

## The cleaning and disinfection by heat of bedpans in automatic and semi-automatic machines

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### SUMMARY

This work is concerned with the cleaning and disinfection by heat of stainless-steel and polypropylene bedpans, which had been soiled with either a biological contaminant, human serum albumin (HSA) labelled with technetium-99m <sup>99m</sup>(Tc), or a bacteriological contaminant, streptococcus faecalis mixed with Tc-labelled HSA. Results of cleaning and disinfection achieved with a Test Machine and those achieved by procedures adopted in eight different wards of a general hospital are reported. Bedpan washers installed in wards were found to be less efficient than the Test Machine, at least partly because of inadequate maintenance. Stainless-steel and polypropylene bedpans gave essentially the same results.

### INTRODUCTION

Systematic investigations into the cleaning – that is to say the physical removal of biological soil – of appliances such as bedpans do not appear to have been reported previously. Yet the sterilization of surgical instruments and appliances of all kinds is an obvious necessity and was stressed as long ago as 1958 (Survey by Nuffield Provincial Hospitals Trust, 1958), while Darmady, Hughes, Jones & Verdon (1959), Darmady *et al.* (1961) and Gibson (1974) emphasised the importance of initial cleaning as a prerequisite to disinfection of bedpans. Failure to achieve good disinfection has been attributed, to some extent, to faecal material still adhering to the bedpans after inadequate washing; the effect of the steam treatment during disinfection is to make this material even more strongly adherent. Even after a period of 5 min. at 100 °C. the material is still a source of surviving organisms.

The present investigation is concerned mainly with measurements of the cleaning of bedpans soiled with a biological contaminant, namely human serum albumin labelled with technetium-99m (HSA-Tc). The technique was essentially the comparison of the radioactivity associated with the pans before and after a cleaning process. In other experiments, the soil was a mixture of HSA-Tc and *Strep. faecalis*; assessment of disinfection could then be correlated with cleaning efficiency on the same test-piece. The mass of soil used in these tests was quite small – much less than the normal faecal content of a used pan. The tests therefore measure the removal of surface soil and may therefore be more significant, as well as more objective, than impressions gained from visual inspection of contamination left

after the removal of gross soil. Two series of experiments were carried out: (a) on a new automatic bedpan washing machine, which we refer to as the Test Machine, (b) on machines which have already been in use for some time in eight different wards in a general hospital. As a result of a survey carried out on the wards, we are able to comment on the problems of machine maintenance and the attitudes of ward staff.

#### MATERIALS AND METHODS

##### *Soiling materials and application to bedpans*

HSA-Tc was chosen as the biological soil for several reasons: its chemical similarity to the proteins in faeces would make for similar behaviour towards cleaning agents and high temperatures; the chemical bond between the HSA molecule and the label is known to be fairly stable; the radiation characteristics of technetium-99m are particularly convenient (Mostafa & Chackett, 1975). Soiling with this material was carried out by depositing 3–4 mg. of the compound as a suspension in saline inside the pan and spreading it all over the inner surface with a cotton-wool swab. The pH of the suspension was adjusted to 7.5, or between 1 and 3, in different trials. The activity used was between 250 and 350  $\mu\text{Ci}$  for each pan.

The bacteriological soil was prepared by incubating a loopful of *Strep. faecalis* (K.R.) in a nutrient broth (Oxoid No. 2) at 37° C. for 18 h. and then mixing with HSA-Tc to give approximately  $10^5$  organisms/ml. The pH was controlled at 7.5. After standing for 5 min. at room temperature, 2 ml. samples of the mixture were used to soil the pans as before.

##### *Bedpan washing and disinfectant machines*

A washing/disinfectant machine (Type BS 55SG) was supplied on loan from Messrs Dent and Hellyer Ltd to the Hospital Infection Research Laboratory at Summerfield Hospital, Birmingham. It cleans one bedpan at a time and uses an automatic cleaning cycle of 2.5 min. (20 sec. cold water rinse, 15 sec. hot water rinse, and 115 sec. steam supply for disinfection). A main rinsing jet is applied in an oscillatory manner towards the inner base of the bedpan so that the under-rim and inner sides receive flowing water rather than the direct thrust of the jet. Two other jets are directed at an acute angle towards the top of the pan. The machine has to be supplied with mains hot and cold water and has a steam generator which is fed from the hot water main through a storage tank. A green indicator lamp on the control panel shows whether a cycle has been 'successful', i.e. whether the temperature recorded by an internal probe in the washing chamber has exceeded 80° C.

In some preliminary experiments we tested the machine itself by attaching thermocouples to various sites on both stainless-steel and polypropylene bedpans and recording maximum temperatures attained during steam cycles. These tests were repeated under conditions which simulated failure of the hot water supply, by connecting cold water mains to the hot water inlet.

Of the machines tested in the hospital wards, those in Wards I to V were manufactured by Messrs Dent and Hellyer but most had been in use for a long time.

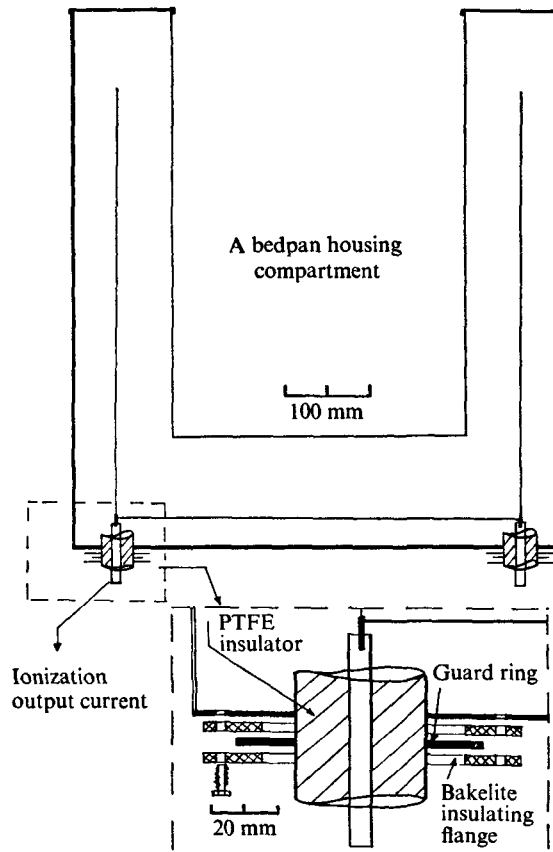


Fig. 1. Design of a re-entrant ionization chamber for assessing radio-activity on a bedpan.

Those in Wards I and II were effectively only washers as they had no steam cycle, and they differed from the others also in having a hot water rinse before the cold water rinse instead of afterwards. Ward III had two disinfectors which utilized the hospital steam supply; Wards IV and V had machines similar in design to the Test Machine. Wards VI and VII had semi-automatic machines of an old pattern made by Messrs Sumerling Ltd; these had a cold water flush followed by a hot water rinse which operated for as long as a control button was kept pressed.

All the above machines were tested with the biological soil. Ward VIII had a Dent and Hellyer machine; both this and the Test Machine were given trials with the bacteriological soil.

#### *Radioactive technique*

Immediately after soiling, and again after the cleaning process, the technetium activity on a pan was assessed by placing it in a large re-entrant ionization chamber of our own design (Fig. 1). The output current from the chamber was fed to a d.c. amplifier (NE type 503 B-1). With this system the lower limit of detection was about  $3 \mu\text{Ci}$ . The activity remaining after cleaning was expressed as a percentage of the initial soil activity after correction for radioactive decay.

Table 1. *Mean temperatures (°C.) at various sites of stainless steel and polypropylene bedpans in the Test Machine*

	Type of bedpan (p = polypropylene, s = stainless steel)	Sites			Green light
		Base	Side of bedpan	Under the rim	
Machine connected to cold and hot water supply	s	88.0 (66)	80.9 (29)	84.0 (59)	On
	p	88.3 (11)	77.3 (10)	82.7 (10)	On
Hot water supply replaced by cold water supply	s	74.0 (25)	65.2 (21)	70.1 (19)	Off
	p	75.6 (15)	59.3 (15)	63.9 (15)	Off

Figures in parentheses indicate the number of observations.

'Green light on' refers to the cycles in which machine's own probe recorded a temperature of at least 80° C.

'Green light off' to those cycles where the temperature failed to reach 80° C.

#### *Bacteriological technique*

Two general methods were used. In the first, sampling areas of about 50 cm.<sup>2</sup> were swabbed using moist cotton wool immediately before and after the cleaning cycle. The organisms recovered were cultured on nutrient agar (Oxoid No. 2) containing 10% horse blood, and incubated for 18 h. This method is known to be rather insensitive and in other trials the inside of each bedpan was rinsed out with 100 ml. of Tween 80 broth, of which 50 ml. samples were then filtered through 0.45  $\mu$ m. membrane filters. The filters from rinses of cleaned bedpans and of unwashed controls were transferred to blood agar plates and incubated for 48 hr., after which the surviving organisms were counted.

#### *Survey of the ward facilities*

During the investigation the opportunity was taken to invite comments from ward staff about the bedpan washing facilities provided as regards performance and maintenance. A total of 36 wards were included in the survey, with a total of 47 machines in use.

### RESULTS

#### *Temperature measurements on the Test Machine*

The maximum temperatures recorded at different sites on stainless-steel and polypropylene bedpans during steam cycles in the Test Machine are shown in Table 1. The upper half of the table gives results obtained when the machine was properly connected to hot and cold water supplies and the lower half for when the hot water was replaced by cold water. With the correct temperature of water supplies the performance was satisfactory, only the inner side of polypropylene pans just failing to attain 80° C. However when run on only one cold water supply the maximum temperatures were generally well below 80° C., and this failure was

Table 2. *Cleaning and disinfection of bedpans in the Test Machine*

	Type of bedpan (p = polypropylene, s = stainless steel)	Type of soil	pH-value of the soil	Average HSA-Tc contamination (% $\pm$ s.d.)	Total no. of organisms recovered after cleaning
With steam	s (10)	HSA-Tc	1-3	8.3 $\pm$ 1.4	—
	s (10)	HSA-Tc	7.5	4.0 $\pm$ 0.8	—
	p (10)	HSA-Tc	7.5	4.8 $\pm$ 1.6	—
	s (10)	HSA-Tc + <i>Strep. faecalis</i>	1-3	26 $\pm$ 5.8	0
	s (10)	HSA-Tc + <i>Strep. faecalis</i>	7.5	2.3 $\pm$ 0.7	0
	p (10)	HSA-Tc + <i>Strep. faecalis</i>	7.5	Not detected	0*
	s (4)	HSA-Tc + <i>Strep. faecalis</i>	7.5	2.4 $\pm$ 0.2	300-500
	Without steam	p (4)	HSA-Tc + <i>Strep. faecalis</i>	7.5	Not detected

Figures in parentheses indicate the number of bedpans tested.

\* Organisms recovered in broth only in two cases from under the rim.

correctly shown by the indicator lamp not illuminating. It may also be noted that the maximum temperature attained by polypropylene pans at any site is never greater than that for stainless-steel pans; this effect is presumably because of differences in their thermal properties.

#### *Cleaning and disinfection of bedpans in Test Machine*

The results of these tests, carried out at pH values of 7.5 and 1-3, are shown in Table 2. The number of organisms recovered from each site is to be compared with an initial loading of between  $5 \times 10^3$  and  $10^4$ .

The worst figures for the biological decontamination are evidently associated with low pH values, showing that the effect of a low pH is to convert the soil into a more adherent form. The best decontamination occurred with the HSA/*Strep. faecalis* mixture on polypropylene pans and this seems to indicate some degree of interaction between the two soils. Disinfection of both types of pan is apparently satisfactory when the steam supply is operative but is clearly not so in its absence. The disinfection which is achieved in such cases is presumably due to the purely mechanical effect of soil removal by rinsing water.

#### *Cleaning of bedpans in ward machines.*

The results for cleaning in the ward machines are shown in Table 3. Three sets of figures are given for the machine in Ward I; the first results were so obviously out of line with those from the other wards that we repeated the trials after two successive attempts to improve machine performance by clearing blocked jets, etc. The improvements achieved are indicated by the smaller values in the second and third entries at the top of the last column.

Table 3. *Cleaning achieved in machines in 7 wards of a general hospital*

Wards	Cleaning cycle time (sec.)	Type of bedpan (p = polypropylene, s = stainless steel)	No. of bedpans tested	Contamination remaining (%)
I <sup>(a)</sup>	90	p	8; 4; 4	35.2 ± 3.9; 14.4 ± 1.4; 9.1 ± 1.2
		s	8; 4; 4	21.0 ± 4.4; 18.5 ± 5.1; 8.0 ± 1.1
II <sup>(a)</sup>	90	p	8	13.3 ± 3.7
		s	8	9.9 ± 3.3
III <sup>(a)</sup>	115	p	12	4.1 ± 1.3
		s	12	5.8 ± 1.1
IV <sup>(a)</sup>	105	p	6	5.6 ± 0.8
		s	6	6.6 ± 1.3
V <sup>(a)</sup>	90	p	12	11.8 ± 2.6
		s	12	10.0 ± 3.0
VI <sup>(b)</sup>	(manual) 60	p	8	19.0 ± 2.5
VII <sup>(b)</sup>	(manual) 60	s	8	21.8 ± 4.6

(a) Dent and Hellyer machines; (b) Sumerling machines.

In general the decontamination is worse than in the Test Machine, and in particular the Sumerling machines on Wards VI and VII compare very unfavourably. Their performance might of course be improved if they were operated for longer periods; in practice this would preferably mean conversion to a self-timing control.

#### *Disinfection of bedpans in machine on Ward VIII*

Nine bedpans of each kind were tested on this machine using the rinse technique to recover the organisms. Measurements on unwashed controls showed that the initial loading was about  $8 \times 10^7$  organisms per 1000 cm.<sup>2</sup> of bedpan surface. After treatment the stainless-steel pans showed an average of 8 organisms/1000 cm.<sup>2</sup> (range 0–22), and the polypropylene pans 13 organisms/1000 cm.<sup>2</sup> (range 0–21).

#### *Survey of ward machines*

The survey of a total of 36 wards revealed that staff on only 25 regarded their machines as satisfactory. The other 11 had complaints ranging from spillage of water to virtually complete breakdown. Many of the 18 Sumerling machines were regarded as 'obsolete' or 'useless', although three similar machines but with automatic start were said to be satisfactory and were regularly used. The Dent and Hellyer machines (6 with steam supply and 7 without) were regarded favourably. There were 13 'disposable' machines in the wards, which were not the subjects of our tests, and many of these were in poor condition and were not fully used.

## DISCUSSION

The results show that in general the use of longer cleaning cycles gives appreciably better cleaning, but the fact that the ward machines are less effective than the Test Machine suggests that the jets are less efficient, probably because of partial blocking by tissues, etc. The effect of unblocking the jets in the machine on Ward I is particularly evident. It seems that partial blocking of the jets on some machines can result in incomplete opening of a valve in the water supply, thus further impairing the washing effect.

The biological decontamination is better if the soil is applied at pH 7.5 than under acidic conditions. This implies that cleaning may be improved by the use of detergents which would raise the pH of the faecal material.

Disinfection is clearly very strongly a function of temperature; at present a temperature of 80° C. maintained for at least 30 sec. is a generally accepted condition for disinfection. The Test Machine does indeed meet these requirements. It is the present tendency however for hospitals to supply hot water at only 40° C. which might result in a slight reduction in the temperature reached by the bedpans. The standard of disinfection would then be somewhat poorer, although it might still be acceptable in certain wards (Ayliffe, Collins & Deverill, 1974). However, possible failure to reach a satisfactory temperature should not be overlooked and the use of the temperature-indicator is to be strongly recommended.

The recovery of organisms by the swabbing technique is known not to be very accurate (Favero *et al.* 1968), yet the percentage recovered (about 6%) in the tests in which the disinfection temperature was deliberately not achieved agree reasonably well with the data from the radioactive measurements. The swabbing method is evidently not sensitive enough when disinfection is good. The broth-rinsing technique examines the bedpans as a whole, as does the radioactive technique as at present used; the latter could in principle be developed to search for contamination on specific areas by using a scanning probe.

A general conclusion from all the tests is that there is not much to choose between stainless-steel and polypropylene bedpans as regards ease of cleaning, but that stainless-steel pans are more effectively disinfected, possibly because of better propagation of heat throughout the pan. It may be advisable to prolong the steam cycle when polypropylene pans are being disinfected.

## OBSERVATIONS AND COMMENTS

Our survey work prompts us to make the following comments; we feel that if proper attention is paid to them the cleaning and disinfection of bedpans could be distinctly improved.

(a) Nurses almost invariably prefer automatic machines to semi-automatic; even some of the old Sumerling machines fitted with autostart mechanisms were acceptable whereas the semi-automatic ones were dubbed 'obsolete' or 'useless'. But we noticed that with many machines a red indicator lamp lit up as soon as the control button was pressed and that many nurses were unaware that the cleaning cycle would not start unless the pressure was maintained for 5–10 sec. Thus it

often happened that the machine failed to start, with the result that a pan would remain unwashed for a long time – until the machine was required again – thereby making cleaning more difficult (Darmady *et al.* 1961).

(b) If the performance of a machine was judged unsatisfactory, nurses rarely tried it a second time, much preferring to wash the pan manually using a brush in a sink. They did not seek the cause of the failure, which may have been a failure to start, as discussed above, or a very obvious blockage of the jets by tissue etc. It seems to us regrettable that on many wards there is no member of the staff who feels competent to make any sort of inspection of the machines in the event of malfunction.

(c) The maintenance of most machines is far from adequate. In many wards, at least one machine was found to have a fault of some kind, such as a poor supply of hot water, spillage of water on the floor through a bad door-seal etc. Staff often noticed such faults but did not think it worthwhile to report anything short of complete breakdown to the hospital Maintenance Department. For their part, the Maintenance Department were in no position to provide regular maintenance.

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#### REFERENCES

- AYLIFFE, G. A. J., COLLINS, B. J. & DEVERILL, C. E. A. (1974). Tests of disinfection by heat in a bedpan washing machine. *Journal of Clinical Pathology* **27**, 760.
- DARMADY, E. M., HUGHES, K. E. A., JONES, J. D. & VERDON, P. E. (1959). Failure of sterility in hospital ward practice. *Lancet* *i*, 622.
- DARMADY, E. M., HUGHES, K. E. A., JONES, J. D., PRINCE, D. & VERDON, P. E. (1961). Disinfection of bedbans. *Journal of Clinical Pathology* **14**, 66.
- FAVERO, M. S., MCDADE, J. J., ROBERTSEN, J. A., HOFFMAN, R. K. & EDWARDS, R. W. (1968). Microbiological sampling of surfaces. *Journal of Applied Bacteriology* **31**, 336.
- GIBSON, G. L. (1974). The problem of the bedpan. *Health and Social Services Journal*, October issue, pp. 7–8.
- MOSTAFA, A. B. M. G. & CHACKETT, K. F. (1975). Radioactive tracers in the assessment of cleaning of surgical appliances. *International Journal of Applied Radiation and Isotopes*, **26**, no. 11, p. 651
- NUFFIELD PROVINCIAL HOSPITALS TRUST (1958). Present sterilising practice in six hospitals. Studies of sterile supply arrangements for hospitals.