained — provided, however, the disinfectant is an oxidizing disinfectant. On page 19 of the report the apparently contradictory results obtained in two series of experiments with potassium permanganate are thus explained: "The wide difference as to the quantity of the disinfecting agent required in two series of experiments depends upon an essential difference in the nature of the fluid in which the germs to be destroyed were contained. The large amount of organic material present in the blood, as compared with that in the culture fluid used in the second series of experiments, fully accounts for the difference, for the disinfecting agent is, itself, destroyed by contact with organic matter."

Also, on page 14, we find the following: "The fact that the oxidizing disinfectants are destroyed in the reaction to which their disinfecting power is due, makes it necessary to use them in excess of the amount of organic material to be destroyed; otherwise germs included in masses of material not acted upon would be left intact in a fluid which is no longer of any value for their destruction, and, as a few germs may be as potent for mischief as a large number, there would be a complete failure to accomplish the object in view." The Committee make essentially the same statement on page 117, and thus conclude: "The only safe rule in the practical use of oxidizing disinfectants is to use such a quantity of the disinfecting agent that

it shall be in excess after the reaction has taken place."

But, if it is necessary to take into consideration the chemical changes which take place in the use of oxidizing disinfectants, why is not the same precaution necessary in the use of all disinfectants? For there is scarcely a substance which has been suggested as a disinfectant which may not undergo some chemical change when brought into contact with such organic mixtures as require disinfection, and there is none which is more liable to change than corrosive sublimate. The Committee, however, either ignorant of this fact, or forgetting it in their haste, actually use the oxidizing property of the hypochlorites, which makes them the most valuable chemical disinfectants at our disposal (since, if we use an excess, we destroy organic matter and germs at the same time), as an argument against them and in favor of corrosive sublimate, which not only may undergo more changes than do the hypochlorites, but such changes as may render it absolutely worthless.

"For this reason," they say (page 14), "the metallic salts, such as corrosive sublimate, which are not destroyed by contact with organic matter have a superior value for the disinfection of masses of material left *in situ*, such as the contents of privy-vaults and cess-pools. In this case, even if germs enclosed in an envelope of albuminate of mercury escape destruction, they will be prevented from doing mischief so long as they are included in such an envelope, and the wonderful antiseptic power of the reagent used will prevent their development for a sufficient length of time to ensure the complete loss of vitality of any pathogenic organisms present." It is, however, a well-known chemical fact that corrosive sublimate is destroyed, or, at least, undergoes chemical changes when brought into contact with organic matter. It is immediately converted by albumen to the insoluble albuminate of mercury. For this reason, albumen is recognized as the most efficient antidote in cases of poisoning by corrosive sublimate. Corrosive sublimate in solution is further decomposed by a very large number of other compounds, organic and inorganic, and by unknown constituents of most organic mixtures. There are but few substances whose range of incompatibilities is so wide. The Committee apparently admit the possibility of its uniting with albumen, but think we shall, even then, attain perfect disinfection, because the germs will be imprisoned within the envelope of albuminate of mercury, and will *probably* be prevented from developing. But this is not disinfection. Disinfection consists in the *destruction* of disease germs.

Later, the Committee realize their error, and admit the inefficiency of corrosive sublimate for the disinfection of excreta. Sternberg thus writes (page 59), referring to some experiments which show that this substance is not efficient for the disinfection of fresh tuberculous sputum: "The experiments of Schill and Fischer, which I had not read when the recommendation was made (referring to the use of corrosive sublimate for the disinfection of sputum and fecal discharges), indicate that it will be necessary to use some other agent when the object in view is to destroy the infective virulence of tuberculous sputum. And in general it will no doubt be better to use an oxidizing disinfectant, such as the hypochlorite of soda, when the germs to be destroyed are imbedded in masses of albuminous material; for such masses are disintegrated and destroyed by oxidizing agents, whereas corrosive

sublimate has the opposite effect in consequence of its power of combining with and coagulating albuminous material." And yet the Committee has recommended a solution of corrosive sublimate of the strength of two drachms to a gallon of water as equally efficient with chloride of lime for the disinfection of excreta, vomited matters, and sputum. Sternberg himself, in his Lomb prize essay, recommends chloride of lime as the most efficient agent for the disinfection of excreta, and recommends corrosive sublimate as efficient for liquid discharges only. But its value for *this* purpose must necessarily depend on the character of the discharges. If they contain albuminous matter in quantity sufficient to form with the disinfectant a coagulum, they cannot be disinfected by it with any more certainty than can solid discharges. The experimental evidence upon which this recommendation is based will be presented later.

The employment of corrosive sublimate for the disinfection of large masses of material, such as the contents of vaults, cess-pools, etc., is absurd, and would not deserve serious notice were it not for the fact that the report of the Committee on Disinfectants, recommending it for this purpose, has been so widely accepted. But the Committee, in a note inserted after their recommendations were printed, admit that the complete disinfection of such masses is difficult and expensive, and probably impracticable, and insist upon the necessity of destroying infectious material before it is thrown into receptacles of this kind. This admission, however, appears to be based upon impracticability due solely to expense and obvious mechanical difficulties, and not to changes tending to render the disinfectant inefficient. But, if a disinfectant is for any reason inefficient for the disinfection of small quantities of excreta, it is for the same reason inefficient for the disinfection of large quantities. The action of corrosive sublimate upon albumen is, therefore, a fatal objection to its use for this purpose. But such decomposing masses are constantly disengaging ammonia and sulphuretted hydrogen, both of which convert corrosive sublimate into insoluble compounds, and, owing to the high atomic weight of mercury, these gases fix comparatively large amounts of this metal.

Decomposing excreta also contain alkaline carbonates, phosphates, urea, and doubtless many other substances which react with corrosive sublimate and destroy its efficacy, for there is no reason for believing that any of the resulting compounds have any disinfecting power.

It has been suggested, however, that the albuminate of mercury, which is slightly soluble, has germicide and antiseptic powers sufficient to make it superior to all other disinfectants for this purpose, and that this can be relied upon to prevent the development of such germs as are imprisoned within the coagulum of albuminate of mercury. Professor Vaughan, for instance, considers it probable that the value of corrosive sublimate as a disinfectant is due to the formation of this albuminate; and Sternberg, in the *Medical Record* for August 1, 1885, affirms positively that the albuminate is a potent germicide, but gives no facts in support of this statement. Klein's experiments, however, suggest that its germicide power is very slight at the most. Admitting, however, that it has such power, the amount re-dissolved is very small, and this is likely to be converted at once to the inert sulphide by the sulphuretted hydrogen present.

Used as recommended by the Committee, corrosive sublimate is a good deodorizer so far as it goes; but has no more value probably than the ferrous sulphate which it has to a great extent superseded.

If we examine the experimental evidence upon which corrosive sublimate is recommended as an efficient agent for the disinfection of solid excreta, we find that it comprises ten or twelve biological tests made with pure cultures of micro-organisms, or with broken-down beef-tea, or with semi-solid fæces. Some of these were successful, others were failures. It does not appear to have occurred to the Committee that the *nature* of the material acted upon had any influence on the result in the unsuccessful experiments, or that any further investigation was desirable for the purpose of discovering the cause of the failures. But it was assumed that the *quantity* of material was too great for the amount of disinfectant employed, and that, if the latter had been added in larger quantity, or if the time of exposure had been longer, the experiment would have been successful. A liberal allowance was, therefore, made on the side of safety, and a recommendation made accordingly. The evidence upon which corrosive sublimate is recommended for the disinfection of liquid discharges is the following: "The liquid discharges from the bowels of patients with cholera, typhoid fever, advanced tuberculosis, septic diarrhoea, etc., may be fairly compared with our broken-down beef-tea as regards physical and biological characters." The amount required to sterilize a certain quantity of broken-down beef-tea was, therefore, determined, multiplied by two, and the product recommended as efficient for the sterilization of an equal amount of liquid faecal discharge. A recommendation based upon experimental work of this amount and character is not creditable to a Committee of the leading Sanitary Association of this country, and is not entitled to the favor with which the one in question has been received.

The importance of the disinfection of excreta, etc., cannot be over-estimated. It is conceded that such material must be disinfected before it is thrown into the vault or similar receptacle, because of the impracticability of disinfecting large masses of matter. A disinfectant, to be effective, must have penetrating power sufficient to bring it into intimate contact with every portion of the material to be disinfected. Corrosive sublimate does not have this power, owing to its property of coagulating albumen. It should, therefore, be replaced, if possible, by some agent to which this objection cannot be made. We have such an agent in chloride of lime. It has the power of penetration; it oxidizes and destroys organic matter, and it is, in addition, an efficient germicide, bearing in mind the fact that it must be used in such quantity that it shall be in sufficient excess after the reaction between it and the organic material is complete.

Corrosive sublimate, in a word, though a very efficient disinfectant, as measured by its power to destroy germs, is limited in its applications. It can be used for the disinfection of furniture and other articles made of wood or porcelain, or even metal, if varnished, the floors and walls of rooms, such parts of ships as can be reached with solutions, the hands and the surface of the body, and clothing and bed-linen, if not soiled with discharges; in other words, for the disinfection of surfaces which are not themselves injured by contact with it, or surfaces which do not contain

material of such a character as to destroy its efficiency. Its use for these purposes is, however, very much restricted, because we have no means of disposing of it, except through lead pipes.

Objections have been made to it because of its poisonous character. The danger of poisoning, however, is very slight. The solutions employed are very dilute, and its taste is sufficiently disagreeable to attract attention before an amount sufficient to do any injury has been taken. If the solutions are colored, the danger of mistakes is much lessened. The same objection may be made with equal reason against all substances which we now recognize as disinfectants. Care is necessary in the employment of all of them, and those entrusted with their use should be informed of their properties, that all necessary precautions may be taken.

There is, however, one process of disinfection with corrosive sublimate to which this objection may with some reason be made. I refer to its use for the disinfection of streets, for which purpose it has been employed by the Board of Health of Boston for the past two years or more. If its use for this purpose is continued, the time cannot be far distant when the beds of the streets will become saturated with various compounds of mercury. All of these, so far as we have any knowledge of them, are violent poisons. Is any danger to be apprehended from continually inhaling or swallowing, month after month, dust loaded with compounds of mercury? This is a question deserving serious consideration at the hands of the Board of Health. While not claiming that the process is positively a dangerous one, I believe it is one which involves some risks, and one which it is advisable, therefore, to discontinue.

UTERINE DISPLACEMENTS AND THEIR INFLUENCE ON THE GENERAL NERVOUS SYSTEM.¹

BY FRANCIS H. DAVENPORT, M.D.

UTERINE displacements have from the earliest times about which we have any medical knowledge been recognized as existing, and as giving rise to disturbances both general and local. It is probable that prolapse and procidentia, as being malpositions which would most quickly and surely be seen, were the first to be diagnosticated and treated. Later, as the vaginal examination became perfected, would follow the forward and backward displacements, reserving for these days of gynecological enlightenment the recognition of the more refined shades of departure from the normal, which have filled our text books with subvarieties, and for whose relief a legion of pessaries has been invented.

The impetus which has been given to the study of this branch of medicine in the last twenty-five or thirty years has resulted in placing a great deal that is of value on a sound basis. With regard to the special branch of uterine disease which is the subject of this paper, the following may be said: We have learned to diagnosticate the various malpositions to which the uterus is liable, and the tactus eruditus is now seeking new worlds to conquer. Tubes and ovaries whose recognition by a large proportion of practising physicians is still a matter of considerable difficulty are pal-

pated by the trained gynecologist, and their pathological changes diagnosticated with wonderful ease. The more remote and insignificant structures of the pelvis are now trying in vain to elude the searching finger of the specialist; and in one of the latest text books minute and lengthy rules are given for finding not only the round ligament and ureter, but even for differentiating the various muscles of the pelvic floor, and palpating the pelvic arteries and nerves.

The chapter on the diagnosis of displacements may in a certain sense be said to be closed. So, too, with the mechanical treatment of these disorders. Necessity is the mother of invention, and the skill and perseverance of the gynecologist in overcoming the difficulties he has had to contend with, have resulted in the multiplication of pessaries of all forms from the external to the intra-uterine, and of substances as various as ingenious, to meet all possible varieties. Slight modifications will continue to appear, but they will be on the lines already marked out, and will in all probability embody no new principle. It is to my mind a fair indication of the feeling which may be supposed to govern the question of treatment in the small proportion of cases which do not show themselves amenable to the mechanical devices alluded to, that progress is in the direction of operative measures, and that too of a bolder character than would have been dreamed of twenty or even ten years ago. Who, for instance, twenty years ago would have thought in his wildest moments of performing laparotomy and suturing the fundus uteri to the abdominal wall to cure an obstinate retroflexion? Yet that has been repeatedly done. It is an outcome to be sure of the feeling of security with regard to opening the abdominal cavity which the splendid results of our leading specialists have developed. Yet still other indications, less striking perhaps, but showing the same tendency, are the Alexander operation of shortening the round ligaments, Sanger's bold procedure of forcibly separating adhesions of the uterus to adjacent parts under ether, or Byford's proposition to shorten the sacra-uterine ligaments by an operation from the vagina.

While such questions as these are, as I have said, practically settled, it is a beneficent law which holds good in any department of human knowledge that it cannot be exhausted. Certain outposts are taken and occupied, and the scene of the conflict shifts to new ground. We know the course which the blood takes in its rapid circulation through the body. We busy ourselves now with counting the millions and billions of white and red blood corpuscles, and noting their varying proportions in disease, or discussing the microscopical character of the membrane which forms the coat of the capillaries. So the question concerning displacements, about which doubt exists to-day, and which are the subjects of discussion, are on entirely different lines from those we have mentioned above.

Curiously enough, one question which it would seem would naturally be the first to be settled, is only recently being met with any unanimity of sentiment. I refer to the normal position of the uterus. It is begging the question to affirm, as some writers do, that an organ, suspended in the pelvis between other organs liable to such temporary variations of size as the bladder and rectum, can have no normal position. On the other hand, it is manifestly absurd to judge a freely movable organ by the same rules as we would a spleen or kidney, and make any deviation from an arbitrary fixed

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