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Bacterial contamination control mats: a comparative study

BY H. M. MEDDICK
Microbiology Department, St David's Hospital, Cardiff, S. Glamorgan CF1 9TZ

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SUMMARY

The ability of six different types of contamination control mats currently in use at the entrances to theatre suites and other clean areas to remove bacteria-carrying particles from theatre trolley wheels was compared. Marked differences in the effectiveness of this property were obtained; and all mats showed some disadvantages. Modification of one of the mats has resulted in improved efficiency under working conditions.

INTRODUCTION

Contamination control mats have been used for many years (Ayliffe *et al.* 1967) as an aid in preventing the transfer of bacteria-carrying particles in dust on equipment and on the soles of footwear from dirty to clean areas such as operating theatres. Several different types of mats are available for this purpose but there are few published reports on their efficiency. As the replacement of these mats is a recurrent expense, a comparison of the efficiency of mats in common use in hospitals was carried out. It is not claimed however that the mats examined were the only mats marketed.

MATERIALS AND METHODS

Six different mats were available (Table 1) and were tested at the entrance to an operating theatre. Trollies used for transporting patients to and from the theatre were used throughout the investigation, and the same procedure was followed for each mat. A mark was placed on the rim of each of the trolley wheels. Contact dishes of the Foster type containing 10 % blood agar were used to take impression cultures of the wheel treads, from one side of the mark before, from the other side after the wheel had passed over the mat. In this way, between the two impression plates, the tread had been in contact only with the mat (and the air). After testing, trollies were returned to normal use. The impression contact plates were incubated aerobically at 37 °C and examined after 18 h incubation. The degree of growth on the plates was graded as follows: ±, Scanty growth; +, light growth; + +, moderate growth; + + +, heavy growth.

As only the degree of growth was important organisms were not identified. Note was also made of any difficulties associated with use of the mats, particularly in relation to the ease of passage of heavy equipment. So that the results could be related to the amount of use, the number of operations carried out while the mat

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Table 1. *Types of mat tested*

Manufacturer	Trade name	Type of mat	Method of use	Cost*	Comparative cost per year†
Tak Chemicals Ltd	Tak Mat SDA	Tacky layers of muslin	Peel off dirty layers as necessary	£22.52/36 layers	1 layer/day £229.95
Tak Chemicals Ltd	Tak Mat NP	Tacky layers of impervious material	Peel off dirty layers as necessary	£26.40/36 layers	1 layer/day, £266.45
Tak Chemicals Ltd	Not yet marketed	Fibrous mat	May be washed or vacuum cleaned	Not released	
Spring Grove Services Ltd	Check Mat	Cotton tufted material	Reprocessed weekly by firm on contract basis	'Stay flat' 48 × 32 in., £0.66/week; 72 × 48, £1.72/week	Including reprocessing, £34.32 or £89.44
Arbrook division of Ethicon Ltd	Safe Entry	Plastic layers coated with sticky material	Peel off dirty layers as necessary	Frame, £18–28 depending on size. Pack of 6 refills, each of 20 sheets, £60	One change/day £180. Not counting capital cost of frame
Dycem Plastics Ltd	Contamination control screen	Plasticized plastic mat	Wash as necessary with soapy water	4 × 2 ft. £35. Double thickness or longer screens *pro rata*	£35 maximum. £17.50 if able to use for 2 years

* These figures include the maximum discounts offered by the supplying firms.
† Using as nearly as possible the same sized mats in each case. These sizes are not necessarily the ones recommended for use in all situations.

was in use was recorded. With minor variations, the traffic over the mat for each operation was constant. At each testing of trolley wheels a note was made of the appearance of the mat surface, and a subjective estimate of its cleanliness made. Mat size was kept constant, approximately 4 ft square. Tests were conducted over a period of 12 months.

RESULTS

The results are presented in Table 2. Three mats – the muslin layer, Tak Mat SDA; the fibrous mat; and the Check Mat – were unsatisfactory as even on first use there was little or no reduction in the degree of growth from trolley wheels before and after traversing the mats.

The Safe-Entry plastic layer mat gave excellent results when first used: the mat being so tacky that overshoes were retained on the mat. This property was lost quickly, and only minimal reduction in bacterial growth was obtained after the mat had been in use for a short time (Table 3).

The impervious layer Tak Mat NP showed a distinct improvement on the

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muslin-layered Tak Mat SDA, but like the Safe-Entry plastic layer mat, lost its effectiveness after a short time (Table 3).

The Plastic Dycem mat proved effective for longer periods (Table 3), reduction in growth being achieved even when the mat appeared dirty. This mat proved to withstand autoclaving at 15 lb for 15 min and 20 lb for 10 min without damage and without reduction in tackiness provided that the mat was kept flat or rolled rather than folded.

Table 4 summarizes the points considered in the evaluation of these mats.

Dycem Plastics Ltd have recently introduced a continuous screen $1{\cdot}2 \times 3\text{–}4$ m (Plate 1) which possesses one advantage in that, by reason of its size and spread, this mat lies securely on the floor and does not ruck with the passage of trollies. During 5 weeks of use, no difficulties were experienced in cleaning the mat *in situ*.

The Dycem plastic layer Tak Mat and the Safe-Entry mats were also tested as entry mats to a Special Care Baby Unit in a teaching hospital with a large volume of pedestrian traffic to the ward. The mats proved effective in reducing the frequency with which the floors of the Unit required washing from twice or thrice daily to once daily.

DISCUSSION

The presence of a mat at the entrance to clean areas was found to be an effective psychological barrier to the unnecessary movement of people and from this point of view, the muslin Tak Mat, the Check Mat and the fibrous Tak Mat were useful even though no significant reduction in bacterial contamination of theatre trolley wheels was achieved. It is clear from Table 2 that these mats are not suited for use in areas where a reduction in the number of particles containing bacteria is considered necessary. For this reason, these mats were not tested extensively.

The Safe-Entry mat was extremely effective when tacky. In use, this property was quickly lost. To maintain effectiveness, the layers required changing at approximately 2–4 h intervals (Table 3) resulting in a significant increase in cost. When freshly laid this mat was so effective that overshoes were removed, leading to many complaints. It can be argued however that these mats are cost effective even with frequent layer changes in situations where traffic is mainly pedestrian and overshoes are no longer required.

The plastic-layered Tak Mat was less tacky than the Safe-Entry mat and was therefore more acceptable to users. This mat was a distinct improvement on the muslin-layered Tak Mat in that dust and dirt which tended to pass through the layers of muslin remained on the top layer in use. To retain the effectiveness of the mat however, the layers required changing at 2–4 h intervals (Table 3) resulting in a significant increase in cost.

During use the mat edges tended to curl, constituting a safety hazard to users and making it difficult for heavy instruments, e.g. X-ray machines, to negotiate. The Safe-Entry Tak Mat showed the same disadvantage.

From the bacteriological point of view, the Dycem plastic mat produced good results consistently over a period of 4–6 h between cleanings (Table 3). This mat, while acceptable to staff, had however two serious faults in use. First, the under

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Table 2. *Semi-quantitative assessment of the removal of bacteria from trolley wheels passing over different mats*

Number of operations performed

Muslin-layered mat (SDA) Tak Chemicals Ltd

	0	1	2	3	4	5	6	7	8	9	10	Total
No. of tests	8	0	4	4	0	4	4	4	4	4	0	36
Range of readings before mat	++ to +++	.	+++	+++	.	+++	++ to +++	+++	+++	+++	.	++ to +++
Range of readings after mat	++ to +++	.	+++	++ to +++	.	+++	++ to +++	+++	+++	+++	.	++ to +++
Average before mat	+++	.	+++	+++	.	+++	+++	+++	+++	+++	.	+++
Average after mat	+++	.	+++	+++	.	+++	+++	+++	+++	+++	.	+++

Tak Mat impervious layers (NP) Tak Chemicals Ltd

	0	1	2	3	4	5	6	7	8	9	10	Total
No. of tests	10	4	8	8	6	4	4	2	0	2	0	48
Range of readings before mat	++ to +++	++ to +++	++ to +++	+++	++ to +++	+++	+ to +++	+++	.	+++	.	+ to +++
Range of readings after mat	± to ++	+ to ++	+ to ++	+ to +++	+ to ++	+ to +++	+ to +++	++	.	+++	.	± to +++
Average before mat	+++	+++	+++	+++	+++	+++	++	+++	.	+++	.	+++
Average after mat	+	+	++	++	++	+++	+++	++	.	+++	.	++

Fibrous mat, Tak Chemicals Ltd

	0	1	2	3	4	5	6	7	8	9	10	Total
No. of tests	8	6	6	4	8	6	4	4	2	0	0	48
Range of readings before mat	++ to +++	+++	+++	++ to +++	+++	+++	++ to +++	+++	+++	.	.	++ to +++
Range of readings after mat	+ to +++	++ to +++	++ to +++	++ to +++	+++	++ to +++	+++	+++	+++	.	.	+ to +++
Average before mat	+++	+++	+++	+++	+++	+++	++	+++	+++	.	.	+++
Average after mat	++	+++	+++	+++	+++	+++	+++	+++	+++	.	.	+++

Check Mat. Spring Grove Services Ltd

	0	1	2	3	4	5	6	7	8	9	10	Total
No. of tests	12	0	4	0	4	0	8	4	0	0	0	32
Range of readings before mat	± to ++	.	++	.	++	.	+ to +++	+ to +++	.	.	.	± to +++
Range of readings after mat	− to ++	.	++ to +++	.	+ to ++	.	+ to +++	+ to +++	.	.	.	− to +++
Average before mat	+	.	++	.	++	.	++	++	.	.	.	++
Average after mat	+	.	++	.	++	.	++	++	.	.	.	++

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Table 2. (*cont.*)

	Number of operations performed											
	0	1	2	3	4	5	6	7	8	9	10	
	Safe-Entry mat. Arbrook Div. of Ethicon Ltd											Total
). of tests	12	12	20	16	8	8	4	16	0	4	0	100
ange of eadings efore mat	+ to +++	++ to +++	+ to +++	++ to +++	++ to +++	++ to +++	+ to ++	++ to +++	.	++ to +++	.	+ to +++
ange of eadings fter mat	± to +	± to +++	± to +++	+ to ++	+ to ++	+ to ++	± to +	± to ++	.	+ to +++	.	± to +++
verage efore mat	++	+++	++	++	++	++	++	+++	.	+++	.	++
verage fter mat	+	++	++	++	++	++	+	++	.	+++	.	++
	Dycem plastic mat											
o. of tests	12	20	24	20	28	8	8	4	12	16	12	164
ange of eadings efore mat	+ to +++	+ to +++	+ to +++	+ to ++	+ to ++	+ to ++	+ to +++	+ to ++	+ to +++	+ to +++	+ to ++	+ to +++
ange of eadings fter mat	±	± to +	± to ++	± to +	− to +	±	± to +	±	± to ++	− to +	±	− to ++
verage efore mat	++	++	++	++	+	++	++	+	++	++	++	++
verage fter mat	±	±	±	±	±	±	±	±	±	±	±	±

−, No growth; ±, scanty growth; +, light growth; ± ±, moderate growth; + + +, heavy growth.

Table 3. *Length of time for which the mats were effective for the removal of bacteria-carrying particles*

Type mat	Length of time between changing or cleaning (h)												Total	Mean
Tak Mat NP	2	3	2	2	3	3	4	2	2	2	3	2	30	2·5
Safe Entry	2	2	2	1	4	1	2	2	1	2	3	3	25	2·0
Dycem*	5	5	5	5	5	5	5	5	2	5	3	5	55	4·6

Tak Mat SDA, Tak Mat fibrous and Check Mat are not included, as they were non-effective from the start.

* These are the times between cleaning the mat, and do not necessarily represent the maximum times that could have been achieved.

surface of the mat and the floor to which it adhered needed to be absolutely clean and dry as, if dirty, the mat tended to ruck up, and if wet, to slip. The top surface when wet was dangerously slippery. These criteria were difficult to achieve in use. Next, even if the mat and the surrounding surface were clean and dry, the mat tended to ruck when heavy beds or equipment, for example, operating tables, had to be moved so that such equipment had to be lifted on to the mat.

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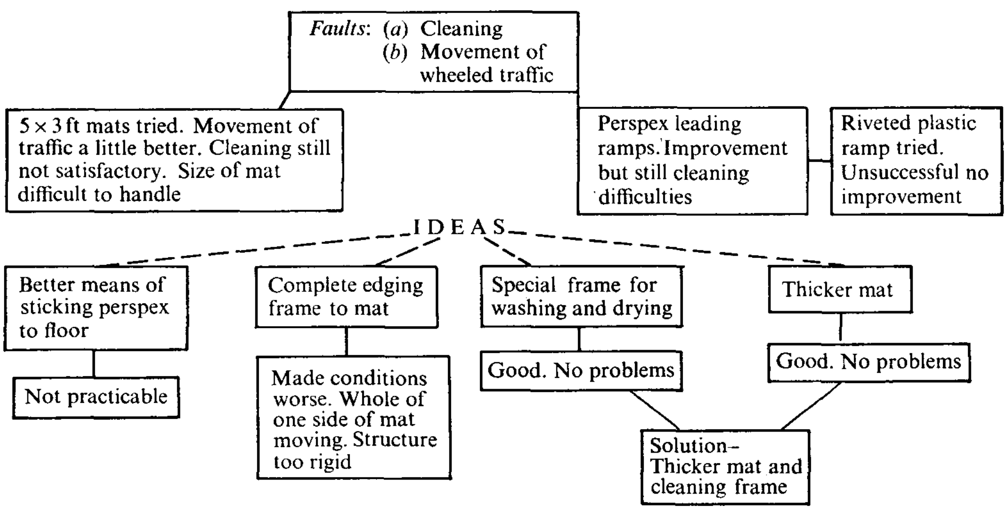
Table 4. *Evaluation of the different mats*

Factors considered	Type of mat: Tak Mat SDA	Tak Mat NP	Tak Mat fibrous	Check Mat	Safe Entry	Dycem
Bacteriological	0	(+)	0	0	(+)	+
Cost	0	0	0	+	0	+
Cleaning or changing	+	+	+	+	+	0 → +
Movement of wheeled traffic	(+)	(+)	(+)	+	(+)	0 → +
Size	+	+	+	+	+	0 → +
Acceptability by users	+	0	0	+	+	+

+, Condition acceptable; (+), condition variable; 0 → +, condition now acceptable after modifications; 0, conditions unacceptable.

Table 5. *Summary of problems encountered with Dycem control screens and their solution*



Regarding cleaning, the Dycem mats were cleaned at 5 h intervals (Table 3) only for the convenience of cleaning staff. The interval could have been much longer.

The Dycem mat was the most efficient of the mats tested in removing dirt and organisms over a period of time and was also cheaper in use. In conjunction with the makers, modifications were attempted to remedy the defects noted above. The object of the modifications was to allow equipment with small wheels to traverse the mat easily without causing rucking, and to standardize the cleaning and drying procedures, at minimum increased cost. Table 5 details the approaches tried and the final solution.

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Washing and drying of the mats was carried out away from the working area by attaching the mat by two clips to a large sheet of stainless steel held vertical by a stand. Both sides of the mat were cleaned with soapy water using a fluffless cloth, and left to dry on the frame. No disinfectant was used.

Increasing the thickness of the mat from 6 mm to approximately 10 mm allowed the mat to seat firmly on the floor and allowed the passage of wheeled heavy equipment without rucking. No difficulties were met in the movement of operating tables, X-ray machines, etc. which had been effected with difficulty during the use of the original 6 mm mat. The thicker mat proved more acceptable to staff in that a lesser degree of cleanliness of the floor and under surface of the mat was required.

With all mats, when the surface becomes too dirty, there is the possibility that dirt and therefore bacteria may be transferred from the mat into the clean area. The thicker mat, together with the Safe-Entry and Tak Mat plastic-layered mats, shows the degree of dirtiness by inspection, and therefore have an advantage over the other mats where inspection gives little or no indication of the presence of dirt. The increase in price of the thicker Dycem plastic mat was offset by its longer working life. While it was claimed that the original mat retained its properties for a year, the life of the thicker mat was claimed to be 2 years. This claim has yet to be verified but to date, both mats have been in continuous use for a year, with washing twice daily and with no apparent loss in efficiency. It would appear advisable, however, when Dycem mats are in use, to establish a monitoring procedure to detect any loss in efficiency.

The efficiency of the mats used, especially the thicker Dycem mat, in the situations described above, suggested that within the hospital there were many places where effective dust control could be beneficial. From the relative costs of the mats examined (Table 1) it can be seen that the plastic mat offers more advantages than other types. It is suggested that the decision to use mats should be subject to critical evaluation. Where there is a need to use mats, a careful choice should be made based on working effectiveness related to cost.

CONCLUSION

Six different types of contamination control mats have been examined for their effectiveness in removing bacteria-carrying particles from theatre trolley wheels. The results provided suggest that the Dycem contamination control screen deserves serious consideration for use in situations where a need exists to control contamination.

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EXPLANATION OF PLATE

Dycem continuous screen, laid at entrance to operating theatre, immediately after passage of trolley.

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