SURGICAL PROCEDURES IN GENERAL PRACTICE

This is one of a series of articles contributed by invitation

THE USE AND ABUSE OF ANTISEPTICS—I

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"Haemostasis is effected, and the wound cavity temporarily packed with gauze soaked in some suitable antiseptic (for example, iodine, carbolic lotion 1 in 20, Dakin's solution, a strong solution of brilliant green, or any other that the surgeon favours)."

Rose and Carless's *Manual of Surgery*, 1937.

That three classes of antiseptic having totally different properties, not to mention others unspecified, should be considered equally useful for a single well-defined purpose illustrates well the somewhat hazy notions about antiseptics and their properties which are current among users. Disinfection by chemical means is a curiously neglected department of medicine, and the most elementary principles connected with it are often imperfectly understood. Antiseptics which have been in use for fifty years and more are so entrenched in their positions that no amount of condemnation appears to shake surgical faith in them, and the continued popularity of those with characteristic smells and colours even suggests that in this matter an appeal to the senses has a force at least equal to an appeal to reason. That practice should be so diverse and misconception so common is perhaps not surprising in view of the fact that reliable information on this subject is scarce and scattered: to arrive at any true comprehension of the properties of an antiseptic it is still necessary to consult original papers. In some instances doubt still remains; the available evidence may be conflicting or composed largely of rudimentary experiments made thirty or forty years ago, while sometimes pertinent observations and comparisons appear never to have been made at all. Nothing short of a fresh and comprehensive inquiry into this subject, undertaken by authority, can dispel all the doubts which beset it. In what follows we aim at suggesting a rational antiseptic technique in which opinion has an adequate basis in facts so far as they are known.

Factors Governing the Action of Antiseptics

The destruction of bacteria (disinfection) or interference with their activities (antisepsis) by chemical means is attempted daily in proceedings ranging between proved usefulness and utter futility. The value of such proceedings must be judged ultimately by their clinical results, but in devising or making a choice between them when such results are equivocal, theoretical considerations must be given weight. This is not the place in which to discuss theories of disinfection, but it must be borne in mind that, while the chemical destruction of bacteria anywhere requires that the agent used should be present in a sufficient concentration for a sufficient time, to achieve this on the body involves two, if not three, other considerations of the utmost importance. The foremost of these is the effect on the agent used of admixture with body fluids and other material. Many antiseptics are inacti-

vated in such an environment owing to immediate chemical combination with body proteins; some, on the other hand, are not. It has next to be considered whether the damage to tissues, whether gross or only microscopic, will outweigh the advantage possibly gained by killing bacteria; some antiseptics are caustic or irritant, others comparatively bland. Thirdly, it is sometimes of interest to know whether an antiseptic is capable of penetrating or diffusing through tissue. These are the factors upon which success depends, and before considering specific uses we must determine how far the properties of various antiseptics enable them to overcome these obstacles.

Properties of the Principal Classes of Antiseptics

We have space to deal here with only five principal classes of antiseptics; examples of others will be mentioned later, while some of lesser importance will necessarily be omitted.

The Halogens.—Iodine and chlorine in various forms are extensively used in surgery. Both of these substances will rapidly destroy almost any kind of micro-organism unprotected by other material, even in extreme dilution; the amount of chlorine required to disinfect a swimming bath is only 0.4 part per million. On the other hand, both combine with and are consequently inactivated by all sorts of organic matter, and for effective action their concentration has to be increased in accordance with the amount of such material present; an increase adequate to certain purposes may be considered impossible, especially since strong solutions of both are highly irritant. Thus iodine is an efficient disinfectant of the intact skin, but admixture with more than a certain amount of blood destroys its activity. The chlorine liberated from materials such as eusol and Dakin's solution combines with proteins in the exudate of a suppurating wound, and whether its continued renewal can overcome this difficulty is disputed. Chloramines and the more recently introduced azochloramid are said to retain some of their activity in the presence of proteins. Iodoform has no antiseptic value as such; it is said to liberate iodine in tissues—an ancient belief lacking modern confirmation. Such benefits as are secured by this and other irritating but germicidally inefficient compounds are possibly due to the exudation of fluid caused by their presence.

Oxidizing Agents.—Antiseptics of this class are less irritant than the foregoing, but are equally prone to inactivation by organic matter of all kinds. In experiments by one of us the bactericidal activity of potassium permanganate was reduced by 95 per cent. on the addition of 5 per cent. of blood to the test mixture, while that of hydrogen peroxide was abolished altogether. Of these two the former is certainly preferable, but it is doubtful whether circumstances ever occur in surgical practice in which its use is clearly indicated. The notion that antiseptics which liberate oxygen have a special action on infections by anaerobic bacteria, although natural, is ill founded: it assumes that this type of antiseptic action is exerted in the tissues, and this is inconceivable.

Salts and Compounds of Heavy Metals.—Mercury occupies the foremost place in this class. The bactericidal action of mercury salts is exceedingly slow and sometimes more apparent than real. These substances should never

be used when rapid action is desired ("rinsing" in mercurial solutions implies a total ignorance of their properties), nor are they effective in the presence of serum proteins, with which they combine. Bacteria apparently killed by mercury perchloride may resume growth if treated with ammonium sulphide to precipitate the mercury or if placed in a medium containing blood. A vast amount of experimental work has failed to take this fact into account, and a grossly exaggerated idea of the bactericidal power of this substance has consequently been current for many years. Mercury biniodide is a weaker antiseptic than perchloride and somewhat less irritant. Among compounds of mercury the best known, mercurochrome, is by far the least efficient, and only the strongest solutions used under the most favourable conditions are likely to have any effect. On the other hand, phenyl mercuric nitrate, metaphen, and merthiolate are much more bactericidal than mercury perchloride; they suffer the same disadvantage of being largely inactivated by serum proteins and still more by blood.

Coal-tar Derivatives.—The distillation of coal tar yields a series of compounds, beginning with phenol, which is soluble in water, moderately bactericidal, and exceedingly poisonous, and proceeding, with increase in the temperature of distillation, through others in which bactericidal power increases and toxicity and also solubility diminish. They furnish two classes of antiseptics: solutions of phenol and of cresols (lysol), which are ideal for *in vitro* disinfection but too caustic for application to the body; and emulsions of tar acids of higher boiling point which are more bactericidal and less caustic, and therefore more suitable for bodily use; such are izal, cyllin, and many others. Recently several antiseptics have been produced, the first of which was dettol, in which the active constituent is a pure substance of this class combined with chlorine instead of a mixture of several; these are less bactericidal than the foregoing, but are comparatively bland and hence applicable in greater concentration or even undiluted.

Whereas the activity of phenol and cresols is well maintained in the presence of organic matter, that of emulsified disinfectants in this class is depressed by it to a varying and greater, but not extreme, degree; appropriate concentrations are experimentally effective in the presence of such materials as blood and serum. All disinfectants of coal-tar origin vary in activity with temperature more than any others; warm solutions may be many times more effective than cold.

Dyes.—This term covers a large variety of powerful antiseptics, some having interesting but highly specialized actions with which we have no space to deal. A distinctive place among them is occupied by the acridine compounds, of which an example is acriflavine, since these are the only substances which have been proved by controlled animal experiment to be capable of averting wound sepsis. They kill or prevent the growth of pyogenic cocci in extreme dilution, act slowly, and in some cases are more bactericidal in serum—a unique property. They are also relatively non-toxic, sufficient concentrations for antiseptic action demonstrably leaving the activities of leucocytes unimpaired; this property is also unique. It is therefore possible to infiltrate tissues with solutions in order to prevent infection or to arrest it at an early stage.

We now come to the practical application of such facts as these. Let it first be understood that choice depends on purpose; there is nothing more foolish than to suppose

that because this or that compound is a "good antiseptic" it should be employed for any purpose whatever. Quite different considerations govern the choice of an antiseptic for use in the body or outside it. In the body an antiseptic will have two main purposes—the prevention and the treatment of infection, with their separate indications—and many different kinds of environment must be considered, according to the site of application and the conditions existing there.

Chemical Disinfection Outside the Body

Among the many materials used in surgery some are best sterilized by heat, others require chemical treatment. Three factors govern the choice of agents for such purposes: their efficiency, their freedom from corroding or other spoiling action, and their cost. The last of these is of most importance in choosing an agent for what may be called gross disinfection, since large quantities may be required for disinfecting furniture, linen and towels, utensils, and excreta. Either carbolic acid (5 per cent.) or lysol (2 per cent.) is commonly employed for such purposes, and both these substances are well suited to them. Lysol is not only a little more than twice as strong a disinfectant as carbolic acid, but is also at present half the price; its use therefore involves only one-quarter of the cost of using carbolic acid. Izal (1 per cent.), Jeyes' fluid (1 per cent.), and other emulsified disinfectants are also suitable for such purposes, and are economical.

Instruments.—The ideal method of sterilizing all metal instruments is by dry heat, though in this country the necessary equipment is rarely to be found. Boiling, preferably in 1 per cent. sodium carbonate, is advocated by some, even for scalpels. Those who prefer not to subject sharp instruments to heat should keep them in a mixture of 1 part of lysol with three of spirit. The common practice of "sterilizing" scalpels in spirit alone, and indeed the use of spirit for various other purposes, raise questions of considerable doubt. In numerous experiments undiluted alcohol has been shown to have only a weak bactericidal action, and from some of these it appears that under certain conditions staphylococci may survive in it for half an hour or even several hours, while some reports allege that spirit may itself contain living bacteria, doubtless in the form of spores. That these are completely resistant to its action has been shown by demonstrating living sporogenous bacteria in material which has been immersed in spirit for twenty years and more. The bactericidal action of alcohol is undoubtedly increased by dilution with water to an optimum strength of 70 per cent. and by the addition of a trace of alkali; but spirit so treated would be unsuitable for some of the purposes for which it is used. Although the employment of spirit as an antiseptic is almost universal, and may be said usually to give satisfaction, we venture to suggest that its suitability merits careful re-examination.

Catheters.—Special considerations apply to non-metallic instruments, and among these a difficult problem is presented by catheters made of material that is spoiled by prolonged heat. Exposure to formalin vapour, which should be continued for a minimum period of four hours and preferably overnight, cannot be depended on to sterilize the inside, since diffusion through so long and narrow a tube as a ureteric catheter in particular is too slow a process. The "formalin cabinet" commonly used for catheters is not in fact claimed by its manufacturers to be capable of sterilizing their insides. A more reliable

alternative is immersion in 0.1 per cent. mercury perchloride for at least one hour, the lumen being filled with the solution by means of a syringe, and freed from it before use by similar treatment with sterile distilled water. Thorough cleansing, particularly of the eye of the catheter, is indispensable before sterilization by any chemical method can be effective.

Suture Materials.—Nine recent examples of post-operative tetanus derived from catgut revealed the fact that long-discredited methods of sterilizing catgut were in use, and some of these methods are still recommended in surgical textbooks. Catgut is a dense and impervious material; to destroy spores embedded in it is the hardest task a disinfectant can have, and quite beyond the powers of many that are efficient enough elsewhere. Be it said again with the utmost possible emphasis that exposure not merely for days but for weeks, months, or even years, to spirit, mercury perchloride or biniodide, chromic acid, essential oils, or 5 per cent. carbolic acid will not sterilize catgut. Nor will dry heat or hot xylol; heat is only applicable during the process of manufacture.

Material sold under the description of "sterile surgical catgut" may not be manufactured in this country except under licence, and is dependable for sterility. The term "boilable" applied to such catgut refers only to the fact that the tubes containing it can be so treated in order to sterilize their outsides before opening without damaging the contents. If raw or "partially sterilized" catgut is to be used there is only one way in which it can be completely sterilized, and that is by immersion for ten days in Claudius's solution (1 per cent. iodine, 1.5 per cent. potassium iodide in distilled water). Other suture materials are neither so dangerous nor so susceptible to damage. Silk may be boiled (theoretically it would be better autoclaved) and stored in either 5 per cent. carbolic acid or 0.1 per cent. mercury perchloride. Silkworm gut is treated similarly.

Anaesthetic Apparatus.—Rubber face masks should be immersed, after cleaning, in 0.1 per cent. mercury perchloride for at least one hour, or, if this delay is inconvenient, in 5 per cent. carbolic acid or 2 per cent. lysol for fifteen minutes; thorough rinsing is necessary after the latter treatment, or the next patient's face may suffer. The extensible concertina tubing employed in some anaesthetic apparatus can harbour a quantity of secretion and multitudes of bacteria in its crevices; it should be similarly treated, and carefully dried before further use.

(To be concluded)

A. Riley and H. I. Suby (*New Engl. J. Med.*, October 14, 1937), who record a personal case, state that the genito-urinary complications of typhoid fever include retention of urine, polyuria, albuminuria, pyuria, haematuria, haemoglobinuria, urobilinuria, bacilluria, infarcts and abscesses of the kidney, nephritis, pyelitis, cystitis, epididymitis and orchitis, oophoritis, salpingitis, gangrene of the genitals, disturbed menstrual function, and premature labour. The authors' case was that of a man aged 30, with no history of venereal disease, who in the first week of typhoid fever developed prostatitis and vesiculitis. Throughout his stay in hospital repeated urine cultures were negative for *B. typhosum*, but cultures of the prostatic secretion were positive. Complete recovery finally took place. No previous examples have been recorded of prostatic invasion with typhoid bacilli in a living patient. Marchildon and Pick, however, have reported two cases in which typhoid bacilli were cultivated post mortem from the prostate in one and the seminal vesicles in the other.

BRITISH HEALTH SERVICES

A COMPREHENSIVE AND CRITICAL REVIEW

P E P (Political and Economic Planning) is an independent, non-party group consisting of more than one hundred members who give their spare time to sociological studies. Its latest achievement is a *Report on the British Health Services*,¹ which has taken three years to compile, and the material for which has been drawn from two hundred persons or organizations. It is one of those objective treatises of which an outstanding example is Charles Booth's work on the life and labour of the people of London: written out of abundant information, dispassionate, but sympathetic and progressive. P E P works anonymously, but the report reveals the expert hand. It is written with inside knowledge, but in a spirit of critical detachment. The section on the British Medical Association, for example, is an admirable statement. If it has a fault it is that the Association is represented entirely as a central legislative body, whereas it possesses a strongly organized periphery. Frequent reference is made to the Association's "Proposals for a General Medical Service for the Nation," its "Hospital Policy," the "exhaustive and challenging" report of its Physical Education Committee, and the recently framed ethical rules for industrial medical officers—"a good example of the free development of new ideas within the framework of well-tested and time-honoured ethics."

Scope of the Survey

This survey is one of the most difficult tasks P E P has undertaken, although it has tackled such subjects as international trade and the development of social services. The difficulty arises from the bewildering number of fragmentary and often conflicting specialisms and the differences of attitude and approach. The health services are like a big old hospital which has had to make numerous extensions and annexes and has lost its unifying centre. The survey begins with the impersonal protective services, including housing and sanitation; passes to the health of the industrial worker, also largely an impersonal service; and reaches the individual in the services for mothers and infants, the pre-school child, and the school medical service. Then follows a description of the organization of the medical profession, the training of the student, the working conditions of the general practitioner, consultant, and public health officer, and the allied services such as nursing, dentistry, and pharmacy. The way is then open for a broad consideration of national health insurance, its defects and anomalies, and the respective places of voluntary and council hospitals. After touching on medical research, nutrition, physical education, and psychological medicine, the report concludes with an assessment of the annual cost of ill-health, which runs well into nine figures.

It is not until all these matters are brought within the covers of one crown quarto volume of 400 pages that one realizes how large and complex they are. There are 19,000 insurance practitioners in Great Britain giving 50 million attendances a year. More than 5 million people participate in hospital contributory schemes. A thousand voluntary hospitals treat in a year 1½ million in-patients and nearly five times as many out-patients. Nearly 500 convalescent homes help a quarter of a million persons to get fit after illness. More than 150,000 mental patients are maintained out of public funds. The health of the school child in England and Wales is looked after by the equivalent of 700 whole-time doctors. Some 14,700 dentists make a valiant attempt to look after the nation's teeth, and 8,000 district nurses bear much of the burden which the daily care of ill-health lays upon the community. How do these services work? How do they fit together?

¹ *Report on the British Health Services* (P E P, 16, Queen Anne's Gate, S.W.1; 10s. 6d. cloth, 7s. 6d. paper boards, postage 6d. extra).