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Improved System for Floor Cleaning in Health Care Facilities

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A new system has been developed for sanitizing floors in hospitals; this system replaces the traditional procedure of daily dusting and wet mopping with a disinfectant-detergent solution and periodic buffing. This new system relies on a sequence of procedures consisting of dust mopping using a chemically treated dust mop, machine buffing of a sprayed-on polymer treatment, and a second dust mopping. The effectiveness of the procedures was evaluated by means of surface sampling for bacterial contamination and air sampling for airborne bacteria and dust. The level of bacterial contamination on the floors was reduced by 93.6% by using the new system, compared with 79.8% by using the conventional process of dust mopping and wet mopping with a disinfectant solution. The levels of airborne bacteria during and after the individual procedures did not vary significantly from the initial level (123.6 CFU/per m^3 of air). A survey of representative colonies from air samples revealed staphylococci, gram-positive bacilli, gram-positive diplococci, yeast cells, and infrequent gram-negative rods. The distribution at the conclusion of the sanitizing process was similar to that at the outset. Similarly, the levels of airborne dust measured during and after the individual procedures did not vary significantly from the initial level. When compared with the traditional method of cleaning by wet mopping, the new method was significantly more effective in removal of microbial contamination and required less labor.

In North America, dry dusting followed by wet mopping has been considered to be the standard daily procedure for floor maintenance in health care institutions, particularly in hospitals (8, 9, 11, 14). Discussions of various steps in floor cleaning have dwelt primarily upon the relative merits of one procedure versus another: e.g., the need or value of dry dust mopping of floors before wet mopping (1, 2, 8, 13, 19), evaluation of the relative merits of wet floor-cleaning procedures (3, 8, 12, 17, 20), or the type of disinfectant-detergent to be used in wet cleaning, e.g., quaternary ammonium versus phenolic versus iodophor products (5, 12, 15, 16). Nonetheless, the minimum daily procedures in almost all systems of health care floor maintenance include both dry-mop floor dusting and wet mopping. In addition, machine buffing, generally after spray application of a small amount of wax or polymer finish, a process termed spray buffing, is carried out at various intervals to maintain a glossy appearance of the floor. Dry dusting may be necessary after such buffing.

The value of each of these individual components of institutional floor-cleaning processes, separately as well as in a variety of combinations, has not been addressed in a single comprehensive study. Thus, a microbiological study to evaluate the effectiveness of each of these components was carried out. These evaluations indicated that a procedure of dry dusting with a chemically treated dust mop followed by machine buffing of a sprayed-on finish, without wet cleaning, produced a greater percent reduction of bacteria on the floor than the traditional process of dry dusting followed by wet mopping with a detergent or disinfectant-detergent. To our knowledge, these results have been neither recognized nor reported; therefore, a detailed investigation of the steps included in the routine wet cleaning of hard-surfaced floors in health care facilities was designed and conducted to compare the results with dry dusting with a chemically treated dust mop or spray buffing or both. The objective of this investigation was to determine whether a more efficient system of microbial cleaning of floors could be attained through dry-particle physical removal alone without wet cleaning.

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MATERIALS AND METHODS

Floor maintenance. The following chemicals and equipment were provided by ServiceMaster Industries Inc., Downers Grove, Ill.: KinSan Dustmop, KinSan Dustmop Treatment (mop treatment chemical), SaniMaster II disinfectant-detergent, Model ESB 300 buffing machine, KinSan SprayBuff Pro spray buffing solution, and PortaVac 100 vacuum machine.

The floors used as substrates for these studies were covered with a resilient flooring material, such as vinyl-asbestos tiles or vinyl sheet flooring, and had been finished with a water-emulsion coating based on acrylic copolymers. Floors were dusted with cotton-blend dust mops (13 by 122 cm) which had been treated at least 24 h previously with KinSan Dustmop Treatment, a petroleum-based dust mop treatment chemical, at a treatment level of 10 to 15% by dry mop weight. The dust mop treatment chemical contained no antimicrobial agents. The mop treatment level was controlled by applying dust mop treatment chemical to mopheads by using a mop treatment machine (Golden Star Inc., North Kansas City, Mo.). Identically treated dust mops were used for all dry dusting procedures. Dust mops were vacuum-cleaned after cleaning no more than 560 m^2 of floor, dependent upon soil levels encountered.

Floors were wet mopped with 50% polyester, 50% high modulus rayon, 567-g wet mops and SaniMaster II, a quaternary ammonium compound disinfectant-detergent. A single, seamless stainless steel 30-liter bucket containing 19 liters of disinfectant-detergent solution and a single wet mop were used for all wet mopping procedures. The wet mop and solution were changed after cleaning ca. 370 m^2 of floor. When floors were not wet mopped in their entirety, stains and spills were removed by spray buffing or spot mopping.

Floors were spray buffed using KinSan SprayBuff Pro, a polymer-based spray buff solution, a red maintenance disk, and a 51-cm buffing machine operated at 300 rpm. The spray buff solution provided no antimicrobial activity. The maintenance disk was vacuum-cleaned after no more than 56 m^2 of floor was buffed with each side of the disk. After spray buffing, floors were dusted with a chemically treated dust mop.

Particulate matter was collected from soiled dust mops and buffing disks by using the PortaVac 100 vacuum machine equipped with a 0.3-μm microfilter.

Investigative evaluations. Floor cleaning studies were carried out in health care facilities and in a large office-warehouse facility. The test area in one health care facility was a high-traffic corridor serving the cafeteria, warehouse, loading dock, and elevators. The test areas in the remaining health care facilities were corridors in medical or surgical nursing units. The test area in the office-warehouse facility was a high-traffic corridor connecting the warehouse and office areas. The same corridor in each test facility was used to evaluate all cleaning procedures included in the study. The floor test area in each test facility was 93 m^2. The dust mop or wet mop was challenged by cleaning a 186- to 279-m^2 floor area before cleaning the test area with the same dust mop or wet mop. A clean buffing disk was used in each test area since disks were cleaned after buffing no more than 56 m^2 per side. During each study of floor cleaning, levels of bacterial contamination were evaluated by environmental microbial sampling of the floor surface and of the air. Relative airborne dust concentration levels were determined by environmental air sampling.

Contamination of floors was measured by using 30 surface agar-contact Rodac plates (Falcon Plastics, Oxnard, Calif.) before and after each cleaning procedure (4, 6, 10). A total of 30 0.1-m^2 sample areas (usually 0.1-m^2 floor tiles) were selected within the traffic lane of each 93-m^2 test area in each test facility. The same sample area was used for sampling before and after each cleaning procedure, but mutally independent sites within each 0.1-m^2 area were sampled. Floors were allowed to become visibly dry before sampling. All contact plates contained 15.6 ml of Trypticase soy agar with lecithin and Polysorbate 80 added as disinfectant neutralizers (BBL Microbiology Systems, Cockeysville, Md.). Plates were incubated at 35 to 37°C for 20 to 24 h before enumeration of CFU. A Quebec dark-field colony counter with electronic register (American Optical Corp., Buffalo, N.Y.) was used for CFU enumeration.

Airborne bacterial contamination was measured by air sampling with a TDL (Elliott) slit sampler (7, 21) operating at 2.8×10^{-2} m^3 of air per min. Petri plates in the slit sampler contained 20 ml of nutrient agar or Trypticase soy agar (BBL). Dust particle air sampling was carried out using a model AP-3 Digital Dust Indicator (Weather Measure Corp., Sacramento, Calif.), which indicates relative dust concentration, operating at 10^{-2} m^3/min, and which excludes particles greater than 20 μm, counts 60% of particles which are 10 μm and smaller, and counts 100% of 0.3- to 5-μm particles in the respirable size range. Air samplers were centrally located within each test area. Samples were collected for 10 min before, during, and after each test procedure. All samples were taken at 84 ± 8 cm above the floor, an epidemiologically significant range representative of the height of patient beds, bedside tables, and treatment tables, as well as the breathing zones of reclining or seated patients.

Microscopic screening examination of microorganisms was performed on representative colonies selected from bacterial air samples collected before, during, and after each cleaning procedure. Organisms were Gram stained and examined microscopically. A coagulase test was performed on staphylococci. Organisms were not identified further.

Aesthetic acceptability of floors was evaluated by 60 measurements of floor gloss (specular reflectance) before and after each test procedure by using a Glossgard II 60° GlossMeter (Gardner Laboratory Div., Pacific Scientific, Bethesda, Md.). Two gloss measurements were taken within each of the 30 sample areas used for microbial surface sampling. A gloss reading of 70 is considered a practical, achievable level.

Results were evaluated statistically using Student's t distribution at the 95% confidence level ($t_{\pm 0.975}$) to compare the effectiveness of alternative procedures or paired combinations of procedures.

RESULTS

Figure 1 shows percent bacterial reductions on the floor which were attained as a result of three conventional floor cleaning processes in health care facilities: dry dusting; dry dusting followed by wet mopping; and dry dusting, wet mopping, spray buffing, and final dry dusting. Data for studies presented in Fig. 1 were collected by using the conventional floor maintenance procedures when floors were consistently wet mopped on a daily basis and spray buffing was performed periodically. The average percent bacterial reduction was virtually identical for dry dusting and dry dusting followed by wet mopping (79.9 and 79.8%, respectively). However, a statistically significant ($P < 0.05$) additional increase in bacterial reduction resulted by adding spray buffing and final dry dusting to the dry dusting and wet mopping procedures. These two additional procedures brought the total bacterial reduction to 96.7%.

Figure 2 shows a comparison of the percent bacterial reduction attained as a result of dry dusting alone versus the process of dry dusting followed by spray buffing and final

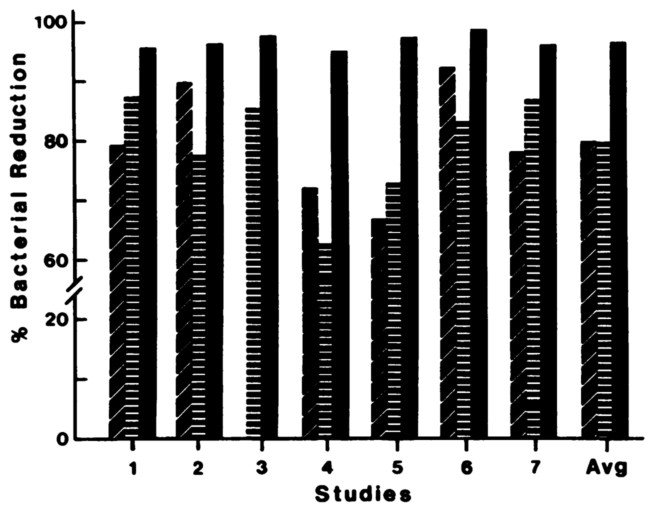

FIG. 1. Bacterial reduction on floors by using three conventional institutional housekeeping procedures. Symbols: ▨, after dust mopping with a chemically treated dust mop; ▤, after dust mopping with a chemically treated dust mop and wet mopping with a disinfectant-detergent; ■, after dust mopping with a chemically treated dust mop, wet mopping with a disinfectant-detergent, spray buffing, and final dust mopping with a chemically treated dust mop.

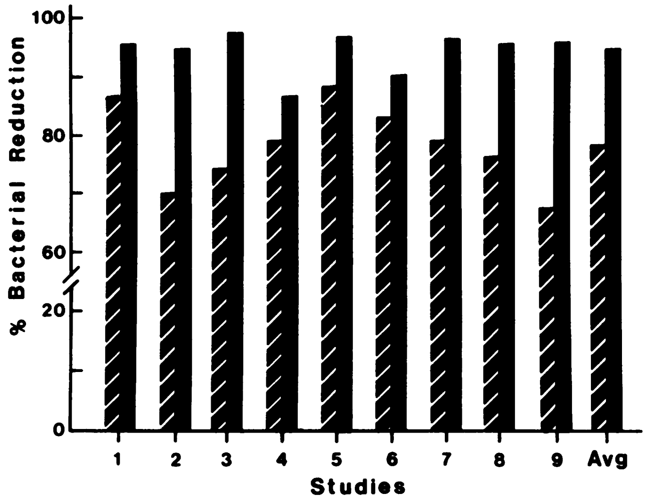

FIG. 2. Bacterial reduction on floors by using two institutional housekeeping procedures without wet mopping. Symbols: ▨, after dust mopping with a chemically treated dust mop; ■, after dust mopping with a chemically treated dust mop, spray buffing, and final dust mopping with a chemically treated dust mop.

dry dusting. Data for studies presented in Fig. 2 were collected using the modified floor cleaning program when floors were consistently maintained without wet mopping. There was no statistical difference ($P < 0.05$) between the average reduction by dry dusting alone (79.1%) and the results shown in Fig. 1 (79.8%) for dry dusting and wet mopping. The increased bacterial reduction due to the addition of spray buffing and final dry dusting was again evident (93.6%) and was not statistically different ($P < 0.05$) from the overall reduction shown in Fig. 1 (96.7%) for the conventional process including wet mopping (chemical disinfection by wet mopping).

Table 1 summarizes the results of bacterial and dust particle air quality evaluations. Data show that neither particulate removal using dust mops nor spray buffing had any statistically significant ($P < 0.05$) impact upon bacterial or dust particle air quality when compared with base-line air quality as determined by measurements obtained before cleaning and after spray buffing and final dry dusting.

Microscopic screening examination of representative colonies from air samples collected before, during, and after cleaning procedures revealed that the predominant microorganisms present in the air were staphylococci (primarily coagulase-negative strains), gram-positive bacilli, gram-positive diplococci, and yeast cells. Gram-negative rods were seen infrequently. There was a consistent distribution pattern of microorganisms among the samples examined.

Table 2 summarizes the levels of microbial contamination found on floors before and after each step in conventional floor cleaning, including wet mopping in seven studies at four locations, and for nine studies in five locations without wet mopping. The final number of CFU per Rodac plate after spray buffing and dusting was statistically lower ($P < 0.05$) than that produced by either dust mopping or wet mopping.

A high-gloss floor surface was maintained for easy cleanability and aesthetic appearance through the new cleaning system. The results of 16,225 gloss readings are shown in Table 3. Gloss was not significantly ($P < 0.05$) affected by dusting, wet mopping, or spray buffing.

DISCUSSION

Two basic considerations were recognized as being critical to any application of the findings to modification of floor maintenance programs currently used in health care facilities. The first was the need for reduction of microbial contamination levels so the potential for environmentally mediated cross-infection would be maintained at the lowest realistically achievable level. Low levels of contamination are considered highly desirable as a quality assurance measure, even though such agencies as the Centers for Disease Control have stated that environmental surfaces have a minor role in transmission of infections (5). By establishing a standard of low microbiological contamination levels on floors, the danger of cross-contamination which is due to floor surfaces should be minimized among patients, staff personnel, and visitors.

The second consideration was that soil and stains should be efficiently removed so the visual appearance of the floors, including gloss and visual cleanliness, would meet criteria for high aesthetic acceptability. Although none of the cleaning procedures had a measurable effect upon gloss, spray buffing did enhance the appearance by burnishing out unsightly scuffs and scratches. Spray buffing also maintained the gloss at a constant level and reduced the frequency required for reapplication of floor finish.

Another benefit was the provision of a safer environment in the health care facility. In 1978, 5% of all work injuries in 25 states occurred among registered nurses, practical nurses, nursing aides, orderlies, attendants, and cleaning service workers (18). Although detailed data on the types of injuries to health care personnel are not available, it is widely accepted that slips and falls are responsible for a large percentage of work-related injuries. Reduction of slip hazards associated with wet floors by eliminating extensive routine wet mopping is an obvious benefit.

An additional advantage is the substantial reduction of floor space blocked off or restricted for use by hazard signs, cleaning equipment, and the wet floor itself during the wet mopping process. Traffic congestion and disruption are thereby reduced in patient areas and other high-traffic areas.

A final benefit is productivity improvement and cost reduction. The new cleaning system reduces the cost of cleaning and maintaining corridor floors by approximately 30%, owing to reduced labor costs.

TABLE 1. Air quality evaluation

Contaminant[a]	No. (mean ± SD) of contaminants per m^3 of air			
	Before cleaning	During dusting	During spray buffing	After spray buffing and dusting
Bacteria	123.6 ± 60.3	127.1 ± 76.8	141.2 ± 102.3	105.9 ± 76.2
Relative dust concentration	328.3 ± 193.3	384.8 ± 191.4	391.8 ± 148.5	345.9 ± 202.1

[a] For each contaminant, 423 air samples extending through 21 months in 13 studies were assessed. Bacteria were collected with a TDL slit sampler; dust concentration was counted with a model AP-3 Digital Dust Indicator.

TABLE 2. Microbial contamination comparison by CFU

Procedure[a]	CFU (mean ± SD) per Rodac plate			
	Before cleaning	After dusting	After wet mopping	After spray buffing and dusting
Conventional floor cleaning	51.2 ± 23.1	10.3 ± 6.8	10.3 ± 6.4	1.7 ± 1.3
New method	45.1 ± 26.1	9.4 ± 6.4		2.9 ± 2.3

[a] For the conventional procedure, 4,754 Rodac samples were assessed in seven studies and four test sites extending through 29 months; for the new method, 5,118 Rodac samples were assessed in nine studies and five test sites extending through 21 months.

There was no statistically significant ($P < 0.05$) further decrease in the number of CFU assessed from floors which were wet mopped as compared with that assessed from floors which were dusted to remove particulate soil with only a dry, chemically treated dust mop. This result is contrary to the widely held assumption that wet mopping with a chemical disinfectant is essential to assure that sanitizing will take place.

There was a significant reduction ($P < 0.05$) in CFU attained by spray buffing and a final dry dusting over that attained by dry dusting alone or by dry dusting followed by wet mopping with a disinfectant-detergent solution. The mechanism by which this sanitizing effect takes place has not been fully elucidated. However, the formulation used in the spray buffing process and the process itself result in a substantial smoothing of the floor finish surface, thus eliminating crypts and other imperfections which serve to entrap microorganisms. Spray buffing also skims off the surface of the finish film on the floor. The spent floor finish and the major portion of the remaining microorganisms are then efficiently collected in the final dry dusting procedure.

In the past, there have been recommendations that dry dusting of floors be avoided and that wet floor cleaning procedures be used exclusively (1, 2). This is based on the belief that floor dusting disseminates dust and microorganisms into the air, thus enhancing the potential for environmental cross-contamination. The same considerations have led to recommendations against machine buffing of floors (1, 2).

However, the results of environmental sampling of both airborne microorganisms and dust particles show that the procedures used in this study do not have a statistically significant ($P < 0.05$) impact on air quality. This is due both to the characteristics of the mop treatment and spray buffing compounds and the practice of periodically collecting the soil and debris which adheres to the dust mops and buffing disks by vacuuming them with a highly efficient vacuum cleaner equipped with a fine particle filtration system.

TABLE 3. Results of gloss readings

Study no.	Avg gloss units[a]			
	Before cleaning	After dust mopping	After wet mopping	After spray buffing and dust mopping
1[b]	72.9	74.5		72.7
2	64.0	65.1		65.7
3[c]	33.5	33.0		36.6
4	76.2	77.2	75.8	77.3
5	74.8	75.8		73.7
6	73.6	74.0	73.3	74.2
7	55.8	56.6		58.5
8	47.3	49.5		55.8
9	67.7	67.5	68.8[d]	66.5

[a] Results of 16,225 gloss readings extending through 14 months by using a Glossgard II 60° GlossMeter. No significant difference ($P < 0.05$) was observed between gloss levels within each study.

[b] New floor finish.

[c] Bare floor.

[d] Automatic floor machine instead of wet mopping.

These results apply to the specifically developed processes, equipment, and chemicals used in these studies. They would not necessarily be applicable to dry buffing processes in which the polymer-based spray buffing product is not used. The amounts of dust particles and microorganisms disseminated into the air will also depend on the speed of rotation of the buffing machine. Although there are machines which operate at 1,000 rpm or greater, their utilization in health care facilities should be subject to specific evaluation of the dissemination of contaminants into the air as the use of the 300-rpm buffing machine was evaluated in this study.

The screening identification study of airborne organisms collected during the various procedures showed that there was no change in the distribution pattern of organisms collected as a consequence of the cleaning procedures. From this observation, it may be inferred that the procedures utilized are not microbiologically selective for any specific organisms.

Conclusions. A new process for routine cleaning and maintenance of hard-surfaced floors in health care facilities was evaluated with respect to its effectiveness in removing bacterial contamination and maintenance of aesthetic quality. This process used a chemically treated dust mop to remove dust particles and a procedure of spray buffing with a polymeric compound to remove soil and microorganisms which adhere to the floor finish. Specifically designed equipment and supplies and specifically formulated chemical products were required in the new process to achieve both microbiological and aesthetic acceptability. The percent bacterial reduction from this process was significantly greater than that achieved with a traditional procedure of wet mopping with a chemical disinfectant. At the same time, the serious hazards of slips and falls associated with wet floors, and traffic disruption, were essentially eliminated. Thus, this process provided greater effectiveness in sanitizing floors and also greater environmental safety. Floor housekeeping costs were also substantially reduced.

This process can be used for the routine cleaning of floors in corridors of patient-care and non-patient-care areas, lobbies and waiting areas, and other unconfined areas which permit the use of buffing machines.

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