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Microbiological Evaluation of Wet and Dry Floor Sanitization Systems in Hospital Patient Rooms

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A new system for sanitizing floors in hospital patient rooms has been developed. The method consists of dry dusting with a cotton-blend, chemically treated (10% by dry mop weight) dust mop. This method was compared with a conventional cleaning protocol consisting of an initial predusting with the same nongermicidal chemical (3% by dry mop weight) followed by wet mopping with a fresh solution of a quaternary ammonium disinfectant-detergent. Each of six rooms was sampled by using RODAC plates (Becton Dickinson Labware, Oxnard, Calif.) on 10 consecutive days for each of the two methods. The study was initially performed during the summer and then repeated during the winter. Results imply that there is no significant difference between the new dry method (81.9% CFU reduction) and the conventional method (83.1% CFU reduction). Furthermore, the initial dry dusting step in the conventional method accounted for virtually all of the reduction by that method. Thus, wet mopping with a germicidal chemical produced no additional significant reduction of natural microbial populations on environmental surfaces beyond that achieved by dry dusting with dust-suppressant chemicals.

There have been a number of reports in the technical literature over the past 25 years which have implied that the use of chemical germicides on medical facility floors contributed little or nothing to the reduction in microbial counts compared with nongermicidal methods (4, 6, 8). Additionally, there has been general agreement that microbial contamination on floors does not play a significant role in nosocomial infections (2). Nonetheless, the traditional use of chemical germicides in daily floor mopping of patient rooms has persisted in the United States, despite its relatively high cost and inconvenience to hospital patients and personnel.

Recently, Schmidt et al. (7) reported on a new technique consisting of dry dusting with a chemically treated mop, machine buffing with a sprayed-on polymer, and a second dust mopping. This method reduced microbial populations by a greater percentage than conventional wet mopping with a disinfectant solution without contributing additional microbial air contamination. However, the method is only applicable to large stretches of floor, such as corridors, because of the requirement for machine buffing.

The current study utilized a modified dry dusting procedure without machine buffing, which could be carried out in occupied patient rooms in a shorter time period and with less disruption than conventional wet mopping. The objective was to compare the two methods based on percent reduction of bacterial contaminants. The comparisons were carried out separately during summer and winter months to account for seasonal differences.

MATERIALS AND METHODS

Floor maintenance. The floors used as substrates for these studies were covered with resilient vinyl tiles (30.5 by 30.5 cm). Once stripped down to the tile, each floor was finished with one coat of an acrylic copolymer-based, water-emulsion top sealer (FloorStar WaterSeal; ServiceMaster Industries, Inc.), followed by two coats of hard finish (FloorStar Exceed; ServiceMaster Industries). The study was conducted using floors in two, occupied, private or semiprivate patient rooms on each of three nursing stations at a large metropolitan hospital. This study compares the efficacy of two cleaning methods: (i) the conventional two-step mopping system and (ii) a test system based on a kinetic sanitizing system.

Conventional mopping system. Floors were dusted with 100% cotton dust mops (30.5 cm) pretreated at least 24 h previously with Dry Mop Treatment (a petroleum-based dust mop treatment chemical containing no antimicrobial agents; ServiceMaster Industries) at 3% of dry mop weight. The same dry mop was used for up to three rooms and the dust mop head was cleaned by brushing with a hard-toothed cleaning tool to remove dust and debris between each room sampling. Floors were then wet mopped in their entirety with 100% synthetic fiber wet mops (50% polyester, 50% high-modulus rayon, 340 g) and allowed to dry completely. A single-bucket system was used. After the mop was rinsed in the bucket solution (1:128 dilution of SaniMaster III, a quaternary ammonium compound disinfectant-detergent; ServiceMaster Industries), it was wrung out with a special torque wringer and then recharged with a fresh 500-ml solution of 1:128 dilution of SaniMaster III. The wet mop was allowed to stand for 10 min before being wrung out for use on the next sample floor.

Kinetic sanitizing system. Floors were dusted with KinSan cotton-blend dust mops (30.5 cm; ServiceMaster Industries) pretreated at least 24 h previously with Dry Mop Treatment at 10% by dry mop weight. The same dry mop was used for up to three rooms and was cleaned with the special cleaning tool between each room. With this method, floors were not mopped in their entirety. Wet mopping was used solely for the purpose of spot mopping for spill-stain removal as needed. When spot mopping was performed, the same

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TABLE 1. Microbiological comparison of conventional versus kinetic patient room floor cleaning procedures

Operator or parameter	Room	% Reduction of mean CFU[a]			
		Conventional method		Kinetic method	
		Summer	Winter	Summer	Winter
1	1	78.6	80.8	86.5	83.6
	2	72.0	98.7	74.2	80.9
	3	63.4	81.9	83.8	89.5
2	4	79.3	69.5	89.1	76.6
	5	94.5	93.3	69.1	72.5
	6	94.0	90.3	87.0	89.8
Mean all rooms		80.3	85.8	81.6	82.2
Mean both seasons		83.1		81.9	

[a] Based on 10 trials per room per season. % Reduction = [(μ CFU per plate before − μ CFU per plate after)/(μ CFU per plate before)] × 100.

TABLE 3. Microbiological comparison of dry treatment steps in patient room floor cleaning procedures

Operator or parameter	Room	% Reduction of mean CFU[a]			
		3% chemical		10% chemical	
		Summer	Winter	Summer	Winter
1	1	82.7	91.5	86.5	83.6
	2	75.5	91.2	74.2	80.9
	3	76.0	83.6	83.8	89.5
2	4	90.7	80.6	89.1	76.6
	5	73.7	80.9	69.1	72.5
	6	88.4	84.6	87.0	89.8
Mean all rooms		81.2	85.4	81.6	82.2
Mean both seasons		83.3		81.9	

[a] See footnote a of Table 1. Chemical concentrations are given as percentages of dry mop weight; 3% chemical was used for the conventional method, and 10% chemical was used for the kinetic method.

procedure used in the wet mop step of the conventional mopping system was applied. No samples from such spot-mopped areas were included in the evaluation.

For both the conventional mopping system and the kinetic sanitizing system, the dry mop treatment level was controlled by applying the dust mop treatment chemical to mop heads with a mop treatment machine (Golden Star, Inc., North Kansas City, Mo.). Throughout the study, all dry and wet mopping was performed by using the standard "S" stroke, beginning at the far side of the room and working toward the door.

Sampling scheme. The high-traffic area of each sample floor was mapped out, and each tile therein contained was assigned a number. For each sample trial, 10 of the high-traffic area tiles were randomly selected. Each tile was then visually subdivided into nine squares. The square to be sampled within each tile was then randomly selected for samples collected pretreatment, post-dry mop treatment, and post-wet mop treatment (where applicable). The square sampled within each tile was mutually exclusive relative to the three treatments. Ten sample trials (one trial per day) were completed in each patient room with one of the two available cleaning systems (the conventional mopping system or the kinetic sanitizing system) before beginning a set of 10 sample trials with the alternative cleaning system. The entire procedure was performed during the summer months of July and August and repeated during the winter months of December and January. Two evaluators were involved in the study, each having responsibility for three patient rooms (one room on each of three different nursing stations).

Bacteriologic evaluation. Floors were sampled with RODAC plates (Becton Dickinson Labware, Oxnard, Calif.) containing approximately 17 ml of Standard Methods Agar with Lecithin-Tween 80 neutralizer (BBL Microbiology Systems, Cockeysville, Md.). All plates were incubated at 32°C for 48 h. Total CFU per RODAC plate were enumerated with the aid of a Quebec dark-field colony counter (American Optical Corp., Buffalo, N.Y.) (3, 5).

TABLE 2. Analysis of variance results of Table 1 data

Source of variation	Sum of squares	df	Mean square	F	P
Between rooms					
Operator	40.56	1	40.56	0.55	0.5012
Error 1 (rooms within operators)	297.54	4	74.39		
Within rooms					
Method	7.94	1	7.94	0.04	0.8466
Operator × method	150.00	1	150.00	0.80	0.4204
Error 2 (method × room within operators)	745.76	4	186.44		
Season	54.00	1	54.00	0.89	0.3999
Operator × season	252.20	1	252.20	4.14	0.1117
Error 3 (season × room within operators)	243.84	4	60.96		
Method × season	36.51	1	36.51	3.67	0.1281
Operator × method × season	88.94	1	88.94	8.93	0.0404
Error 4 (method × season × room within operators)	39.83	4	9.96		

TABLE 4. Analysis of variance results of Table 3 data

Source of variation	Sum of squares	df	Mean square	F	P
Between rooms					
Operator	11.34	1	11.34	0.10	0.7680
Error 1 (rooms within operators)	455.09	4	113.77		
Within rooms					
Method	12.47	1	12.47	0.43	0.5483
Operator × method	6.30	1	6.30	0.22	0.6657
Error 2 (method × room within operators)	116.33	4	29.08		
Season	32.90	1	32.90	0.75	0.4363
Operator × season	121.95	1	121.95	2.77	0.1715
Error 3 (season × room within operators)	176.28	4	44.07		
Method × season	19.62	1	19.62	2.60	0.1822
Operator × method × season	21.09	1	21.09	2.79	0.1699
Error 4 (method × season × room within operators)	30.19	4	7.55		

RESULTS

Data comparing the percent reduction achieved by the proposed kinetic cleaning method with that achieved by the conventional two-step method with a liquid chemical germicide are presented in Table 1. Each operator carried out each procedure (conventional and kinetic) on 10 days in each room. The entire comparison was carried out first during the summer and then repeated during the winter. Thus, data are interpreted via a $2 \times 2 \times 2$ factorial design involving three factors (two operators, two methods, and two seasons). Data were then analyzed by analysis of variance with repeated measures (9). Table 2 summarizes the analysis of variance results. Except for a marginal three-way interaction (operator $\times$ method $\times$ season) all other effects were not statistically significant.

However, in the conventional two-step cleaning process the initial dry dusting step accounted for virtually all of the microbial reduction. Therefore, the dry cleaning step in the conventional method was separately compared with the new kinetic method. These data are summarized in Table 3, with the analysis of variance results appearing in Table 4. Once again, no statistical significance could be demonstrated for any of the effects. This finding implies that the higher percentage of chemical (10%) used in the kinetic method did not contribute to additional microbial reduction compared with the basic dry chemical method (3%), which is routinely used as a preparatory step in the conventional wet cleaning process.

Although no seasonal effect was noted, the percent reductions were slightly higher during the winter samplings for both methods and for the dry cleaning step in the conventional method.

DISCUSSION

Schmidt et al. (7) have previously documented the advantages of dry cleaning compared with wet cleaning procedures on hospital floors. These include primarily the safety factor (to avoid falls associated with wet surfaces), the convenience factor, and the improved productivity and cost reduction associated with dry cleaning methods. They also documented the microbiological and esthetic equivalence of the dry cleaning method relative to wet cleaning procedures for corridors in health care facilities. In this study, we have extended this dry cleaning concept to hospital patient rooms. Safety for both the patient and staff personnel was found to increase greatly with the use of the dry cleaning method. In addition, staff personnel found it more convenient to work around this method than around wet cleaning schedules. Again, productivity, as measured by time saving and product cost reduction, was noticeably improved. In patient care settings, the importance of esthetics should not be underestimated and should be a primary objective regardless of these other factors. The frequency of stripping and refinishing floors with glossy polymer coats is a major contributor to esthetic satisfaction in these environments. In general, the dry treatment can maintain a satisfactory appearance between refinishing procedures, if dry dusting is supplemented by spot mopping as necessary.

The microbiological quality of the patient environment has been much discussed. Although the weight of evidence diminishes the importance of floor microbes in nosocomial infection problems, there is general agreement that low microbial levels in the patient environment should be the goal of a good hospital environmental quality control program. Because hospital housekeepers tend to associate good sanitation with traditional wet cleaning techniques, there is a reluctance to abandon the use of chemical germicide solutions in patient rooms, particularly in rooms designated for infectious isolation. Nonetheless, in the absence of evidence linking floor contaminants to infection and with the repeated finding that dry cleaning results in microbial reduction equivalent to that of wet germicide cleaning, time and dollars could be saved by reassessing the need for traditional wet mop cleaning of hospital floors.

RODAC plates are generally considered to be the method of choice for quantifying microbial contamination on flat surfaces. They are simpler to use than swabs and the results are more reproducible in addition to yielding at least comparable recovery efficiency (1). However, it is not uncommon to observe increases in surface colony counts (regardless of sampling method) after wet cleaning with detergents or germicides or any other wet cleaning regimen (8). The explanation most commonly advanced is that clumps of soil (with multiple contaminants) have been broken up by wet detergency, resulting in microbial dispersal. Thus, the original count (CFU) may have represented more cells per colony, whereas the count after cleaning represents fewer cells per colony. This phenomenon may produce a distorted picture of the reduction in microbial floor contaminants attributed to each cleaning method (dry versus wet). Although this explanation does not necessarily negate the conclusion of equivalence for dry versus wet cleaning methods, it should be carefully considered before attaching conclusive significance to the results obtained in this study.

The salient findings of our study comparing the percentage reduction in microbial colony counts following patient room floor cleaning by dry and wet methods can be summarized as follows. (i) A one-step dry treatment (KinSan) yielded a percent reduction (81.9%) statistically equivalent to the conventional two-step wet treatment with a chemical germicide (83.1%). (ii) During conventional two-step treatment virtually all of the percentage reduction could be attributed to the initial dry treatment step with a chemically treated (dust suppressant, nongermicidal) dust mop. (iii) The KinSan treatment (with 10% chemical concentration) does not yield any apparent advantage compared with the initial dry chemical treatment (3% concentration) of the conventional procedure, since there is no significant difference between the percent reductions produced by these two treatments.

These data imply that dry treatment with dust suppressant chemicals decreases microbial colony counts on patient room floors to at least the same extent as that achieved by chemical germicide solutions. Thus, if esthetic equivalence can be demonstrated, there is a potential for significant cost reduction in hospital patient room cleaning protocols.

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