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Medical Research Council War
Wounds Committee and
Committee of London Sector
Pathologists

THE PREVENTION OF “HOSPITAL INFECTION” OF WOUNDS

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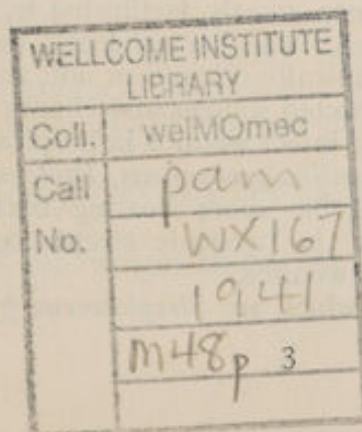


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THE PREVENTION OF "HOSPITAL INFECTION" OF WOUNDS

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INTRODUCTION

(Heavy type figures in brackets refer to practical instructions given in the Rules on pp. 15 to 21.)

Although war has again thrown into prominence the problem of hospital infection of wounds, such infection is not a phenomenon peculiar to war conditions. Several recent pre-war studies have revealed a low but definite incidence of hospital infection indicating defects of aseptic technique.

The results of these defects are not striking in peace-time and are usually accepted with equanimity except when occasional disasters compel attention. In war-time, however, the consequences are more obvious, because war wounds are more liable to infection and many of them, being infected before admission to hospital, provide an abundant reservoir of pathogenic bacteria. During this war several observers have recorded a high incidence of hospital infection which makes imperative an overhaul of existing practice in the care of wounds. A satisfactory technique should stand the severest test of war-time conditions, and nothing short of the abolition of hospital infection should satisfy the surgeon. This memorandum is the outcome of a study of the problem in several hospitals, and it deals with the care of wounds in the wards. Hospital infection may, of course, also occur in the operating theatre, but the standard of asepsis in wards is commonly much below that of the theatre and, in most wards in which surgical technique has recently been watched, practice falls short of the standard which the prevention of hospital infection demands. The following recommendations, if adopted, should go far toward solving the problem of hospital infection. For instance, a revision of wound dressing technique along lines similar to those indicated below has already in one hospital reduced a *Streptococcus pyogenes* infection rate from 15.4 per cent. in 78 patients to 1.1 per cent. in 95 patients.

Allowance has been made for the limited facilities of many hospitals under present conditions; in most of them the adoption of these recommendations, although calling for a small initial expenditure, should result in a reduction of working costs and a saving of labour. For example, it would save the laundering of many towels and gowns, and would make unnecessary the provision and sterilisation of many rubber gloves. The provision of adequate equipment for sterilisation by boiling would save much time and antiseptic now expended on relatively inefficient disinfection of instruments, utensils and waterproof sheeting.

It cannot be too strongly emphasised that a reliable aseptic technique is impossible without a sufficiency of suitable instruments and adequate means for their sterilisation.

The additional instruments required are mainly Cheatle's instrument forceps and simple dissecting forceps. Spencer Wells artery forceps which are too worn for theatre use can be substituted for the latter.

Many may find it difficult to change habits which conflict with the recommendations of this memorandum, but it is believed that the recommendations involve a change in, and not an addition to, existing aseptic procedures. The evolution of a safe prophylactic technique in a ward has been greatly facilitated by collaboration of bacteriologists with surgeons and nurses. The bacteriologist can demonstrate cross-infection as it occurs, whether it is clinically obvious or not, and bacteriological tests in the ward itself often reveal unsuspected sources and channels of infection.

The pathogenic bacteria which may infect wounds in hospital include *Streptococcus pyogenes*, *Staphylococcus pyogenes*, *Bacillus pyocyaneus*, *Proteus*, coliform bacilli, the diphtheria bacillus, occasional anaerobic spore bearing bacilli and a few others. Commonest and most important are the pyogenic streptococci and staphylococci. The diphtheria bacillus rarely infects wounds.

Haemolytic streptococci (most of which are *Streptococcus pyogenes*) normally live

in from 5 per cent. to 30 per cent. of human throats and occasionally in the nose; *Staphylococcus pyogenes* lives in from 20 per cent. to 40 per cent. of human noses and on 10 per cent. to 20 per cent. of human skins. Hospital infection may be derived from throats, noses and skins, but a more important reservoir is in other wounds which are themselves already infected.

From these sources, contamination of wounds occurs by **contact** with soiled fingers, instruments, dressings and lotions; by infected **droplets** from the mouths and noses of those nearby when dressings are off; and from the **dust** in the air of the ward. Contact is probably the commonest mode of infection, but contamination from all three sources must be avoided as far as possible.

Since wounds are protected from infection except when dressings are being done, "cross infection" among them should be easier to control than is another kind of "cross infection" also found in hospitals, namely cross infection of the upper respiratory tract. The nose and throat act as a filter which collects bacteria from a very large volume of air, but a wound is more like a plate of bacteriological culture medium in a Petri dish which is kept closed most of the time.

The analogy between a wound and a plate of culture medium suggests the principle which should underlie the technique of handling wounds in the ward. A surgeon in the theatre works in a relatively clean room and takes elaborate and costly precautions to exclude infection from a large area in which he can then operate with freedom; the dresser and the bacteriologist, on the other hand, usually work in an environment of infected dust and dirty objects, among which they must maintain strict bacteriological control over a comparatively small area, which is exposed for the shortest possible time, and in which only the simplest manipulations are undertaken. In the ward, a wound should be treated much as a bacteriologist treats a plate culture in the laboratory. The technique need not be as elaborate or as costly as that of the operating theatre.

Dressings which are very extensive and complicated, and which involve prolonged exposure and manipulation of the wound, cannot be protected by the precautions which suffice for simpler dressings in the ward, and should therefore be done in a room set aside for the purpose. In ideal circumstances, all dressings would probably be done in a special theatre, because the aseptic technique of the theatre is thorough and well known, and because a theatre is necessarily a cleaner place than a ward. In present circumstances, however, most dressings must be done in wards, and there is no reason why they should not be done there satisfactorily, with adequate protection of the wounds. Measures which reduce hospital infection of wounds also safeguard the nurses themselves against infection.

The reduction of hospital infection is easier in some kinds of ward than in others. Wards containing compound fractures and plastic cases present difficulties which are hardly encountered in those devoted to brain or abdominal surgery. Under emergency conditions, when many ward arrangements are improvised, each ward presents its own problems. The instructions which follow cannot be expected to solve all of these, but all are probably capable of solution if the principles here outlined are understood and respected. These principles may be summarised thus:

1. During the period when dressings are in progress precautions should be taken to keep the bacteria in the ward air as few as possible (2, 3). Direct droplet infection is prevented by making all persons in the ward (except patients if they keep silent) wear masks (10 to 14).
2. Hands, whether wet or dry, scrubbed or unscrubbed, are to be regarded as in all circumstances dirty, and should not be allowed to touch the wound or anything which comes in contact with it. Hands wearing non-sterile gloves, rank as bare hands; sterile surgical gloves are worn only in special circumstances (6).
3. Wounds are to be kept covered, and are to be uncovered only for the shortest possible time.
4. The skin around the wound should be treated with the same care as the wound itself.

5. It is easier to keep things sterile if they are dry. Hands and instruments should be dry, since bacteria are readily washed from them into the wound if they are wet.
6. Comfort is necessary to efficiency. It is achieved by careful preliminary arrangement of the light, the patient and the trolley.
7. The most perfect dressing technique may not prevent infection unless the steriliser, baths, utensils, floors and all ward accessories are properly cared for.
8. Precautions must not be relaxed with wounds which are already infected.

1. THE CONDUCT OF DRESSINGS

The early morning activities of a ward are domestic, and include the making of beds and the sweeping of floors, during which the bacterial content of the ward air rises to a maximum. Bed making and floor sweeping should therefore cease *at least* an hour before the first dressing is taken off.

A period for dressings should be fixed for each day of the week, at a time when it is known that all other activities are at a minimum. When dressings begin, the ward is closed to all non-essential traffic, windows and doors are shut, and everyone in the ward (except patients, *provided that they remain silent*) dons a mask.

A dressing done by one person single handed is likely to occupy more time and to be less safe, than if assistance is obtained. Assistants may be junior, but must be carefully trained in their work. For a simple dressing, the Dresser and Assistants do not "scrub up," nor do they wear gloves. They wash their hands with soap and hot water and dry them on a clean towel. The dressing technique described below is devised for two persons, a Dresser and a Trolley Assistant; their respective activities are kept carefully distinct, in order to avoid the risk of transferring from one wound to another loose particles of dried scab, pus, etc., which are liable to fall onto the hands of those handling dressings, bedding, etc., and may fall off again on to wounds or sterile materials.

The use neither of instruments nor of the most carefully sterilised gloved hands can be expected to cover the loose particle risk; the only safeguard is a careful distribution of "clean" and "dirty" duties between the Dresser and the Trolley Assistant.

At times, the Dresser will require help in removing a bandage, holding a limb, or manipulating sandbags or pillows, and in lifting the lids of the "Destructor" and "Salvage" bins (see below). None of these things should be done by the Trolley Assistant, who handles clean objects such as instrument forceps, vaseline gauze tins and other articles on the trolley which may pass from one bedside to another. It is evidently desirable that a third person—a "dirty assistant"—should be at the call of the dressing team. If the ward staff is so short handed that a "dirty assistant" cannot be called upon, the Dresser rather than the Trolley Assistant should attend to bedclothes, pillows, bin lids, etc., washing his hands free from loose particles as often as may seem necessary.

The dressing trolley is prepared near the steriliser and brought to the bedside (33). That part of the upper deck of the trolley nearest to the Dresser is reserved for the things that he will handle. These include the jar into which he discards his forceps, and, standing on a clean enamel tray, bottles of sterile saline for irrigation, the sulphonamide castor or insufflator, and so on. The Dresser alone handles these, and replaces them on the trolley. They are not touched by the Trolley Assistant.

The lighting is adjusted; a seat is placed for the Dresser if comfort demands one, and the position and bedclothes of the patient are *gently* arranged, with minimal disturbance of dust.

The Dresser first removes the bandages, which he places in the "Salvage" bin, and then the outer dressing, the reclaimable part of which also goes into the "Salvage" bin. These reclaimed bandages, etc., must be boiled or autoclaved before they are used again. Any part of the outer dressing which is so soiled that it must be thrown away is placed in the "Destructor" bin (36). (The lids of both bins should if possible be operated either by foot or by a "dirty assistant," not by the Trolley Assistant.) (35 to 41)

The Dresser then washes and dries his hands. He does not "scrub up"; the object of washing is not to make the hands sterile, but to prevent loose infected particles from falling from them. While the Dresser is doing this, the Trolley Assistant opens the dressing packet and places it conveniently for him. With the instrument forceps (Cheate's) the Trolley Assistant then places a sterile swab in a large sterile gallipot. The Dresser moistens the swab with saline from the saline bottle (see below).

When the Dresser returns from washing, the Trolley Assistant, using the instrument forceps, hands him two pairs of sterile forceps, of which he takes one in each hand. With these, he removes the inner dressing and places it in the "Destructor" bin.

Using the same forceps, the Dresser next removes any bits of slough or scab, or stitches, and places them on the swab in the gallipot. A common method of dealing with wound debris is to pick it off the wound with forceps and deposit it on a moistened swab held in another pair of forceps. The danger that particles may fall on to the bed, or whatever lies beneath the swab, is avoided by the use of the gallipot.

If necessary, the Dresser then cleans the skin around the wound, using swabs sparingly moistened with a suitable skin disinfectant.

If packing, etc., other than that in the dressing packet, is to be introduced into the wound, each piece should be picked from its container by the Trolley Assistant, using the instrument forceps or a third pair of sterile dressing forceps, which must never be soiled or brought into contact with the Dresser's forceps. The Trolley Assistant, using sterile scissors, also cuts off lengths of gauze, tape, etc., to the Dresser's order, passing them to him with sterile forceps.

The Dresser covers the wound with sterile gauze from the dressing packet. When the inner dressing is finally adjusted, the Dresser discards his forceps into a special jar for re-sterilisation. The Trolley Assistant's forceps must not touch those of the Dresser when passing sterile dressings to him.

In the technique described, the Dresser uses only two pairs of forceps and with them touches only:

1. the inner dressings, both old and new;
2. sterile material passed to him by the Trolley Assistant with forceps; and
3. the wound itself.

At no time, therefore, do bacteria other than those already in the wound get on to the Dresser's forceps.

The Trolley Assistant's forceps, on the other hand, must not be soiled with bacteria from any source, for they are used on clean materials kept in communal containers.

If it is necessary for the Dresser to lay aside his forceps temporarily during a dressing, as when he wishes to use scissors, he should rest them in, not across, the gallipot, their handles sticking well up into the air so that he can grasp them again easily. If he uses scissors he will rest them also in the gallipot, once they are soiled, until he can discard them into the dirty instrument jar.

When he has discarded his forceps, the Dresser adjusts the new outer dressing with his hands and puts on the bandage. He then retires and washes his hands. He does not leave the bedside while the wound is exposed.

The Trolley Assistant removes used articles from the trolley, cleans and reboils soiled instruments, dishes, etc., and then washes his hands, before setting up the new trolley and proceeding to a fresh case.

In patients with multiple wounds one wound may be infected and another not; precautions must therefore be taken, by dressing each wound separately, to avoid infecting one wound from another.

When the dressings of the ward are finished for the day, wounds remain covered except when surgeons wish to inspect them, or samples have to be taken from them. If there is a risk of the dressing becoming dislodged, it should be fixed with mastic, which is less painful than strapping and more adherent than collodion. On all such occasions, the exposure and re-covering of the wound must be subject to all the precautions against infection which are used in a complete dressing.

2. HANDS

TOILET AND CARE OF THE HANDS DURING DRESSINGS (4, 5)

"Scrubbing up" does not guarantee sterility of the hands; it is not good for the skin, and leaves the hands wet. Wet hands are more dangerous than dry ones; the drippings from wet hands and arms contain bacteria from the skin, and are liable to infect wounds.

After washing with soap and water, the hands should be dried on a clean towel. A rinse in spirit does not disinfect, is wasteful, and is not to be recommended. Drying the hands on a rag wrung out of weak disinfectant is ineffective.

For these reasons, hands, however treated, should be regarded as contaminated, and dressings should be performed with dry hands of social cleanliness, in such a way that hands and fingers *never touch* any of the following:

1. The wound itself;
2. The skin which surrounds the wound, and which is covered by the dressing;
3. The inner dressing;
4. Jaconet, rubber tubing or other material beneath the outer dressing;
5. Sterile dressings, swabs or lotions;
6. The inside of sterile utensils.

To say that hands are, of necessity, bacteriologically dirty does not excuse them from being kept scrupulously clean in the ordinary "social" way. Frequent washing in soap and hot water, followed by drying on a clean towel, is most desirable, especially in the case of those not yet thoroughly familiar with the technique of dressing wounds. Even if hands are only "socially" clean, clothing, handkerchiefs and the inside of masks, which may be heavily contaminated, must not be fingered while dressings are in progress.

RUBBER GLOVES (6 to 8)

The risk of punctures and tears, the expense of gloves, and the danger of a false feeling of security combine to make the routine use of gloves in surgical wards undesirable. If the hands are regarded as always "dirty," the wearing of gloves becomes unnecessary except for dressings which are too complicated to be managed with forceps alone, for palpation, and for the protection of the wearer's hands when handling a dressing the outside of which is very dirty, or when giving a patient a bath.

Surgeons or nurses using *sterile* gloves in the ward should first "scrub up" and dry their hands on a sterile towel, and should then adopt all the precautions regarding hands which are customary in the operating theatre.

Non-sterile gloves worn for the protection of the wearer's hands must be regarded as no safer than bare hands.

PALPATION

Palpation in the neighbourhood of a wound may be a necessary part of case examination. (Tenderness can be elicited by using a piece of wool held in dressing forceps, instead of a finger.) Usually the skin near a wound, rather than the wound itself, is palpated, but from the bacteriological point of view both procedures are dangerous. The skin within two or three inches of a wound may be infected by the discharges, and must be treated as a part of the wound itself.

Palpation, as, for instance, on a teaching ward round, may introduce a risk of wound-to-wound infection. It is also likely to distribute the nose and throat bacteria of those who palpate, for fingers commonly bear the nose and throat bacteria of their owners. There is little point in protecting a wound against nose and throat bacteria by wearing a mask if the same bacteria are transferred to it on fingers. Palpation should be practised as little as possible, and sterile gloves should be worn for the purpose.

If many cases are to be examined in succession, special care is necessary, for then the risk of cross-infection is greatest.

When a nurse finds herself suffering from a septic finger she should report it *at once* and go off surgical duty. The smallest inflamed spot constitutes a danger. Among the likely contributory causes of septic fingers are the handling of infected dressings, the over-zealous scrubbing of the hands with a nail brush (sometimes kept in a bowl of disinfectant of dubious activity), and the washing of soiled bandages by hand, to remove discolouring matter before they are boiled (42).

3. PREVENTION OF DROPLET INFECTION

Surgeons, nurses, porters, students, etc., suffering from recognised upper respiratory inflammation of any kind must report *at once* and go off surgical duty until the inflammation has completely subsided (15).

(Nurses often need holidays for the cure of upper respiratory and other infections acquired in the ward. The time off duty is sometimes reckoned as part of a nurse's annual leave. This is most undesirable, because the nurse is tempted to suppress evidence of mild infections for fear of jeopardising her proper holiday.)

The subsidence of inflammation is to be judged on clinical grounds: many cases of upper respiratory tract inflammation will continue to "carry" the infecting bacteria for many weeks after recovery, but, except in the case of diphtheria, it is neither practicable nor necessary to postpone the return of convalescents to duty until swabs from them are entirely free from pathogenic bacteria.

Convalescent carriers and healthy carriers, recognised as such by swabbing but not suffering from active inflammation, should remain off duty only while swabs yield profuse cultures of the infecting organism. Apart from known convalescents, up to 20 per cent. of the ward staff may be carriers, and will not be recognised as such except on the rare occasions when a bacteriological examination happens to be made.

The danger of wound infection by droplets from both known convalescents and unknown carriers can be reduced to a minimum if all those taking part in surgical work—preparation of sterile materials, operations, wound dressing, etc.—wear properly fitting and impervious masks (10 to 14 and Appendix A).

The pattern of mask is a matter for individual taste, though many types now in use are ineffective. To be effective a mask must satisfy the following requirements:

1. It must be impervious. A layer of paper or cellulose acetate between two layers of linen or gauze will make it so. Gauze masks without paper have been shown to be efficient for the period of an average operation only if more than ten layers of gauze are used.
2. The mask must fit well under the chin, because many infected droplets fall almost vertically. The sides of the mouth must also be guarded.
3. The mask should not be hot or uncomfortable, and should not impede breathing. For constant ward use, linen or some material like it, may be found more comfortable than gauze, and will not shrink so much with repeated washing.

Masks act merely as mechanical barriers to prevent the fall of droplets from mouth and nose on to wounds. They need not be issued sterile, but should be collected and boiled and ironed daily, a supply being placed in the ward each morning, so that surgeons and nurses may each take their own for the day. A few extra should be provided for visitors during the dressing period.

Two suitable patterns of mask are described in Appendix A (p. 21).

4. PREPARATION AND DISPOSAL OF MATERIALS USED FOR DRESSINGS

DRESSING PACKETS

Individual dressing packets wrapped in stout paper covers and autoclaved are safer than dressings packed and sterilised in bulk in drums or bags which have to pass from bed to bed and are continually reopened (16, 17).

Sterile dressing packets should be protected from damp (e.g. from the steamy atmosphere of a sterilising room).

WARD SURGICAL UTENSILS

These include bowls (seldom provided with lids), kidney dishes (which never have lids), sometimes rectangular dishes (which may, but usually do not, have lids), douche cans (again lidless) and arm baths. Glass dishes provided with lids are suitable, but may break during sterilisation. Square eight-inch enamel dishes with flat lids and handles are sometimes available, and fit on to the top of a dressing trolley without any waste of space.

Satisfactory lids should be provided for all sterile vessels. If proper lids cannot be obtained, they can sometimes be improvised. No lids at all are probably safer than lids which are too small, which fall into the vessels they are supposed to cover, or are otherwise inefficient.

Surgical utensils without lids are comparable with bacteriological culture plates without lids.

STERILISATION OF BOWLS, DISHES AND INSTRUMENTS

Boiling in water, or water containing 2 per cent. sodium carbonate, is the method of choice. The addition of 2 per cent. washing soda to the water makes it more lethal to bacteria, and diminishes rusting of instruments. Strong (20 per cent.) washing soda can be kept in a jug near the steriliser and diluted for use to 1 in 10 or 1 in 15 (19).

The steriliser must be big enough to permit full immersion of the largest vessels sterilised in the ward. It should preferably be big enough to sterilise all the ward dressing utensils in one boiling. Small sterilisers lose water quickly by evaporation and are cooled below boiling point when large cold objects are introduced.

The most suitable steriliser for a busy ward is a gas-heated laundry copper, which should be installed in the service-room. Failing this, a fish kettle at least 12 inches deep and 24 inches long will serve.

A *boiling* period of two minutes is normally required for bowls and instruments. If, however, there is reason to suspect that bowls or instruments have been contaminated with pathogenic spore-bearing bacilli, they should be sterilised in boiling 2 per cent. soda solution for five minutes.

Conditions in some emergency hospitals are such that bowls cannot be boiled at all. In such cases chemical disinfection is the only alternative. Chemical disinfectants must be used long enough and strong enough (see Appendix C, p. 26). Boiling is cheaper in both material and labour.

Boiling is the correct treatment for forceps, probes, rubber tubing and glassware. The experience of many surgeons indicates that scissors and knives can be satisfactorily boiled. It may be true that prolonged boiling blunts cutting edges, but if instruments are protected from bumping into one another by a wrapping of gauze or lint, or, in the case of scalpels, held in a zinc rack, boiling in 2 per cent. soda for two minutes has little destructive effect on their cutting edges. The gain in safety and convenience if all instruments are boiled is considerable.

Immersion in disinfectant is not satisfactory, because it does not sterilise reliably unless the antiseptic is strong enough and used for long enough, and because instruments so sterilised need washing before use.

Bowls and instruments can be kept dry and sterile for hours or days, provided that they are correctly treated during and after sterilisation.

It is unnecessary and extravagant to keep sterile instruments in spirit. Spirit is not an additional safeguard if the instruments are properly covered and handled only with instrument forceps (Cheate's); the provision of sterile water or saline for washing away the spirit before use involves extra material and labour, and a risk of infection from wet instruments and hands. Seventy per cent. alcohol, which is the most effective dilution, contains 30 per cent. of water and will rust instruments. Where boiling immediately before use is likely to be impracticable, the sterilised

instruments should whenever possible be kept in the dry state in a covered sterile receptacle. If this cannot be done, *Liquor formaldehydi chirurgicæ* is suitable for the storage of most instruments other than needles. It consists of Borax 1·5, Solution of Formaldehyde 2·5, Phenol 0·4, Distilled Water to 100. The borax prevents rusting of steel instruments kept in the solution for a week or more. Instruments kept in this solution need to be rinsed before use.

STERILE TOWELS

Sterile towels are needed to place on the bed during a dressing, and to dry gloved hands which have been sterilised by washing (43).

It is wasteful and not very safe to use them as tablecloths or to cover sterile materials. They may not remain sterile for long, particularly if they become wet. A sterile towel used to cover sterile materials is not easily laid aside: two hands are generally needed, and contamination of the under side of the towel is common. If all the sterile objects on a trolley are covered by one towel, they may all have to be exposed when only one is needed.

It is not desirable to trust sterile towels as temporary dressings for wounds: the towel may fall off, the patient may lift it to examine his wound, and it invites breach of the rule that inner dressings must not be fingered. The use of temporary dressings should be avoided as much as possible (44).

DRESSING TROLLEY AND BINS

If Rules 32 to 41 are followed, there is no objection to wheeling the trolley from one bedside to another.

These rules have been framed to protect the sterile materials on the trolley from contamination from the air and from the patient. Success will depend on the efficiency of the dressing team.

5. BATHS, LOTIONS AND IRRIGATIONS

BATHS AND ARM BATHS (54 to 62)

Baths and arm baths are fruitful sources of hospital infection of wounds. They are difficult to sterilise.

For arm baths, the cheapest and safest method of sterilisation is immersion in boiling water. Tank or boiler sterilisers of sufficient size should be installed in wards in which the use of arm baths is habitual.

Ward baths can be "sterilised" only by the use of strong disinfectants (60 and Appendix C). Weak disinfectants are unreliable for bath cleaning. Scrubbing with soap and water is quite inadequate. Pouring boiling water over the bath surface from a kettle has little effect on the bacterial flora and does not remove the grease.

The bacteria of a bath are most numerous in the line of vaseline and grease which forms at the level of the water surface.

Wooden rims around baths should be permanently removed. Chipped enamel is difficult to sterilise; chips should be painted as soon as discovered. Arm baths which are badly chipped should be discarded.

Special care should be given to the sterility of waterproof sheets used when giving patients baths, or as covers for arm baths which lack their lids. Unless very carefully sterilised, waterproof sheets often carry large numbers of pyogenic cocci on their surfaces. (See Appendices B and C.)

The fluid remaining in an arm bath after a wound has been soaked in it may contain many millions of haemolytic streptococci per cubic centimetre. Precautions must therefore be taken over its disposal (58).

LOTIONS (45 to 53)

Due care should be taken in the sterilisation of all saline and lotions to be used on wounds, and in the maintenance of their sterility before and during use.

Lotions may become contaminated from the air, by droplets or by contact with hands and fingers before they reach the wounds on which they are to be used.

Examples of the wrong use of sterile lotions are their delivery on to a wound or dressing by being squeezed by hand out of a piece of gauze, and the testing of their temperatures by the immersion of a finger.

IRRIGATIONS (63, 64, 65)

The methods of irrigation recommended remove some of these risks.

The familiar combination of a douche can, rubber tube and glass cannula has certain bacteriological disadvantages:

1. There is usually no lid.
2. Lotion has to be poured into the can.
3. The can is difficult to set down; some patterns have to be held in the hand when in use.
4. When the can is set down, the cannula (the outside of which is not sterile), is sometimes put into it.
5. The fingers which hold the cannula are likely to be wet with lotion, which may run back from them into the wound.

Disadvantages of this kind may be avoided by the method given in Rule 64.

Irrigation includes the washing out of large cavities, such as empyema cavities, the moistening of saline dressings on burns and the soaking off of adherent dressings.

6. CHEMICAL DISINFECTANTS

Whenever possible, sterilisation of instruments and equipment by boiling is to be preferred to chemical disinfection, because it is more reliable and less costly in time and material. For certain purposes, however, chemical disinfectant solutions are indispensable; and, in present circumstances, when facilities for boiling are sometimes inadequate, recourse to chemical disinfection as a makeshift emergency measure may be inevitable. The selection of chemical disinfectants needed is small, and should be made with regard to efficacy, convenience and cost.

Each disinfectant must be used only for its proper purposes, for a sufficient time and at adequate strength. The weaker the antiseptic, the longer it takes to sterilise. Improper use gives a false sense of security without disinfecting; it is thus dangerous as well as wasteful.

There is little uniformity of practice in the use of disinfectants in wards. Often the chief users are the most junior probationers, who have received little accurate instruction in the matter. A list of the disinfectants to be used, with notes on their correct usage, should be posted in every bathroom and sterilising room and ward. This list should be made out by, or checked by, the hospital bacteriologist, and should refer to the disinfectants which are actually available in the hospital.

A sample list is given in Appendix C.

Examples of ineffective and wasteful disinfection are:

1. The use of disinfectants which are too weak or too dilute to kill bacteria in the time available—e.g. methylated spirit or too dilute lysol.
2. Application to places that need not, or cannot, be disinfected. Floors and passages need not be chemically disinfected, except when some gross local pollution is known to have occurred. Drains and sinks cannot be disinfected; they can, however, be "made sweet" by treatment with soda and disinfectant chemicals (see Appendix C).
3. The use of unnecessarily expensive disinfectants when cheaper varieties would serve as well or better.
4. The use of disinfectants, usually the more expensive, merely as deodorants.

7. SOME POSSIBLE SOURCES OF WOUND INFECTION

CLOSED PLASTERS

Closed plasters applied over wounds are rich reservoirs of pathogenic bacteria, which soak through the plaster when it becomes soft and discoloured, or escape in pus from its ends. In either case the bacteria will soil bedding, hands or anything else which the plaster touches. If a plaster becomes contaminated externally it should be changed unless there is serious surgical contra-indication. Dirty plasters which cannot be changed should be wrapped in a thin layer of absorbent material which can be renewed when necessary. Sterilising the surface of the plaster with disinfectants is ineffective. The incorporation of antiseptics in the plasters does not prevent infection of their surfaces.

Wounds treated by the closed plaster method become infected while in hospital just as other wounds do. Probably most of this infection occurs when the plasters are changed.

When a plaster is opened, pathogenic bacteria from it, and from the dressing within it, are scattered into the surrounding air.

Precautions to be observed when working with plasters which enclose wounds are outlined in Rules 66 to 72.

X-RAY, MASSAGE AND PHYSIOTHERAPY DEPARTMENTS

Most X-ray departments are not equipped to dress wounds, but dressings are sometimes removed in them, to search for a foreign body or to examine an open fracture, etc. Those in charge of X-ray departments must realise the danger of spreading infection among wounds. Wounds should, when possible, be X-rayed in the ward or theatre, rather than in the X-ray department. A surgeon or house surgeon should be present, to prevent unnecessary breaches of aseptic technique.

Wounds for X-ray examination should be specially dressed in the ward, with a thin layer of gauze covered with oiled silk or other impervious material that is transparent to X-rays. This material is stuck firmly to the surrounding skin with adhesive plaster transparent to X-rays; it need not, and must not, be moved during examination.

Precautions similar to those for the X-ray department should be taken with patients undergoing treatment by massage, heat, etc.

DUST

If wounds, sterile materials, lotions and instruments are uncovered for the shortest possible time, and if wounds are dressed with the precautions against contamination from dust which have already been described, the risk of air borne infection is probably small. Of the general measures which can be taken to reduce the bacterial content of ward air, ventilation is probably the most effective.

The activities which chiefly contribute bacteria to the air of a ward are bedmaking, floor sweeping, and cutting plasters; plaster cutting should not be done in the ward (66). Bacteria will be scattered less from bedclothes if the latter are *handled gently and slowly*. This may be important when preparing to change a dressing. Experimental work has shown that the application of mineral oil to bedding markedly reduces the number of bacteria and the amount of dust liberated when beds are made; but so far no method of application of the oil which is suitable for routine hospital use has been found. Recommendations on this subject must await the results of further research.

The number of bacteria distributed by floor sweeping and by ordinary traffic can be reduced by treating wooden or linoleum floors with spindle oil—(specific gravity, 0.885–0.890; closed flash point 335° F.; open flash point 345° F.; viscosity, 210 Redwood seconds at 70° F.; obtainable from most dealers in petroleum oils). Bacteria are not killed by the oil, but are held on the floor.

Floors should be scrubbed before the initial oiling. The oil should be applied thinly once every three weeks, with a mop covered with a piece of coarse cloth or

hessian; it should not be applied by hand. Floors treated with oil are a little slippery for some hours, which may be a serious disadvantage in a ward where rubber-shod crutches, sticks or artificial limbs are used. If, however, the oil is applied in the evening, and the excess is wiped off with a dry cloth next morning, slipperiness is reduced to a minimum. Oil treatment is not suitable for rubber floors.

Whether floors are oiled or not, the dust disturbance of dry sweeping can be considerably reduced by the preliminary scattering of moist sawdust or tea leaves, though this measure is much less effective than oiling the floor.

Vacuum cleaners of a pattern which includes a satisfactory filter are probably more effective than any form of sweeping.

The dust on walls, tables, lockers, etc., should be removed with a *damp* cloth.

8. GENERAL REMARKS

BACTERIOLOGY FOR NURSES

Aseptic techniques cannot be revised or maintained without the intelligent co-operation of the nursing staff, who must understand the principles underlying the measures intended to prevent infection. In this connection, direct bacteriological demonstration is worth much verbal explanation; those who have seen cultures made from their own persons, and from the wounds of their patients, will more readily appreciate the necessity of the precautions recommended. Nurses are commonly taught bacteriology in a condensed and dogmatic form. An attempt is made to cover the whole field of medical bacteriology, and to deal systematically with the infective diseases, in one short course; the inevitable compression distorts the perspective, and more important matters are treated as cursorily as the less important. There is not time for practical instruction, and, as a result, the nurse has to assimilate difficult, jargon-ridden information almost entirely as a theoretical subject. To her the infecting microbe is often as remote an object as the hydrogen atom is to the beginner in physics.

During her training, it is neither necessary nor possible for a nurse to acquire more than an elementary knowledge of bacteria, etc., and of the simpler phenomena of infection and immunity. But every effort should be made to give her some direct experience of bacteria as they concern her duties in hospital, particularly with regard to the development and spread of infection, methods of sterilisation and other hygienic measures. This object can be attained by a short practical course. Lectures, however excellent in character or however numerous, cannot achieve the same result as actual experience in handling a few cultures, swabs, etc.

During recent months short courses of practical bacteriological exercises for nurses taking part in dressings in surgical wards have been held in several hospitals, under more or less experimental conditions. The courses were very simple and adapted to the local conditions of the hospitals. A laboratory is not necessary; these courses were held, for example, in small side rooms and operating theatres. The nurses showed great interest, and there is no doubt that they were stimulated to a more enlightened attention to precautions in their ward work.

SUPERVISORS FOR CONTROL OF INFECTION

Even when a safe procedure has been instituted its maintenance in a hospital will need constant supervision. Working conditions change, personnel also changes, new treatments are introduced and old ones modified. Throughout all these changes there is need for someone with access to wards and sterilising rooms, who has sufficient seniority to command attention and the necessary knowledge of bacteriological method to superintend all matters relating to asepsis, antisepsis, disinfection and bacteriological control generally in surgical wards, or in a hospital as a whole. In a large hospital, these duties, if combined with teaching of students and nurses, would justify the appointment of a full-time special officer to supervise the control of infection.

9. RULES

(The following rules are given in dogmatic form because the reasons for them have been stated in the text, which may be used for reference by Sisters and others who instruct nurses.

These rules do not embody a description of dressing ritual of the kind suggested on pp. 6 and 7, because it is felt that surgeons will devise their own rituals, which must vary according to the nature of the surgical work and the resources of the ward.

Heavy type figures in brackets in the preceding text refer to the rules given below.)

Dressings.

1. A dressing should be performed by at least two persons—a Dresser who takes off bandages and outer and inner dressings, attends to the toilet of the wound and re-dresses it; and an Assistant whose sole duty is to look after the trolley and pass clean things from it to the Dresser.
2. The dressing period is to be preceded by a quiet interval of at least one hour, during which sweeping, dusting, bedmaking and other activities which raise the dust are forbidden.
3. The same quiet is to be maintained during the dressing period and before it, while the trolley is being prepared. Doors and windows are closed and traffic through the ward is stopped. Bedclothes are to be manipulated gently and slowly.

Hands and gloves.

4. A simple dressing is performed with two pairs of sterile forceps held in ungloved hands which have been thoroughly washed with soap and hot water and dried on a clean towel. "Scrubbing up" should not be practised for ward work, except when using sterile gloves, which must be put on with all theatre precautions.
5. During a dressing, hands and fingers *never touch*:
 - a. the wound itself,
 - b. the skin which surrounds the wound and which is covered by the inner dressing,
 - c. the inner dressing,
 - d. jaconet, rubber tubing or any other material which lies beneath the outer dressing,
 - e. sterile materials, sterile lotions, or the inside of sterile vessels.
6. Sterile gloves are worn for dressings too complicated to be managed with forceps alone. They are put on as in the operating theatre.
7. Clean gloves, not necessarily sterile, are worn for handling dressings which are heavily soiled on the outside, for giving patients baths, and for the protection of non-infected abrasions on the hands. Non-sterile gloves worn for the protection of the wearer's hands are as dangerous to wounds as ungloved hands.
8. Rubber gloves can, if necessary in an emergency, be made sterile while on the hands, by washing them thoroughly with soap and hot water, drying them on a sterile towel and treating them with a suitable antiseptic after washing (see Appendix C).

Septic hands.

9. Any person taking part in surgical work who suffers from a septic finger or hand or forearm must report it at once and go off surgical duty. The smallest inflamed spot constitutes a danger.

Masks.

10. During the dressing period, masks are worn by all persons in the ward except patients, who must keep silent.
11. Masks must be worn on visiting rounds if wounds are to be inspected.
12. Masks are to be worn by those removing bowls, instruments, dressings, etc., from sterilisers and autoclaves, and by those preparing sterile materials and sterile lotions (for example, filling arm baths).
13. Masks must contain an impervious layer of paper or cellulose acetate which is inserted after laundering (see Appendix A).
14. Masks are collected, boiled and ironed daily. A fresh supply is placed in the ward each morning, so that each surgeon and nurse may take one for use throughout the day. When not in use, the mask is best worn round the neck, or folded nose-side-inward and carried in a special pocket of the apron or white coat. The handkerchief must not be carried in the same pocket.

Respiratory infections.

15. Surgeons, nurses, porters and students suffering from upper respiratory inflammation of any kind must report at once and go off surgical duty until the clinical signs of inflammation have subsided completely.

Dressing packets.

16. Materials for each dressing are made up in an individual packet wrapped in calico towelling or in stout paper, and sterilised in the autoclave. Any of the contents of a dressing packet left over after a dressing has been done are re-sterilised before use.
17. A fresh dressing packet must be used for each dressing, even when multiple dressings have to be done on one patient.

Ward sterilisers.

18. The steriliser must be large enough to contain all bowls and dishes that require sterilisation, and to allow their total immersion in boiling water.
19. The addition of 2 per cent. washing soda to the water in the steriliser makes it more lethal to bacteria and spores, and diminishes rusting of instruments. Twenty per cent. washing soda may be kept in a jug near the steriliser and diluted 1 in 10 or 1 in 20 for use. Each morning the steriliser is filled with soda solution: as evaporation lowers the water level, plain hot water is added to make good the loss.

Bowls and dishes.

20. Bowls and dishes are normally sterilised by total immersion in boiling water or soda solution for two minutes. If the ward equipment does not permit of this, they should be sterilised by swabbing with undiluted lysol and then thoroughly rinsed in flowing hot water from the tap.
21. Lids are boiled with dishes, and used to cover those that are to contain sterile materials, instruments or lotions.
22. After boiling, bowls and dishes are removed from the steriliser by means of large forceps, shaken to free them from excess water, and placed on a surface, such as slate, wood or American cloth, which can be swabbed with disinfectant from time to time. They should not be inverted on this surface, but should be protected from dust by sterilised lids. In a ward, sterilised bowls and dishes need not stand on a sterile towel.
23. Improvised lids must be large enough not to fall inside the vessels which they are supposed to cover.

Instruments.

24. For a simple dressing, the Dresser and Trolley Assistant each require two pairs of sterile forceps (dissecting forceps five inches or more in length, or ring-handled forceps).

25. Forceps, scissors and other instruments are normally sterilised by immersion in boiling water or soda solution for two minutes. They are lifted from the steriliser by instrument forceps, shaken to remove excess fluid—the remaining film of water dries quickly—then placed at once in a sterile dish and covered with a sterile lid.
26. Clean scissors and knives are sterilised in boiling 2 per cent. soda solution for two minutes. Blunting is avoided by wrapping them in lint or gauze, or, in the case of scalpels, supporting them in a zinc rack.
27. Instruments are lifted from their sterile dish with instrument forceps by the Trolley Assistant, and handed to the Dresser.
28. The blades and hinges of scissors and ring-handled forceps, and the distal two inches of dissecting forceps, must not be fingered during use.
29. During the performance of a dressing the Dresser may rest his instruments temporarily in (not across) a large sterile gallipot on the trolley, the handles standing well up into the air.
30. Instruments can be preserved in a sterile state in dry, sterile, covered dishes. The lids may be fastened with adhesive tape. Disinfectant solutions are not necessary; but instruments which rust easily may if necessary be kept sterile in *Liquor formaldehydi chirurgicalis* (see p. 11).
31. Soiled instruments are placed in a special jar on the trolley. They are scrubbed with lysol (1 oz. to half a pint) by means of a wire or bristle brush, before being boiled.

Dressing Trolley.

32. The trolley may pass directly from one bedside to the next, provided that there are a separate set of instruments, a separate dressing packet, and a fresh large sterile gallipot for each dressing.
33. On an ordinary two deck trolley, the arrangement is:

Upper deck (mainly sterile things).

- a. Instrument forceps in a jar of disinfectant,
- b. Packet of sterile dressings,
- c. Sterile instruments in a sterile covered dish,
- d. A large sterile gallipot, and any other sterile bowls or dishes that may be needed,
- e. A jar, which may contain weak disinfectant, for the receipt of soiled instruments,
- f. On that part of the upper deck nearest to the Dresser, a rectangular tray upon which stand the irrigation bottle containing sterile saline, and the sulphonamide castor or insufflator.

Lower deck (in general, clean but not sterile things).

Clean bandages, adhesive plaster, safety pins, etc. Sterile towels are not needed as tablecloths, or to cover the loaded trolley.

34. When the round of dressings has been completed, the outsides of vessels such as the irrigation bottle and the sulphonamide castor, which have been handled by the Dresser, are wiped with lysol (1 oz. to 1 pint); this is allowed to act for a few minutes and then rinsed off with hot water from the tap.

Bins.

35. Soiled bandages and reclaimable used dressings are placed in the "Salvage" bin, and boiled or autoclaved before being used again.
36. Dressings which are too soiled to be reclaimed are placed in a separate "Destructor" bin for incineration.
37. The "Salvage" bin and the "Destructor" bin have lids which are kept on at all times. A bin with a lid worked by a foot pedal, such as is used in households, is desirable.

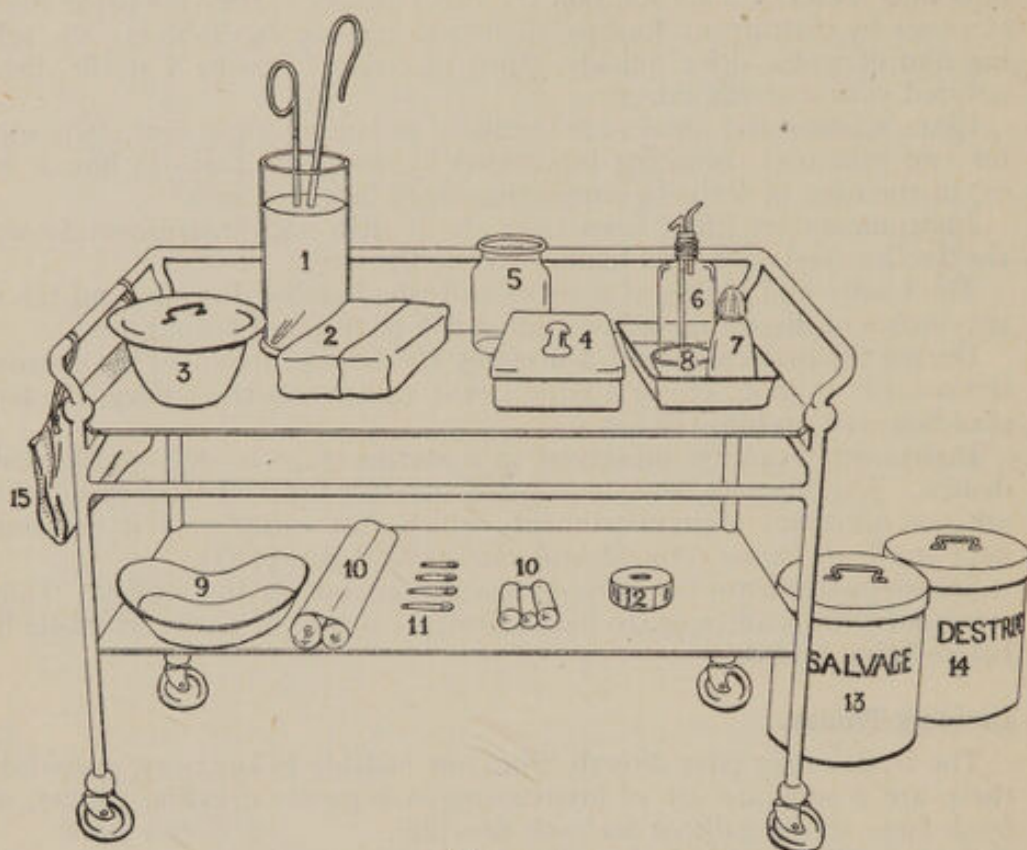


FIG. I.

Arrangement of Dressing Trolley for a simple dressing.

1. Instrument forceps in disinfectant. 2. Dressing packet. 3. Sterile bowl, covered. 4. Sterile instruments in covered sterile dish. 5. Jar for soiled instruments. 6. Irrigation bottle of saline. 7. Sulphonamide castor. 8. Large sterile gallipot. 9. Kidney dish. 10. Bandages. 11. Safety pins. 12. Adhesive tape. 13. Salvage bin (on floor). 14. Destructor bin (on floor). 15. Bag for salvage of dressings opened but not used.

38. The bins rest on the floor beside the trolley, and not on the trolley itself. They may be moved from bedside to bedside until full. They must not be filled to the brim.
39. They are emptied outside the ward into larger covered bins, which are taken to the incinerator. Large outdoor bins must at no time stand uncovered where birds, flies and vermin can reach their contents.
40. All bins should be swabbed out with lysol (1 oz. to half a pint) daily.
41. Dirty dressings, such as plasters, which are too large for the bins, should be wrapped in moistened sheets for transport to the large bins or to the incinerator. The sheets must be sterilised afterwards.

Soiled bandages.

42. Soiled bandages are transferred from the "Salvage" bin either into a larger bin, or directly into the boiler. They are boiled for two minutes in water containing a little washing soda, after which ordinary manual washing removes all dirt and discoloration.

Sterile towels

43. Sterile towels may be placed under sterile instruments or other sterile objects which must be laid on the bed during a dressing or transfusion, though for this purpose a sterile bowl is often better. For a dressing a patient need not be draped with sterile towels as for an operation.

Temporary dressings.

44. Temporary dressings are to be avoided as much as possible. A sterile towel alone is not an adequate temporary dressing. It may be used as a temporary *outer* dressing, provided that the wound is covered with a proper *inner* dressing which is handled only with forceps.

Saline.

45. Saline used for bathing and irrigating wounds is autoclaved in bottles closed by screw caps. Cork or rubber stoppers are unsafe for this purpose.
46. The covered part of the neck of the bottle must not be fingered when the screw cap is removed.
47. When possible, sterile saline is used direct from the bottle in which it has been autoclaved. If it must be decanted into a sterile bowl, the bowl should be provided with a lid.
48. When saline is to be used in large quantities, as for an arm bath, autoclaved 18 per cent. salt solution is diluted 1 part in 20 with tap water.
49. Saline or water must not be autoclaved in bottles of capacity greater than one litre.
50. Partly emptied bottles of sterile fluids must not be re-stoppered for future use, unless it is *known* that full precautions against contamination were taken at each opening.

Sterile water.

51. Tap water may be used as sterile water for lotions, provided that it is drawn direct from a non-leaking, clean tap. Hot water is usually safer than cold.
52. Water sterilised by boiling must be adequately protected after boiling, and used as fresh as possible.
53. Distilled water, unless sterilised, is to be regarded as infected.

[Arm baths.

54. Arm baths are best sterilised by boiling. Non-enamelled metal arm baths may be filled with water and boiled on a gas ring.
55. Arm baths which cannot be boiled are thoroughly rubbed with undiluted lysol and thoroughly rinsed with tap water. **STRONG LYSOL IS A POWERFUL CAUSTIC AND SMALL SPLASHES CAN PRODUCE SEVERE BURNS. GREAT CARE MUST BE EXERCISED IN ITS USE. IT MUST BE APPLIED ON A MOP, OR BY SOMEONE WEARING RUBBER GLOVES.**
56. During use, an arm bath is to be covered with a sterile lid or by a waterproof or jaconet sheet sterilised by boiling or autoclaving.
57. The temperature of the lotion in an arm bath is either measured with a thermometer or gauged by feeling the *outside* of the bath (see Rule 5). The thermometer is kept in lysol (1 oz. to 1 pint).
58. The contents of a used arm bath may be disinfected by mixing 1 oz. of Izal, or similar disinfectant (see Appendix C) with each gallon of lotion and allowing the mixture to stand for one or two hours in the bath before emptying it into the bedpan sluice (not the sink).
59. Enamelled arm baths which are badly chipped should be discarded.

Ward baths.

60. The ward bath must be thoroughly cleaned after use for each wounded patient. The bath surface is thoroughly rubbed with undiluted lysol, or with a mixture, which may be made in the bath itself, of domestic cleaning powder and lysol (1 oz. to half a pint). **STRONG LYSOL MUST BE APPLIED WITH GREAT CARE, ON A MOP BY SOMEONE WEARING RUBBER GLOVES.** After cleaning with lysol, the bath is *very thoroughly rinsed* with

tap water. Special attention is paid to cleaning the plug, outlet, chain and all bath appurtenances, and to the "grease line."

61. Chips in the enamel must be painted as soon as they are discovered.
62. Persons who give baths to wounded patients should protect their own arms and hands with rubber gloves or gauntlets.

Irrigation of wounds.

63. To moisten dressings on burns, for example, pour on to them sterile saline direct from the bottle in which it has been sterilised. The saline is autoclaved in 20 oz. screw-capped bottles; the screw cap is removed and a sterile rubber bung fitted with two pieces of glass or metal tubing is inserted into the neck of the bottle (Fig. 2). Bung and tubing are sterilised by immersion for two minutes in boiling water; they are taken from the boiling water and inserted forthwith into the bottle of sterile saline. Care must be taken not to splash the nozzle of the bottle when pouring. When the bottle is not in use, the nozzle is protected from air contamination by a piece of sterile lint or gauze. One bottle should serve for the irrigation of several dressings.

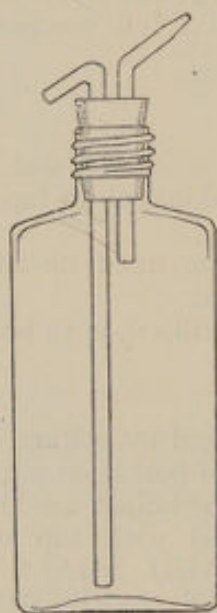


FIG. 2.

64. For larger irrigations, such as washing out the pleural cavity, use a blood transfusion bottle of the ordinary war emergency type, fitted with a rubber bung and delivery tubes, as shown in Fig. 3. The longer piece of glass tubing is an air inlet; the shorter piece is attached to a length of rubber tubing fitted with a glass cannula and a spring clip.

The saline is autoclaved in the bottle, which is provided with the usual screw cap. The assembled bung, tubing, cannula and clip are wrapped in paper and sterilised in the autoclave at 105° C. to 109° C. (see Appendix B). A piece of lint wrapped round the bung and tubing prevents sticking, and may itself be used as a sterile towel upon which to rest the cannula if the irrigation has to be interrupted. The sterilised bung and tubing are easily attached to the bottle at the bedside; during the irrigation, the bottle is suspended at the required height above the bed.

If one bottle of saline is insufficient, two or more can easily be used, the bung being transferred from the empty bottle to the new one.

65. "Undines" are not to be used for the irrigation of wounds. It is almost impossible to fill them without contaminating the lotion, and they are difficult to sterilise.

Plasters enclosing wounds.

66. Closed plasters on wounds should be opened in a special plaster room and not in the ward.
67. Plaster shears must be boiled immediately after use on each plaster.
68. Persons opening plasters should wear masks and gloves.
69. Plasters must be moistened while being opened.
70. Plasters which are becoming dirty and soft may be wrapped in some sterile absorbent material, which must be changed frequently, to prevent pollution of the bedding, etc.
71. The discarded plaster must be placed at once in a closed bin. If the plaster has to be carried out of the room to the bin, it should first be wrapped in a damp sheet, which must be disinfected after use.
72. The board or plate on which fresh plaster bandages are spread must not be contaminated with soiled plasters or plaster shears.

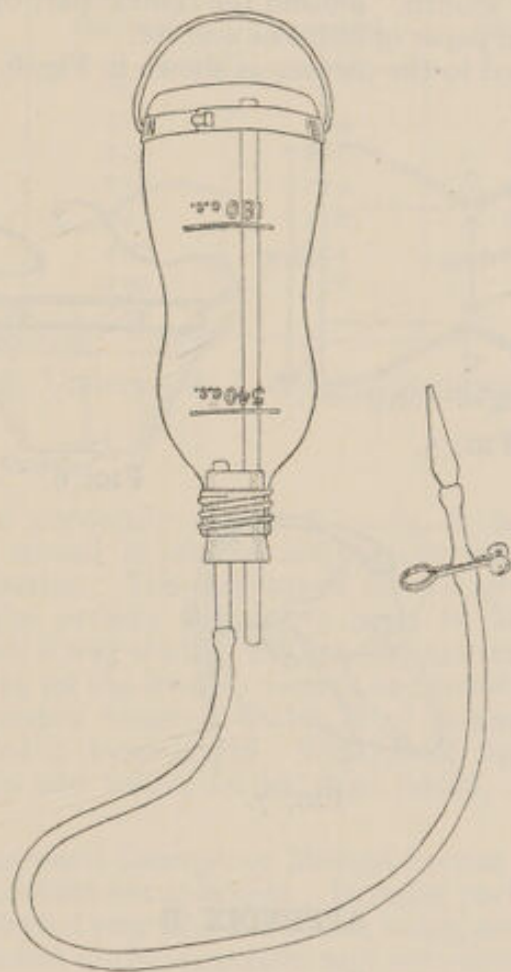


FIG. 3.

APPENDIX A

PATTERNS FOR MASKS

Masks made of gauze are less comfortable and shrink more on laundering than do those made of linen or balloon fabric.

1. Simple rectangular mask of linen, balloon fabric or gauze (Fig. 4), made in the form of a pouch into which a sheet of paper is inserted. The dimensions should be at least those shown. One free edge of the opening of the pouch should be folded inwards, as in a pillow-case, to prevent the paper from working out during use. This is not shown in Fig. 4.

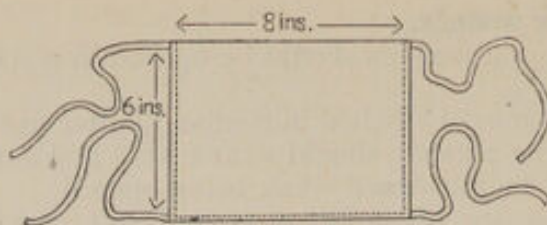


FIG. 4.

2. "Nosebag" mask. Two pieces of linen are cut to the measurements shown in Fig. 5 and sewn together along the dotted lines. The double layer is then folded along cd and made into a bag by sewing along the interrupted lines. A certain amount of individual fitting is required, to ensure adequate protection at the sides of the mouth. ab and the central part of ef are left open for the insertion of pieces of paper or cellulose acetate.

Tapes are attached to the corners as shown in Fig. 6.

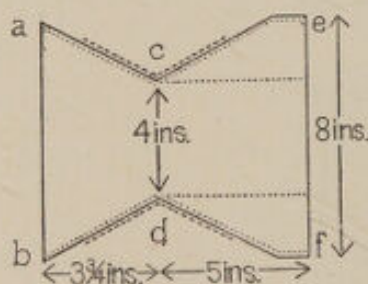


FIG. 5.

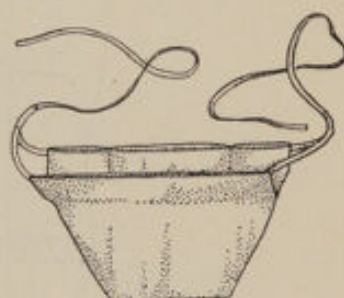


FIG. 6.



FIG. 7.

APPENDIX B

STERILISATION

Moist heat is the most efficient and economical means of sterilising hospital dressings, instruments and utensils. Two procedures are commonly used: (1) boiling in water (100° C.), and (2) exposure to steam under pressure (118° C. to 120° C., or 20 lbs. steam pressure).

1. *Boiling in water*.—See Rules 18 to 27.
2. *Steam under pressure (Autoclave)*. Sterilisation in the autoclave is reliable only if the articles to be sterilised are exposed to a sufficiently *high temperature* and sufficient *moisture* for a long enough *time*. It is therefore necessary that steam shall penetrate through all the material in the steriliser. To ensure that this happens, the air originally in the steriliser must be driven out, either by washing it out with a current of steam, or by sucking it out with

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a vacuum pump. (Some autoclaves are fitted with a vacuum pump, others are not; each pattern requires its own treatment).

For the same reason, all dressings must be loosely packed, and the drums or bags which contain them correctly designed. All towels, gowns, etc., must be *dry* at the time of packing.

AUTOClave TEMPERATURES IN DEGREES CENTRIGRADE WITH VARIOUS DEGREES OF AIR DISCHARGE AND VARIOUS GAUGE PRESSURES

Gauge Pressure in Pounds	Amount of air discharged before closing the steam outlet tap				
	All (pure steam)	$\frac{2}{3}$ (20 in. vacuum)	$\frac{1}{2}$ (15 in. vacuum)	$\frac{1}{3}$ (10 in. vacuum)	None
	°C.	°C.	°C.	°C.	°C.
5	109	100	94	90	72
10	115	109	105	100	90
15	121	115	112	109	100
20	126	121	118	115	109
25	130	126	124	121	115
30	135	130	128	126	121

Table adapted from W. B. Underwood: *Textbook of Sterilisation* (see Appendix D).

Precautions to be taken in packing.

1. *Metal containers.* As previously indicated (p. 9), it is preferable that the dressings for each wound should be individually packed and wrapped in paper before sterilisation. The contents of the packets must not be tightly compressed, and the packets themselves must be loosely packed in the metal drums, in such a way that all the dressing materials can be completely and easily permeated by the steam. Gowns and towels and all other fabrics must likewise be packed loosely. Cotton wool in any quantity should be unrolled and packed in loose layers. Waterproof sheeting must be inter-layered with towels and rolled, rather than folded, or folded as little as possible.
2. *Bags.* Bags of the standard Emergency Medical Service pattern may be used when metal containers are not available. Dressing packets should be packed loose in the bag in such a way that it does not bulge, and the bags themselves must be loosely stacked in the autoclave, and not compressed.
3. *Rubber gloves.* Rubber gloves require special treatment, both as regards packing and sterilisation. The gloves, having been cleaned by washing with soap and water and then with distilled water, should be packed flat with a layer of gauze between them, and then placed loosely in the container. If gloves are sterilised at 125° C., they become vulcanised; they must not, therefore be sterilised with ordinary dressings, but separately at 105–110° C. (5–10 lbs. steam pressure) (see Table) for 10 to 15 minutes.

Removal of goods from the autoclave after sterilisation.

Cleanliness must be maintained in handling dressing containers, etc., when they are taken from the autoclave, as contamination may easily take place through improperly closed steam vents. The operator should always wear a clean overall and a mask.

Instructions for the use of the Autoclave.

Efficient removal of air is essential for proper sterilisation.

(a) Gas or electrically heated autoclave; without vacuum attachment.

1. See that there is sufficient water in the bottom of the autoclave before lighting the gas or turning on the electric current.
2. Open the vents of the dressing containers and place the latter in the autoclave.
3. Close the lid of the autoclave and screw it down firmly and evenly, leaving the steam outlet tap open.
4. Allow steam to escape from the outlet tap in a steady jet until all the air has been expelled. If air is left in the autoclave, a given pressure of steam does not develop its full temperature. To determine when all air has escaped, attach a long rubber tube to the outlet tap, allowing the other end of the tube to dip into a bucket of cold water. At first, when steam and air are escaping together, bubbles rise to the surface of the water in the bucket. When all air has been expelled, bubbles no longer rise to the surface, for the steam condenses immediately in the cold water. Note the time taken for this stage to be reached, and add five minutes, to obtain the time during which a steady flow of steam should be allowed to escape before the outlet tap is closed. Once this time has been determined for any given autoclave, it is not necessary to use the rubber tube and cold water bucket test each time the autoclave is run.
5. Close the steam outlet tap and allow the pressure to rise on the gauge to the desired figure (15-20 lbs. per sq. in. = 120-125° C.), and maintain for 20 minutes.
6. When sterilisation is complete, allow the autoclave to cool down to zero pressure before opening the steam outlet tap. Unscrew the lid and remove containers, etc., and close their steam vents.

(b) Autoclave with laid-on steam; with vacuum attachment.

1. Open the vents in the dressing containers and place them in the autoclave. Linen bags of dressings should be placed on trays or stacked vertically.
2. Close the autoclave completely. Evacuate the steriliser to a negative pressure of 15-20 in. of mercury and maintain for five minutes, to remove air from the steriliser and from the packets within it.
3. Close the vacuum valve and turn on the steam until the pressure gauge reads 20 lbs. pressure. Adjust the steam inlet valve and maintain this pressure for 20 minutes. This gives a temperature of 118°-120° C.
4. At the end of this period close the steam inlet valve, open the vacuum valve and re-evacuate the autoclave to a negative pressure of 15 ins. for 15 minutes. The purpose of this is to dry the dressings and towels.
5. When the autoclave has cooled down sufficiently it may be opened, the containers removed and their steam vents closed.

Recording and periodic testing.

Where the sterilising apparatus is fitted with an automatic pressure recording device, examine the record and, if it is satisfactory, release the dressings for use in the wards.

Where the sterilising apparatus is not fitted with an automatic pressure recording device, the duration and amount of pressure attained should be noted in a special book and, with the vacuum autoclave, the negative pressure (see above) should be recorded also. The date and serial number of each batch of sterilised containers should be marked on the tins, drums and bags. It is advisable that the whole routine of autoclaving should be under the supervision of a pathologist, who should carry out monthly bacteriological tests. Colour indicators are not reliable tests of the efficiency of an autoclave.

STERILISATION OF SYRINGES

Many of the methods commonly employed for sterilising syringes are not trustworthy, and have on occasions given rise to serious trouble. It is advisable to set aside different syringes for injections and for aspirations.

Syringes and needles cannot be sterilised with certainty by immersion, even for long periods, in spirit or other antiseptic solution: heat provides the only safe means. Syringes may be sterilised by (1) boiling water, (2) steam under pressure, (3) dry heat, or (4) hot oil.

1. Boiling in water provides the quickest and simplest method. When not in use, the syringe is put away dry and clean. To sterilise it, place the separate parts and the needle in cold water in a small steriliser, and bring to the boil. Continue the boiling for two minutes. Remove the parts of the syringe from the boiling water with instrument forceps, shake off excess water, and assemble *as soon as the parts have cooled sufficiently to allow the plunger to fit the barrel*. A few in-and-out movements of the plunger will dry the syringe and attached needle. The sterilised syringe and needle should be dished up in a covered dish.

(Some "all-glass" syringes can be assembled before they are boiled; others, and all metal-and-glass (record type) syringes, are liable to break unless the plungers are boiled separately, or if the syringe is placed directly into boiling water.)

2. Syringes can be autoclaved. If *quite* clean, "all-glass" syringes may be assembled before autoclaving; some syringes, however, and particularly those made of metal and glass, are liable to crack unless the parts are autoclaved separately.
3. In hospitals provided with a hot-air sterilising oven, all-glass syringes are most conveniently dry sterilised by baking. The clean syringe is assembled, together with its needle, and placed in a large test tube. A small piece of glass tubing resting on cotton wool protects the needle and allows the syringe to be removed from its tin without contamination of the needle. A temperature of 145°C . for *at least* one hour is needed. Several syringes can be sterilised together in a tin.

This method is not suitable for syringes made of both metal and glass, which may break or develop defects in their cement.

4. Sterilisation of syringes and needles with hot oil.

The hot oil method of sterilising syringes and needles has the advantages that time is saved, syringes are seldom broken in the process, and needles retain their sharp cutting edges and do not rust; the needles also penetrate the skin more easily when they are oily.

The apparatus necessary consists of a metal cup holding 2-3 oz., held fixed on a rigid stand above a small adjustable gas flame; a thermometer reading to 200°C . clamped to the stand and dipping into the oil (liquid paraffin or olive oil) in the cup. Convenient oil sterilising baths, heated by either gas or electricity, are on the market, but in the absence of these the apparatus can be readily improvised.

To sterilise a record type syringe for use the needle is taken off and oil at a temperature between 120°C . and 130°C . is rapidly drawn into the syringe. When the plunger is drawn up to the full extent the syringe should be removed from the oil and inverted, so that the hot oil reaches every part of the inside of the syringe. The oil is then expelled, and the process repeated two or three times. Then the needle is affixed, wholly immersed in the oil, and oil is drawn in and out a few times. The syringe is now ready for use. The whole process is complete in 30 seconds or less. When sterilised the syringe can be kept ready for use by wrapping the needle in a small piece of sterile lint.

Care is necessary in adjusting the gas flame so that the temperature does not exceed 160°C ., otherwise there is an unpleasant smell of burning oil. After some weeks the oil becomes seriously discoloured, and it should then be

renewed. This method differs from the other methods of sterilisation in that only the needle and the *inside* of the syringe are sterilised.

To sterilise needles alone, the cleaned needle is held in the oil for half to one minute. It is then removed with forceps and fixed to the syringe or stored in a suitable container. By this procedure an ordinary steel needle may be in daily use for months, with occasional sharpenings on a needle stone.

Unless strict attention is paid to the instructions given for the hot oil method of sterilisation, the temperature of the oil may not be high enough to sterilise, or it may rise so high that the oil catches fire. The method therefore requires particular care.

APPENDIX C

DISINFECTANT SOLUTIONS: STRENGTHS AND USES FOR SPECIAL PURPOSES

Lysol: a solution of cresol in soap. Useful for disinfecting greasy surfaces because it is soapy. It is generally irritating to the skin, and care should therefore be taken in its use.

It can be used as follows:—

<i>Use</i>	<i>Dilution and Time.</i>	<i>Remarks.</i>
Baths Arm baths } Bowls } Only if they can- Bins } not be boiled. Dishes }	Undiluted; for at least one minute (2 oz. required for bath, 1 oz. for arm bath).	Rub thoroughly over the surface of <i>baths</i> and other containers, using a mop or rag in a <i>gloved hand</i> . Wash well with sterile or tap water afterwards.
Rubber draw sheets and waterproof sheets, if boiling or autoclaving is impossible. ..	$\frac{1}{2}$ oz. to 1 pint of water.	Sponge over with rag soaked in this solution. Rinse thoroughly with tap water afterwards.
Fabrics (which may not be boiled).	$\frac{1}{2}$ oz. to 1 pint of water, for at least 1 hour; $\frac{1}{2}$ oz. to 2 pints for soaking overnight.	
Swabbing down trolleys and tables.	1 oz. to 1 pint of water.	
Jars for instrument forceps. ..	$\frac{1}{2}$ oz. to 1 pint of water.	

Phenol antiseptics. The commercial disinfectants made from phenols, which have higher phenol coefficients than cresols like lysol, are of two main types—*Black fluids*, such as Jeyes' Fluid,* and *White fluids*, such as Izal.† These may be

* The British Disinfectant Manufacturers' Association state that the following other British proprietary disinfectants are of this type: Antifect; Bactocene; Coetas; Disolite; Exenol Superior; Hycol; Hygenol Fluid Disinfectant; Ialine Special; Kilcrobe 10/12 Black; Killgerm 10/12 Black; Lawes; Metro; Monsanto Black Disinfectant No. 4; Sanitas-Bactox; Septol; Special Creitas; Cooper's Standard Fluid; Vitalin No. 99.

† The British Disinfectant Manufacturers' Association state that the following other British proprietary disinfectants are of this type: Baxol X; Betazone No. 1; Exenol D.A. White; Ialine No. 8; Jeyes' White Cyllin; Kilcrobe 18/20 White; Killgerm 18/20 White; Lawes L.W.4; Monsanto White Disinfectant Fluid No. 1; Sanitas-okol; Sal-Hycol; Star White; Sterilite; Superlin White; White Bactocene; White Kerol; White Septol; Wright's Vetersol; Voxsan M.A.F. Disinfectant Fluid.

used for large-scale disinfection, as for disinfecting or deodorising drains, sinks and floors.

<i>Use</i>			<i>Dilution and Time</i>	<i>Remarks</i>
Sinks	..	..	Traps and sluices can be "kept sweet" by flushing with hot water containing soda, 1 oz. to 1 quart, last thing at night. Disinfectant, e.g. 1 oz. of Jeyes' Fluid or equivalent to 1 pail of soapy water, may be left in them overnight, or for at least an hour, as a deodorant.	
Drains	..	..
Fabrics	..	..	$\frac{1}{2}$ oz. to 1 pail of water for soaking overnight.	The fabrics will smell strongly.
Floors ..	..	..	As a deodorant with very mild antiseptic action, Jeyes' Fluid or equivalent, $\frac{1}{2}$ oz. to 1 pail of soapy water. For local pollution, swab with lysol or Jeyes' Fluid or Izal or equivalents (2 to 4 oz. to 1 pint).	

Chloroxylenol solutions.

Liquor antisepticus N.F. and the proprietary preparations Dettol, Kilsol, O-syl, Peractum, Perkol, Superlin N.P. fluid, Supersan, Streph, Zant and Zenol are examples of chloroxylenol solutions.

These preparations are weaker than lysol but are said to be non-irritant to most skins. They are more expensive than cresol and phenol disinfectants, and should be used only for special purposes for which the more irritant disinfectants would be unsuitable.

<i>Use</i>			<i>Dilution and Time</i>	<i>Remarks</i>
Skin	..	..	Undiluted; for at least 2 minutes.	Hands washed in soapy water. Small quantities of solution well rubbed in. Dry the hands on a sterile towel.
Rubber gloves on hands in an emergency	..	..	Undiluted; for at least 2 minutes	Wash in soapy water and then as above.
Skin disinfection around a wound	..	..	1 oz. <i>Liquor antisepticus</i> N.F. to 5 oz. of water.	

To be safe, a disinfectant must be used for sufficient time and at an adequate concentration. Times and concentrations needed are different for different proprietary preparations, and are commonly not marked on the bottles in which hospital dispensaries issue disinfectants for use in the wards. It is therefore most important that a list of times, strengths and uses of the disinfectants which will be available in a ward should be posted up in a prominent place in the ward itself and in the sterilising room and bathroom. Such a list should be compiled, or checked, by the hospital bacteriologist.

APPENDIX D

REFERENCES

In selecting the small number of references given below, no attempt has been made to present a complete bibliography of the subject; several important publications have undoubtedly been omitted.

The intention has been to provide a guide to a few of the more recent and more readily available papers on subjects dealt with in this memorandum, paying special attention to those which contain helpful practical instructions.

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