Impact of Protective Footwear on Floor and Air Contamination of Intensive Care Units

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Abstract

Background: Use of protective footwear before entering the intensive care units is enforced with the assumption that it lowers the incidence of bacterial floor colonization. The present study was carried out to find the efficacy of protective footwear on bacterial floor colonization.

Methods: The study was carried out in the intensive care unit of a tertiary care hospital. The study was divided into two phases of two weeks each, phase I with and phase II without use of protective footwear. Samples were taken at six different sites namely footwear exchange area; visitors /staff route; partitioned patient cubicle; central monitoring area; open patient cubicle and scrub up areas. Floor samples were taken at 0600, 1100, 1700 and 2200 hours and air samples at 0600 and 1700 hours. Bacteria were identified and colony forming units (cfu) measured from floor and colony forming units/metre³ (cfu/m³) from air sample cultures.

Result: A total of 9521 bacterial colony forming units were isolated from 192 samples in phase I from the floor samples and 9971cfu from 192 samples in phase II. From 96 air samples in each phase, a mean of 262 cfu/m³ in phase I and 220cfu/m³ in phase II were isolated. The difference between the two phases was statistically not significant (p value > 0.05 for both).

Conclusion: Floor and air colony counts showed no significant difference in the two phases with and without protective footwear. Protective footwear had no significant impact on bacterial contamination of floors.

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Key Words : Floor contamination; Intensive care unit; Protective footwear; Floor samples; Bacterial floor colonization

Introduction

The practice of using protective footwear before entering the intensive care units (ICU) is enforced with the assumption that it lowers the incidence of bacterial floor colonization. It is also assumed that it may lower the chances of infections caused due to failures in decontamination and aseptic techniques. The studies carried out in ICUs across the world have been contradictory. Some support the use of protective footwear [1], while others claim no significant difference in floor contamination with the use of footwear [2,3]. One study even indicated higher contamination with the use of overshoes [4,5]. These facts are important as a significant proportion of the bacteria found in ICU air were redispersed floor bacteria. All these studies have been carried outside India in different hospital working conditions than ours. Therefore we decided to study the impact of protective footwear on floor contamination in an ICU of a tertiary care hospital.

Material and Methods

The study was carried out at the ICU of a tertiary care hospital in Western India. Samples were collected on four

full working days a week for four weeks.

In the ICU wet floor mopping using phenol is routinely done at 0700, 1030, 1400, 1700 and 1930 hours respectively. The commercially available polyethylene protective footwear was used. The bacteriological samples from floor were collected by a sterile cotton swab stick moistened with sterile normal saline. The samples swab sticks were put in a sterile test tube and sent for culture. For collection of air samples "LA030 HI AIR PETRI" air sampling system by HIMEDIA with a flow of 100 litres of air /20 seconds was used.

The study was divided into two phases. Phase I lasting for two weeks when all the visitors and staff were allowed in the ICU wearing conventional protective footwear. Phase II followed this period and also lasted for two weeks. During this phase, all visitors including staff were allowed to enter ICU with their ordinary footwear without any sterility intervention. The numbers of visitors were approximately the same during both phases.

The floor samples were taken at 0600, 1100, 1700, 2200 hours at six predefined sites, namely Site 1 – site of exchange of footwear / wearing of protective footwear; Site 2 – visitors/ staff route; Site3 – patient bed space (partitioned); Site 4 – central monitoring area; Site 5 – patient bed space (open) and Site 6 – common entrance of toilet and kitchen.

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The 1700 hours sample was taken after floor mopping. All the floor samples were plated on Blood Agar and Mac Conkey Agar. The plates were incubated at 37°C and reporting was done after 48 hours. The colonies grown were identified using appropriate tests [6] and quantitative estimation of the organisms was done using the counting microscope. Study for anaerobic organisms was not carried out. Fungal colonies were not typed [6]. Results were expressed as colony forming units (cfu) for each isolate.

Air sampling was also done on all days at 0600 and 1700 hours at the six sites using nutrient agar plates which were placed inside the sampler and sampled for 100 seconds, exposing them to 500 litres of air. Air sampling was done at the patient's bed level (75cms height from floor) at all sites. The plates were incubated at 37°C for 24 hours. Quantitative estimation was done using a counting microscope.

The average bacterial counts for each day from different sites was used for calculation. Paired "t" test was applied for statistical significance between the two phases and "p" value < 0.05 considered significant.

Results

A total of 384 floor samples and 192 air samples were collected in both phases. From 192 floor samples in phase I, a total of 9521 bacterial cfu were grown. From an equal number of samples in phase II, 9971 cfu were isolated. From the 96 air samples in each phase, a mean of 262cfu/m³ in phase I and 220 cfu/m³ in phase II were isolated. Floor culture samples and air sample cfu taken in the two phases of the study

showed no significant difference (Fig. 1-3).

The colony counts from floor samples increased with elapsed time since the last mopping operation and it was highest at 0600hours (Fig.4). However, air colony counts did not show any variation with time (Fig.5) in both the phases, which could be attributed to wet mopping and settling of particles on the floor thus making air counts indifferent after some time. Methicillin resistant staphylococcus aureus (MRSA) and fungi were the commonest organisms isolated. The fungal colonies were not typed. The organism was cultured in all the 192 plates in both phases I and II (Fig. 6). E coli was isolated in 6.7% and 4.6% of the plates in phases I and II respectively. Pseudomonas (1.5 and 1.04%), enterobacter (1.04 and 0.5%), klebsiella (0.5 and 0.5%) and actinomycetes (0.5 and 0.5%) were the other organisms isolated in the respective phases.

Discussion

Methicillin resistant staphylococcus aureus was the predominant organism identified in the floor cultures while the fungal colonies were ubiquitous. Escherichia coli, pseudomonas, klebsiella and enterobacter species were sporadically isolated. There was no preponderance of gram negative organisms in the toilets or pantry. It could be attributed to regular cleaning practices and bed bound patients not using these areas.

Floor contamination in the hospital ward setting is mainly from the bacteria shed by patients and staff, dispersed as skin squames and droplets which are likely

Fig. 1 : Average floor bacterial counts at six sites during two phases of study showed no statistically significant difference.

Fig. 2 : Daily average floor bacterial counts during the two phases of the study showed no statistically significant difference.

Fig. 3 : Air colony counts at the six predefined sites during the two phases showed no statistically significant difference.

Fig. 4 : Floor bacterial counts at different times during two phases. Time of floor mopping is shown by arrows

Fig. 5 : Air colony counts at different times during the two phases of study showed no statistically significant difference.

to be infected with skin commensals. On an average, an individual sheds 10^6 squames per day [7,8]. The predominant organisms are likely to be staphylococcus epidermidis and other coagulase negative cocci, diphtheroids and bacillus species. These make up for 99% of the total organisms on a dry ward floor [7].

Floor colony counts of microbes in wards remain constant throughout the day because the rate of shedding by the room occupants is constant. Cleaning and disinfection have a temporary effect on the microbial numbers. Cleaning decreases the microbial counts by 80% and the disinfectants by 95-99%. In one study with use of dry mops the floor bacterial count reduced by 55% and with wet foam a reduction of 75% was documented [9]. A constant shedding of skin squames from the staff and patients accounts for a microbiological equilibrium within two hours in a busy ward. This could explain our finding of lowest microbial counts after mopping and the increase as the interval from mopping increases. The highest colony counts were from areas with maximum human activity such as the nursing station area and the entrance to the ICU.

It has been shown earlier that footwear (ordinary shoes, clean shoes, shoe covers) do not significantly affect floor contamination [2,3]. This study also shows that there is no significant reduction in floor colony counts whether overshoes were used or not. Consistent with human activity, the amount of bacteria was low in the morning and increased in the middle of the day when a steady state seems to have reached. The use of non sterile shoe covers was the limitation of this study. This could have probably played some role in preventing new microbes from the "street" entering the ICU.

Air colony counts in room air depends upon the number of occupants, their activity and the air flow rate. Staphylococcus aureus remains the commonest air-borne pathogen in the ICU and operation theatres. Usually it does not cause disease as it is rarely dispersed at a distance of more than one meter and dies rapidly. The same is true for gram negative pathogens that are sensitive to drying. Use of laminar air flow and air filters

Fig. 6 : Bacterial strains isolated in floor cultures. Others include pseudomonas, enterococcus, klebsiella and Acetobacter.

is common in operation theatres [10], but not in minor operation theatres or ICUs. This study shows that air colony counts remain stable in different locations throughout the day.

In conclusion we found that the ICU contained very high floor and air colony counts as compared to the laid down standards. The use of protective footwear had no significant impact on bacterial colony forming units isolated from floor and air in the intensive care units. Their use can be dispensed with and expenses on protective shoe covers avoided.

Conflicts of Interest

None identified

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