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An in-use evaluation of decontamination of polypropylene versus steel bedpans

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Summary: A prospective cross-over study in three different wards has demonstrated the lack of effect of two disinfectants compared with a detergent when added to the washing cycle of automatic bedpan washers that employ hot water centrally supplied at 60°C. An unexpected and potentially important finding was that polypropylene pans were much more effectively cleaned and decontaminated than their stainless steel counterparts. The role, if any, of bedpans in the epidemiology of nosocomial infections remains a mystery. The continued absence of information clearly incriminating these ubiquitous devices in the transmission of potential pathogens, or of genes encoding antibacterial drug resistance, raises questions as to whether extensive efforts to achieve a high degree of decontamination of bedpans are necessary at all.

Keywords: Bedpan decontamination; bedpan cleaning; chemical disinfection; epidemiology of nosocomial infection.

Introduction

Although the bedpan has received little attention in the literature as a source for nosocomial infections, it remains a potential reservoir for organisms excreted from the gastrointestinal tract (Curie *et al.*, 1978; Gibson, 1976). Therefore, some degree of decontamination after use by patients is generally recommended. Various methods have been advised (Darmady *et al.*, 1961; Ayliffe *et al.*, 1974; Lowbury *et al.*, 1981; Editorial, 1983; Nystrom, 1983), the currently preferred being a bedpan washer with a heat disinfection cycle which meets certain temperature and time requirements. Different types of such appliances are employed in hospitals, and some, as at our medical centre, combine hot water flushing with chemical disinfectants, perhaps to compensate for wash temperatures lower than the 80°C recommended by Ayliffe *et al.*, (1974) or the minimum 85°C used in Sweden (Nystrom, 1983). Low-temperature washing combined with chemical treatment has been promoted by the manufacturers as ostensibly encouraging a more tolerable (cooler) and pleasant (less smelly) working environment for those responsible for the operation of such machines.

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This study was inspired by the somewhat costly and curious practice, prevalent in our hospital at the time, of adding a chlorhexidine-cetrimide concentrate to automatic bedpan washers in use. A prospective study was designed to test the effects, on disinfection and cleaning, of two disinfectant additives as compared with a simple detergent solution, under normal conditions of use.

In addition to confirming our hypothesis that adding disinfectant solutions to large volumes of water for a short time influences neither the degree of decontamination achieved nor the cleaning of bedpans, this study documents the observation that polypropylene bedpans were more effectively cleaned and decontaminated than those made of stainless steel. This unexpected finding is at odds with those of an experimental investigation carried out by Ayliffe *et al.* (1974), in which polypropylene bedpans were not as easily cleaned as steel ones, and were more difficult to bring to a temperature adequate for disinfection.

Methods

Study design

The decontamination achieved by three solutions was compared in a prospective serial cross-over study of bedpans in three different wards (internal medicine, general surgery, and orthopaedics). Each solution was employed in the bedpan washing machine of each ward in rotation, allowing at least 1 week after changing solutions before observations were made. Bedpans were sampled on three days of 1 week in each location during the use of each solution. Statistical evaluations were performed using the χ^2 test.

Disinfectant solutions

The solutions studied were a combination of 1·5% chlorhexidine and 15% cetrimide ('Savior', Abic Ltd, Ramat Gan, Israel); 7·5% alkyldimethylbenzylammonium chloride in a non-ionic detergent ('Zoharseptal', Zohar Dalia, Kibbutz Dalia, Israel); and the detergent alone. Solutions were used concentrated as supplied by the manufacturers.

Bedpan washing machines

The bedpan washers ('Auto VLD', Agencinox, Aillant-sur-Tholon, France) perform a 1-minute cycle, spraying first cold water (approximately 30 s) and then hot water (approximately 30 s) onto the interior and exterior surfaces of the bedpan. The hot water is centrally supplied at about 60°C. The total volume of water delivered per cycle is dependent on the pressure in the water supply, and probably varies between about 30 and 45 l. During the hot water phase approximately 27 ml of concentrated disinfectant/detergent solution is automatically drawn from a reservoir and added to the water flow over a 3-second period.

Bedpans

In recent years, the hospital has been purchasing polypropylene bedpans to gradually replace the traditional stainless steel type. Almost all the polypropylene pans tested were of one type (The Vollrath Co., Sheboygan, Wisconsin, USA). Both varieties were included in the study as they were encountered in the wards, in approximately equivalent overall proportions.

Bedpan sampling

The sampling method employed was chosen to assess the condition of bedpans ready for use by patients, i.e. bedpans on the drying rack after being processed in the washer. For practical reasons the following procedure was adopted. Five bedpans found on the drying racks in each ward on each morning of the study were sampled. Each ward had a complement of about ten bedpans. No attempt was made to test the same bedpans on each occasion. If any residual water was noted the bedpan was allowed to drain prior to sampling. A swab-rinse technique was used. Ten ml of sterile nutrient broth was added to the bedpan, the entire floor of which was then vigorously rubbed with a cotton-tipped swab for 30 s. The broth was then aspirated with a sterile Pasteur pipette, placed in a sterile tube and transported immediately to the laboratory. After mixing with a vortex mixer, the bacterial count was estimated by spreading an inoculum of 5 μl of the broth over the whole surface of a nutrient agar plate using a sterile glass rod. Suspensions were also streaked onto blood agar and MacConkey agar to allow superficial differentiation of Gram-negative bacilli from Gram-positive organisms.

Degree of bedpan soiling

A scoring system was applied for assessing residual faecal soiling. Any discolouration of the swab used in collecting the specimen by faecal matter was noted, white being regarded as 'clean' (score 0), and any degree of yellow or brown taken as 'dirty' (score 1). A score of 2 indicated macroscopic faecal contamination evident on close inspection and 3 represented gross soiling.

Results

A total of 135 bedpan examinations were made, 45 in each of the wards. A bacterial count of 10 000 colony forming units (cfu) ml^{-1} was chosen arbitrarily to distinguish heavily and less heavily contaminated bedpans. It is apparent from the data in Tables I and II that as additives to the wash the disinfectant solutions were no more effective than simple detergent in cleaning or decontaminating the bedpans. Even if the stricter criterion of no growth (less than 200 cfu ml^{-1}) versus any growth was applied, the findings remained almost identical.

The results were further analysed according to the type of bedpan examined. Figure 1 shows the tendency for polypropylene bedpans to yield lower bacterial counts. In the group with counts of less than 10 000 cfu ml^{-1} 42 of 64 polypropylene bedpans (65·6%) showed no growth, whereas only 23 of 70 stainless steel appliances (32·9%) were similarly negative ($P<0{\cdot}0005$). Figure 2 illustrates the similar effect found for the degree of

Table II. *Residual bedpan soiling by type of solution added to the wash*

	Number of observations (%)			
Count*	Detergent	Chl–Cet**	QAC**	Total
<10 000	28 (63·6)	20 (44·4)	30 (66·7)	78 (58·2)
⩾10 000	16 (36·4)	25 (55·6)	15 (13·3)	56 (41·8)
Total	44 (100·0)	45 (100·0)	45 (100·0)	134 (100·0)

* Cfu ml^{-1} of rinse fluid.
** Chl–Cet = Chlorhexidine/cetrimide solution; QAC = Alkyldimethylbenzylammonium chloride.
Detergent *vs.* Chl–Cet: $\chi^2=2{\cdot}57$, $P=0{\cdot}11$; Detergent *vs.* QAC: $\chi^2=0{\cdot}01$, $P=0{\cdot}9$; Chl–Cet *vs.* QAC: $\chi^2=3{\cdot}65$, $P=0{\cdot}06$.

Table II. *Residual bedpan soiling by type of solution added to the wash*

	Number of observations (%)			
Count*	Detergent	Chl–Cet**	QAC**	Total
Clean	28 (62·2)	32 (72·7)	26 (57·8)	86 (64·2)
Dirty	17 (37·8)	12 (27·3)	19 (42·2)	48 (35·8)
Total	45 (100·0)	44 (100·0)	45 (100·0)	134 (100·0)

* Clean = rinse swab remains white; Dirty = any degree of faecal soiling.
** Chl–Cet = Chlorhexidine/cetrimide solution; QAC = Alkyldimethylbenzylammonium chloride.
Detergent *vs.* Chl–Cet: $\chi^2=0{\cdot}69$, $P=0{\cdot}41$; Detergent *vs.* QAC: $\chi^2=0{\cdot}05$, $P=0{\cdot}83$; Chl–Cet *vs.* QAC: $\chi^2=1{\cdot}58$, $P=0{\cdot}21$.

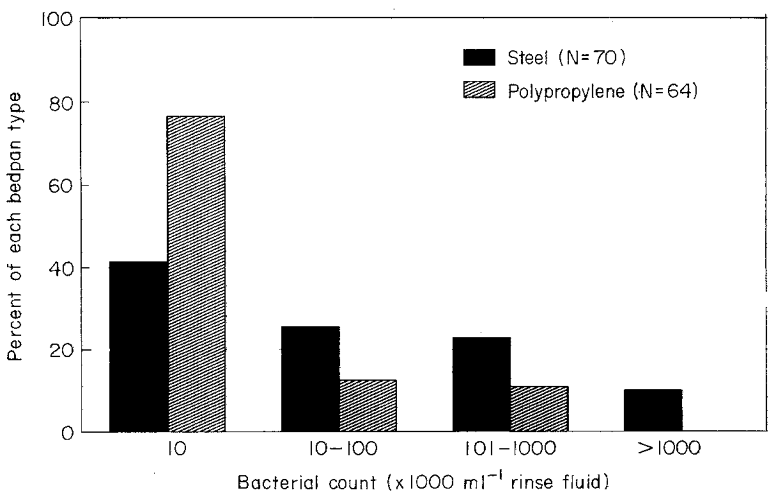

Figure 1. Proportion of bedpans of each type by bacterial count in the rinse fluid.

faecal soiling. The data are summarized in Table III. Polypropylene bedpans were significantly cleaner and had significantly lower counts than stainless steel ones. Table III also shows that Gram-negative bacilli (as opposed to the Gram-positives which were essentially all *Bacillus* sp.) were relatively frequent contaminants, especially of stainless steel bedpans.

Steel and polypropylene bedpans were not distributed evenly between the wards. This afforded an opportunity for testing the hypothesis that bacterial counts and degree of soiling would be higher in wards with a higher proportion of steel pans and *vice versa*. The results in Table IV confirm this and indicate the strength of the associations.

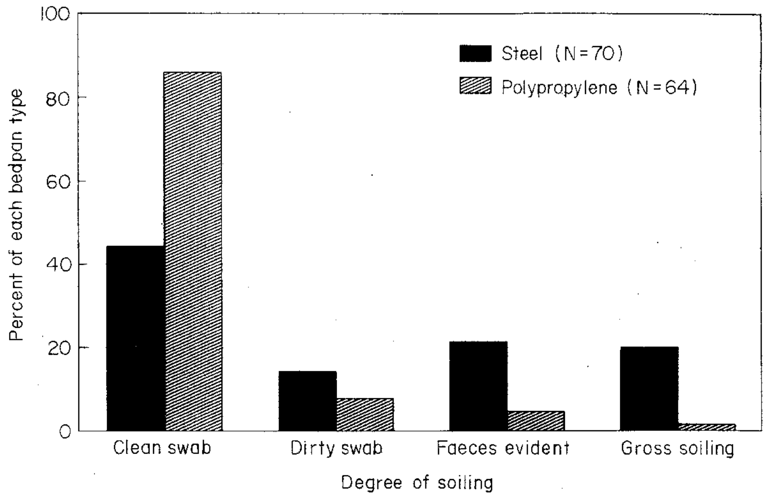

Figure 2. Proportion of bedpans of each type by degree of faecal soiling.

Table III. *Bacterial counts, degree of soiling, and type of flora by bedpan type*

	Number of bedpans (%)		
Characteristic	Stainless steel $n=70$	Polypropylene $n=64$	*P* value
Count			
<10 000 cfu ml^{-1}*	29 (41·4)	49 (76·6)	
⩾10 000 cfu ml^{-1}	41 (58·6)	15 (23·4)	0·00008
Soiling			
Clean	31 (44·3)	55 (85·9)	
Any faecal soiling	39 (55·7)	9 (14·1)	0·000001
Flora			
Any Gram-negative**	48 (70·6)***	22 (34·4)	
No Gram-negatives	20 (29·4)	42 (65·6)	0·00003

* Cfu ml^{-1} rinse fluid.
** Growth on MacConkey agar.
*** $n=68$ (two observations missing).

Table IV. *Bedpan type, bacterial counts and degree of soiling, by ward*

Characteristic	Number of observations (%)			*P* value
	Ward 1	Ward 3	Ward 2	
Bedpans				
Stainless steel	43 (95·6)	27 (60·0)	0 (0·0)	
Polypropylene	2 (4·4)	18 (40·0)	45 (100·0)	
*Bacterial count**				
< 10 000 cfu ml^{-1}	13 (28·9)	28 (63·6)**	37 (82·2)	
⩾10 000 cfu ml^{-1}	32 (71·1)	16 (36·4)	8 (17·8)	0·000001
Soiling				
Clean	17 (37·8)	30 (68·2)**	39 (86·7)	
Any faecal soiling	28 (62·2)	14 (31·8)	6 (13·3)	0·000007

* Cfu ml^{-1} rinse fluid.
** $N=44$ (one observation missing).

Discussion

The disinfection of bedpans

The failure to achieve adequate decontamination of bedpans in this study came as no surprise, considering the clearly suboptimal conditions available for disinfection (Ayliffe *et al*., 1974; Nystrom, 1983) in the bedpan washers used. The addition of disinfectants during the washing cycle proved to have no advantage over detergent alone. Whether the detergent effect alone of the three solutions tested influenced cleaning, cannot be determined in this study. The fact that about a third of the bedpans remained with some degree of faecal soiling (Table II) suggests that if such an effect indeed operated, it was not marked.

While bedpans have not been clearly demonstrated to constitute a source for nosocomial infection, their potential in this regard has been widely acknowledged. Whether or not there is a general need for efficient disinfection of bedpans, as seems to be required in Sweden for example (Nystrom, 1983), remains open for study. Ayliffe *et al*. (1974), citing an apparent lack of spread of unsuspected *Salmonella* infections, suggest a selective approach in which at least areas at special risk for cross-infection (e.g. paediatric, maternity and infectious diseases units) should be equipped with washing machines capable of a high degree of disinfection. It is our view that while direct risks to the patient remain undefined, the potential role of bedpans in promoting colonization of hospitalized patients with frequently multiresistant nosocomial organisms should *not* entirely be discounted, and that efficient washer-disinfectors should be installed wherever possible. The alternatives, using chemical processes (Lowbury *et al*., 1981) seem largely unattractive.

What seems clear from published studies is that temperatures less than

80°C for at least 1 minute will not reliably disinfect bedpans (Ayliffe *et al.*, 1974; Mostafa & Chackett 1976). It should be noted, however, that the main importance of the studies quoted is in the performance of commissioning tests on newly installed equipment, as well as in evaluating machines for purchase. The use of chemicals in addition to heat in washer-disinfectors does not appear to receive any substantial attention in the literature. In a limited study of three commercial bedpan washer disinfectors, Koller (1978) concluded that a 45-s spray with water at 85–93°C was better at reducing bacterial counts than rinsing with warm disinfectant solution.

Polypropylene or stainless steel?

Published data comparing stainless steel and polypropylene bedpans from the standpoint of ease of cleaning and decontamination are minimal. Nystrom (1983) appears to have studied metal pans only. Ayliffe *et al.* (1974) on the other hand, found that soil was better removed from metal than from polypropylene, and that it was more difficult to achieve the same degree of decontamination in the latter, possibly owing to the slower penetration of heat through the plastic. They do, however, acknowledge that the test of disinfection used was particularly stringent (Nilehn, 1972). It should also be recalled that much higher temperatures were achieved than in the present study.

The tests of soiling in the British studies were also very different from contamination by faeces. Ayliffe *et al.* (1974) used a standard soil mixture comprising serum, milk powder and nigrosin, which may well have different properties of adherence to different surfaces. A further point of difference was their use of standardized inocula of defined organisms.

Using radioactive human serum albumen as a soil, Mostafa & Chackett (1976) found no substantial difference between steel and polypropylene bedpans. The extent to which these artificial measures may influence the results obtained and their interpretation is illustrated by the consistent finding, in the same study, that when the albumen was combined with bacteria (*Streptococcus faecalis*), the best cleaning effect was shown on polypropylene pans. This phenomenon was taken by the authors to indicate a degree of interaction between the organisms and the albumen.

Another possibility is that at the lower temperature used in our study, there is less of a tendency for adherent faecal material to be 'baked on' to the bedpan surface, thus allowing detection of a difference due to the surface properties of the materials.

All the above considerations may at least partly explain the apparently paradoxical findings of Ayliffe's group and our study. Which conclusion is more relevant has to be seen in the light of the essential inadequacy of the disinfection attained by washing at 60°C, as at our hospital. Nevertheless, a properly controlled 'field study' comparing polypropylene and steel bedpans in efficient washer-disinfectors at temperatures in excess of 80°C will be needed to resolve this question.

Might differences in practices between the wards studied have contributed to the results? This potential bias cannot be entirely ruled out in this study, although its likely impact is thought to be limited since the same machines and wash methods were used in all the wards.

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