

A METHOD OF DISINFECTING ANAESTHETIC EQUIPMENT

BY

M. E. H. BARROW AND M. J. MEYNELL
United Birmingham Hospitals, England

SUMMARY

Attention is drawn to the degree of contamination of anaesthetic equipment and the responsibility resting upon anaesthetists for disinfecting all apparatus between cases. Possible methods of disinfection are briefly reviewed. Reasons of efficiency, convenience, cost and practicability are given for suggesting that a domestic washing-up machine is the best form of disinfection so far devised.

Although Ziegler and Jacoby (1956) suggested that corrugated tubing and reservoir bags may not be significantly contaminated with bacteria by patients, anaesthetists have become increasingly aware of the existence and dangers of such contamination of the equipment they use. The role played by this vehicle in postoperative infection has not yet been ascertained but it is now well known that ventilators used in intensive care can be responsible for both re-infection and cross-infection. An editorial on this matter (1964) leaves the reader in no doubt that the risk is real and that the anaesthetist must make it his duty to ensure that cross-infection will not occur. The editorial goes so far as to suggest that the same standards should be applied to the work of the anaesthetist as to that of the surgeon.

Our interest in this problem was sharply stimulated by two recent outbreaks of post-operative chest infection which followed the opening of theatre suites. Before the introduction of the method of disinfection herein described, only the endotracheal tubes, connections and the pharyngeal airways received attention. These were thoroughly washed by hand, autoclaved and packaged. Laryngoscopes were washed under the tap by the theatre attendant.

Under these circumstances bacteriological investigation showed that parts of the anaesthetic equipment yielded profuse growths of *Staph. aureus*, *Strep. faecalis*, *Esch. coli*, *Klebsiella aerogenes*, as well as *Ps. pyocyanea* and *Prot. vulgaris*.

The accepted methods of disinfection were considered, namely high and low temperature

autoclaving, boiling, steeping in antiseptic, e.g. chlorhexidine (Stratford, Clark and Dixon, 1964), and hand washing in soap and water. All were rejected, for various reasons given below, in favour of some automatic device which would both wash and pasteurize.

METHOD OF DISINFECTION

The baskets of a Swan Maid domestic washing-up machine were modified to accept anaesthetic equipment in such a way as to be most advantageous for the washing action of this machine.

The equipment is arranged suitably as shown in figure 1. All the apparatus is dismantled as far as possible, i.e. the expiratory valve, corrugated tubing, bag mount and bag are separated into the component parts. All parts must have their openings pointing downwards, bags must be hung up and corrugated tubing looped over the top rack and the ends impaled on the spikes of the bottom rack. Metal parts, catheter mounts, etc., are impaled on suitable vertical spikes in the bottom rack. Laryngoscope blades are stood in the tray resting in the front of the bottom rack.

The machine is then put through its normal cycle, the thermostat having been originally set as high as is allowed by the adjustment lever. The detergent agent, Hygleam C (recommended by the manufacturers for use in their machine for dish-washing) is added in the recommended way and quantity before closing the machine and so starting the cycle.

Figure 2 shows the temperature recorded by a thermocouple during a complete cycle. In one case the thermocouple was placed at the lower

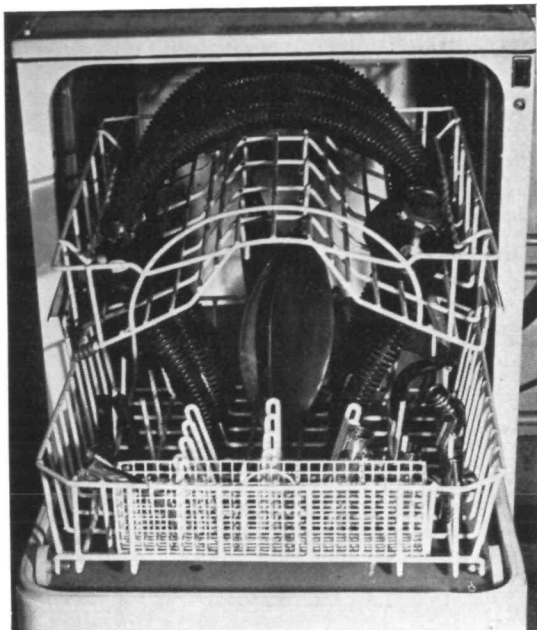


FIG. 1

Anaesthetic equipment positioned ready for disinfection.

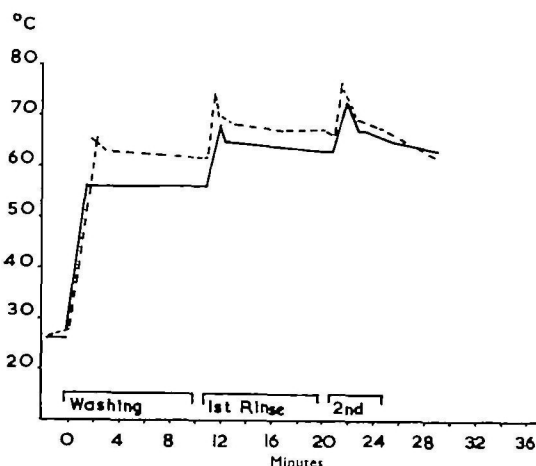


FIG. 2

Temperature within anaesthetic equipment during disinfection in the Swan Maid washing-up machine.

- Thermocouple inside a corrugated hose half-way along it at the apex of the curve.
 - - - Thermocouple at the lower end of a catheter mount.

end of a catheter mount held vertical on a spike in the lower tray. In the other, the thermocouple lay half-way along the inside of a standard length of corrugated hose. This part of the tubing, as packed, lies at the top of the machine in the middle.

When unloaded the equipment is quite dry, macroscopically clean and all metal parts bright.

BACTERIOLOGICAL STUDIES OF THE ACTION OF THE "SWAN MAID" MACHINE

Corrugated hose was heavily contaminated with 24-hour broth cultures of *Staph. aureus*, *Esch. coli*, *Proteus vulgaris*, *Ps. pyocyanea* and *Strep. faecalis*, and then processed in the machine. At the completion of the cycle the tubing was removed and washed with sterile nutrient broth, and these washings cultured. No growth was obtained after 24 and 48 hours incubation at 37°C.

This procedure was repeated with a mixture of sputum specimens and cultures of the above organisms. The tubing was left lying on the laboratory bench for 2 hours before being processed in the machine. Again washings with nutrient broth were sterile after incubation for 48 hours.

Facepieces, connectors and laryngoscope blades were investigated in a similar manner. After thorough preliminary contamination with cultures, they were processed in the machine. Again washings were sterile in all instances.

No extensive studies were made with heat-resistant organisms such as spore bearers or viruses. In one preliminary study, however, using *B. subtilis*, a growth was obtained only from the corrugated tubing, and none from metal parts, catheter mount or reservoir bag.

DISCUSSION

Stark, Green and Pask (1962), although advising that all equipment coming into direct contact with the patient should be sterilized, do not consider the risk of infection from the remainder of equipment likely. They suggest that to keep separate apparatus for known infected patients is adequate. Stratford, Clark and Dixson (1964), on the other hand, disagree with this view. They rightly regard the hazard of cross-infection

as existing even in patients apparently free from upper respiratory infection. They conclude that this hazard must be removed.

It is the duty of every anaesthetist to make sure that the equipment used is as free as possible of pathogenic bacteria. To be completely sterile is impracticable for two reasons, these being cost and the very nature of the manoeuvres required during general anaesthesia.

The ideal method of disinfection is by sterilization in an autoclave. To avoid the rapid deterioration of all equipment not made of metal, the autoclave must be a low temperature model. Such a machine is costly, and would have to be used by all theatres in the hospital. This would dictate an enormous stock of equipment, and also large and costly containers (probably disposable envelopes).

Jenkins and Edgar (1964) suggested a much cheaper method, one of pasteurization as was suggested for cystoscopes by Francis (1959). This method is quite impractical for several reasons. First, there is no mechanical washing to remove collections of saliva, pus, etc. Second, air pocketing is nearly impossible to overcome in tubing, and boiling will not disinfect tubing if air pocketing occurs (Meynell, unpublished observation, 1965). Third, much of the equipment after such treatment is wet. Corrugated tubing and reservoir bags are almost impossible to dry. It would be only too easy, when using a facepiece during induction of anaesthesia, inadvertently to pour water on the patient's face.

Stratford, Clark and Dixon (1964) make the economical suggestion of immersing all equipment in 0.1 per cent chlorhexidine for 20 minutes. They show that this gives a reasonable degree of disinfection. However, once again all apparatus is taken out soaking with solution. Further, all apparatus would have to be mechanically washed before immersion, as it would before pasteurization.

The nature of the Swan Maid washing-up machine overcomes these various disadvantages. It is economical at £120 when one machine will serve twin theatres. The equipment gets a thorough mechanical wash in a detergent solution. It is heated three times in such a manner as to kill all but sporing organisms and, presumably, some viruses.

The rather surprising degree of disinfection obtained may in part be attributable to the detergent. Hygleam C (Swan Brand name of Bulpitt & Sons adopted for Freedom made by Procter & Gamble Ltd.) at 1 oz. (manufacturers' recommended quantity) in 1½ gallons of water, which is the capacity of the tank, provides, theoretically, 33 p.p.m. of available chlorine. Pirie and colleagues (1965) showed that, in alkaline solution without chlorine, *Esch. coli* was killed in 2 minutes and coagulase positive *Staph. aureus* in 30 minutes at a temperature of 52°C. But when 20 p.p.m. of chlorine (actual amount) was available both organisms were killed in 15 seconds at the same temperature. During the washing part of the cycle of the Swan Maid machine the temperature ranges between 55° and 65°C, and the available chlorine is 33 p.p.m. (theoretical value).

Provided the equipment is left inside the closed machine for 20 minutes after the end of the cycle, even the corrugated tubing is taken out quite dry—the whole process taking 45 minutes. If taken out immediately, the equipment is wet, but not soaking, and so is usable in 25 minutes. Therefore no large stock of equipment is required, and since the machine is sited in the theatre suite, no costly packaging is necessary.

Endotracheal tubes have been processed in this way before autoclaving in packages for storing.

It is not claimed that the Swan Maid machine will guarantee absolute sterility; rather that it will kill those pathogenic bacteria with which anaesthetic equipment is likely to become contaminated. It is felt very strongly that this machine provides an economic and easy method of securing an acceptable degree of disinfection, a degree of disinfection which it is our duty to provide each time after equipment is used.

The Swan Maid washing-up machine is made by Bulpitt & Son of Birmingham. Any Swan Maid agent can obtain from them baskets modified and re-dipped for use with anaesthetic equipment.

ACKNOWLEDGEMENTS

We are most grateful to Miss J. Tilley, the Theatre Superintendent of the General Hospital, Birmingham, and to Messrs. Bulpitt & Son and Procter & Gamble Ltd. for their co-operation.

REFERENCES

- Editorial (1964). Cross-infection during anaesthesia. *Brit. J. Anaesth.*, **36**, 465.
- Francis, A. E. (1959). Disinfection of cystoscopes by pasteurization. *Proc. roy. Soc. Med.*, **52**, 998.
- Jenkins, J. R. E., and Edgar, W. E. (1964). Sterilisation of anaesthetic equipment. *Anaesthesia*, **19**, 177.
- Pirie, D. G., Chater, C. W., Wescott, C. E. A., and Telford, E. (1965). The testing and performance of detergent-sterilisers under operating conditions in the catering industry. *Chemistry and Industry*, p. 1676.
- Stark, D. C. C., Green, G. A., and Pask, E. A. (1962). Anaesthetic machines and cross infection. *Anaesthesia*, **17**, 12.
- Stratford, B. C., Clark, R. R., and Dixon, Shirley. (1964). The disinfection of anaesthetic apparatus. *Brit. J. Anaesth.*, **36**, 471.
- Ziegler, C., and Jacoby, J. (1956). Anesthetic equipment as a source of infection. *Curr. Res. Anaesth.*, **35**, 451.

UNE METHODE POUR DESINFECTER LES APPAREILS D'ANESTHESIE

SOMMAIRE

On attire l'attention sur le degré de contamination des appareils d'anesthésie et sur la responsabilité qui incombe aux anesthésistes pour désinfecter tout le dispositif entre les malades. On passe en revue brièvement les méthodes possibles de désinfection. On donne les raisons d'efficacité, de commodité, de coût et de caractère pratique pour suggérer qu'une machine à laver domestique est la meilleure forme de désinfection imaginée jusqu'ici.

EIN VERFAHREN FÜR DIE DESINFEKTION VON NARKOSEGERÄTSCHAFTEN

ZUSAMMENFASSUNG

Es wird auf den Grad der bakteriellen Verseuchung von Narkosegerätschaften und die Verantwortung des Anästhesisten für eine Desinfektion aller Geräte zwischen zwei Narkosefällen hingewiesen. Mögliche Desinfektionsmethoden werden kurz besprochen. Aus Gründen der Wirksamkeit, der leichten Handhabung, der Kosten und der Brauchbarkeit wird eine im Haushalt übliche Geschirrspülmaschine als die soweit beste Desinfektionsmethode empfohlen.

BOOK REVIEW

Parenterale Ernährung (Parenteral Nutrition). Edited by K. Lang, R. Frey and M. Halmágyi. Anaesthesiology and Resuscitation, No. 6. Published by Springer Verlag, Berlin, 1966. Pp. x+156; tables and figs. Price: DM.19.60.

This report of a symposium on parenteral nutrition, held at the Johannes Gutenberg University, Mainz, in October 1964, is divided into two parts. The first six papers are concerned with theoretical considerations and experimental results of parenteral administration of amino-acids, carbohydrates and fats. For protein regeneration all contributors use Aminofusin (Pfrimmer), a mixture of various essential amino-acids which rarely causes anaphylactic reactions. Though amino-acid infusions can never entirely prevent a negative nitrogen balance postoperatively, they can reduce it, especially when combined with an anabolic preparation. Amino-acids should not be wasted to cover energy requirements as these ought to be provided by carbohydrates, alcohols and, if necessary, fat emulsions. Advantages and disadvantages of dextrose and laevulose in different diseases are discussed as well as the polyalcohols sorbit and xylit. The latter, an intermediate link in glucose metabolism, is well tolerated even by diabetics, its utilization depending on age and not on any underlying disease. Experiments in dogs with fat emulsions produced from soya beans (Intralipid) gave better results than cottonseed oil derivatives. Toxic side effects after fat infusions occur in man either almost immediately or only very much later, after 20 bottles or more, as an "overloading syndrome". Therefore, no more than 14 bottles ought to be given.

Fourteen clinical papers deal with parenteral nutrition in various fields of surgery, including reports on balanced therapy over many weeks, up to 90 days in the only paper given in English. For energy supply a sugar:fat ratio of 3:1 in grammes is recommended. Fat emulsions may cause haemoglobin reduction and serum bilirubin increase. If amino-acids are used more potassium than contained in the standard solutions ought to be given, and for infants histidin ought to be added to Aminofusin. In several institutes mixed parenteral nutrition is given during the pre-operative period.

One author prefers enteral to parenteral nutrition, either by stomach tube or by gastrotomy (Witzel fistula), as the digestive juices can then act and overloading of the circulation is avoided.

Of special interest are observations in gynaecology and obstetrics. Differences in utilization and excretion of various amino-acids in pregnant and non-pregnant women have been investigated. Fat emulsions given during labour hardly raise the total lipids in the baby and are not deposited in the placenta. An unexpected side effect of fat infusions is an increase of uterine motility which has been utilized to produce abortion in cases of planned interruption of pregnancy and to induce labour in post-maturity cases. One suggested explanation is the stimulating action of unsaturated fatty acids on all smooth muscle.

References are given with most papers but discussions have not been included. Much useful information can be found in this volume which is as well produced as the previous numbers of this series.

Luise Wislicki