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Original Research Article

Effectiveness of Cleaning Practices of High Touch Surfaces Using Sodium Hypochlorite Disinfectant in an Intensive Care Unit

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Abstract

Environmental cleaning is an integral element of nosocomial infection prevention. The aim of our study is to determine the efficacy of environmental cleaning practices by estimating the microbial contamination of high touch surfaces in an ICU. We used sodium hypochlorite disinfectant and followed one cloth with one dip on a single surface in one direction technique. Sixty-one pre-cleaning and post-cleaning samples each were collected demonstrating a decrease in bioburden from 59% to 8%. Thus, we report a detailed account on the cleaning protocols practiced in a resource limited setting which are efficient and cost effective.

Keywords: High touch surface; sodium hypochlorite; disinfection; environmental cleaning.

Abbreviations

HAI: Hospital Acquired Infections
HCW: Health care worker
CDC: Center of Disease Control
HICPAC: Healthcare Infection Control Practices Advisory Committee
PICU: Pediatric Intensive care unit
MSSA: Meticillin sensitive Staphylococcus aureus
MRSA: Meticillin resistant Staphylococcus aureus
VRE: Vancomycin resistant Enterococcus.

INTRODUCTION

Health care associated infections (HAI) are one of the most daunting public health threats worldwide. There have been several studies over the years focusing on the impact of HAI on patient safety, long term morbidity, increased resistance of microorganisms to antimicrobial agents, higher financial burden for the patient and their families, prolonged hospital stay and overall excess mortality. As per WHO report on the burden of endemic HAI worldwide published in 2011, the pooled prevalence in mixed patient populations in low- and middle-income countries was 10.1%-15.5% (WHO report, 2011).

One of the core factors determining acquisition of HAI is the patients' environment in the hospital. Microorganisms present in the Hospital environment consists of both endogenous and exogenous sources. Endogenous sources refers to normal flora of body sites such as skin, nose, mouth gastrointestinal tract or vagina which can cause infections in vulnerable patients under favorable conditions and exogenous sources are external to the patient such as various touch surfaces, hospital bed, Health care workers (HCW), medical devices, monitors and patient care equipment (WHO report, 2011). These sources act as reservoir of pathogens and have been identified as major contributor of cross transmission, patient colonization and infection. The most common offending pathogens include *Meticillin Résistant Staphylococcus aureus (MRSA), Vancomycin Resistant Enterococcus (VRE), Clostridium difficile, Acinetobacter spp, Pseudomonas, and burkholderia app*. In the study to estimate relative contribution of different potential sources for ICU acquired infections, environmental contamination contributed to about 20% of the infections (R.A Weinstein, 1991). Contamination of inanimate surfaces may occur as the consequence of direct patient shedding of bacteria (higher from infected than colonized patients) or via HCWs' hands (Vincenzo Russotto *et al.*, 2017). Other factors that affect surface

contamination and transmission are the type of organisms, source destination, humidity level, size of inoculum, patient to staff ratio and ICU infrastructure (Vincenzo Russotto *et al.*, 2015).

Environmental cleaning has long been identified as an important measure in prevention of HAI. CDC and HICPAC guidelines for environmental infection control in health care facilities have sub-classified environmental surfaces into medical equipment and patient room surfaces such as bedrails/controls, bedside tables, cardiac tables, telephone, light switches, door handles, trash can etc (Sehulster L *et al.*, 2003).

The aim of our study is to determine the efficacy of environmental cleaning practices by estimating the microbial contamination of inanimate environmental surfaces surrounding the patients before and after cleaning in the Pediatric Intensive Care Unit (PICU).

METHODS

Study Design

This study was performed in the Pediatric Intensive care unit of a tertiary care referral center in India. We used 1% sodium hypochlorite as per guidelines of Ministry of Health and Family Welfare, India (Ministry of health and family welfare 2020). The HCW involved with housekeeping underwent monthly training sessions and demonstrations of cleaning techniques for high touch surfaces. For the purpose of this study we identified total of 10 high touch surfaces in the PICU based on its availability, relative importance and frequency of handling; lesser handled surfaces were excluded from the study. We chose bed rails, bedside tables, cardiac tables, ventilator surfaces, monitors, suction regulator knobs, humidifiers, switch buttons, dressing trolley and IV poles. Swabs were collected approximately 15 minutes before and after a scheduled cleaning.

Cleaning Protocol

The cleaning process starts with supervised preparation of 1% sodium hypochlorite solution. Disinfected cotton cloths approximately 20in x15in in size which are cutout from surgical drapes and linens were dipped in the solution to wipe the high touch surfaces. The method used was one cloth with one dip on a single surface in one direction. A new cloth was used each time for the next surface. The used clothes were never dipped back again in the disinfectant. After each cleaning session, the used clothes were disinfected and then laundered for reuse.

Specimen Collection

Cotton swabs were used for collection of samples. They were soaked in normal saline and rubbed over the surface thrice and then placed in sterile culture tubes. The specimens were immediately inoculated on Blood agar and Mac Conkey agar. Colonies were studied the next day for comparative analysis of bacteriological load, biochemical characteristics and Antimicrobial susceptibility pattern.

RESULTS

Out of the 61 samples collected before cleaning, 36 samples grew organisms, showing contamination rate of 59%. We noted the following incidence of contamination on high touch surfaces before cleaning: Suction regulator knob (100%), monitor screen (75%), cardiac table (75%), ventilator surface (75%), IV stand (75%) bedrail (60%) and bedside table (50%).

The organism isolated from these samples were *Coagulase negative Staphylococci* (n=13), followed by *Meticillin sensitive Staphylococcus aureus* (n=10), *MRSA* (n=04) and *Acinetobacter Spp*. (n=04), *Enterococcus (n*=01), *Klebsiella* spp (n=02) (Figure 1).

In post cleaning specimens, only five swabs grew organisms, *Coagulase negative Staphylococci* (n=03) and Meticillin sensitive *Staphylococcus aureus* (n=02). The bioburden dropped from 59% to 8% post cleaning. (Table 1). The decrease in the bioburden was found to be statistically significant (Table 2).

Average log reduction in bacterial growth post cleaning using sodium hypochlorite 1% as a disinfectant was 4.2. The percent kill of disinfection was 94.6% (table 3.)

Table-1: Organisms isolated from High touch surfaces BEFORE cleaning

High touch surface	No of samples	Positive growth	MSSA	MRSA	Coag. Negative Staphylococci	Klebsiella	ESBL Klebsiella	Acinetobacter	MDR Acinetobacter	Enterococci	Streptococci	Pseudomonas
Bed rails	10	06	0	02	03	0	0	01	00	0	0	0
Bed side tables	10	05	02	0	02	0	0	0	0	01	0	0
Switch buttons	5	00	0	0	0	0	0	0	0	0	0	0
Humidifiers	4	00	0	0	0	0	0	0	0	0	0	0
Dressing trolley	01	00	0	0	0	0	0	0	0	0	0	0
Monitor screens.	08	06	02	0	01	0	0	0	03	0	0	0
IV stand	04	03	0	0	01	01	0	0	0	0	01	0
Cardiac table	08	06	03	02	0	0	01	0	0	0	0	0
Suction port knob	07	07	01	0	05	0	0	0	0	0	0	01
Ventilator surface	04	03	01	0	02	0	0	0	0	0	0	0
Total isolates	61	36	10	04	13	01	01	01	03	01	01	01

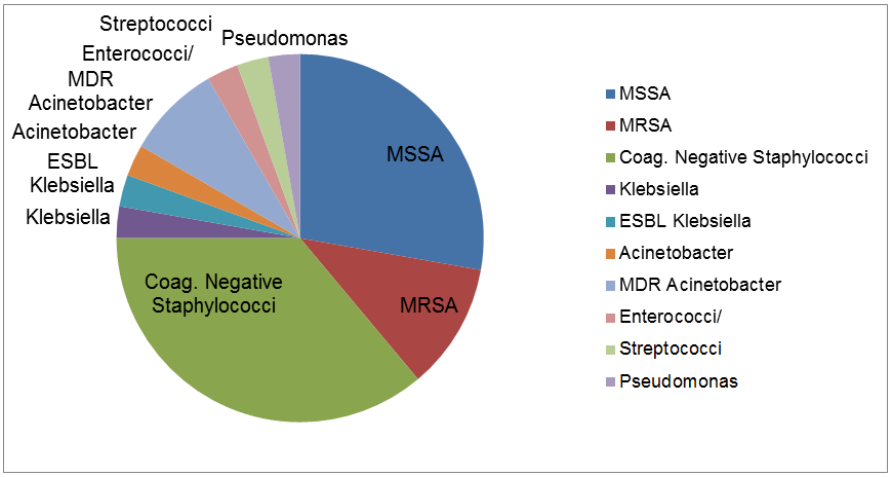

Fig-1: Showing contamination of high touch surfaces with different organisms

Table-2: Comparison between samples collected before and post cleaning

High touch surface	No of samples	Positive growth Precleaning samples	Positive growth Post cleaning samples	McNemar Chi square	p value
Bed rails	10	6	1	26.200	0.000
Bed side tables	10	5	1	27.200	0.000
Monitor screens.	8	6	0	29.008	0.000
IV stand	4	3	1	29.183	0.000
Cardiac table	8	6	0	29.008	0.000
Suction port knob	7	7	1	25.208	0.000
Ventilator surface	4	3	1	29.183	0.000
Switch buttons	5	0	0		
Humidifiers	4	0	0		
Dressing trolley	1	0	0		
Total isolates	61	36	5		

There is statistically significant decrease of positive growth in high touch surface areas after cleaning.

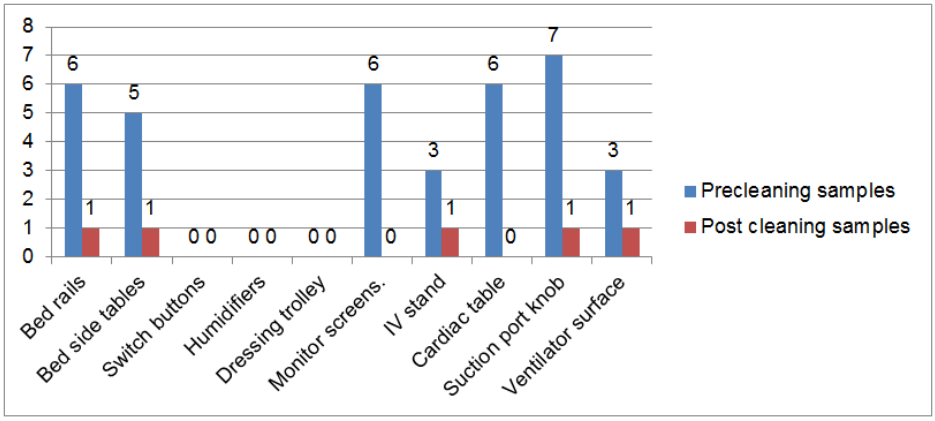

Fig-3: Bar diagram showing comparison between contamination rate of high touch surfaces before and after cleaning

Table-3: Table showing average log reduction in bacterial count and percent kill after disinfection post cleaning

Sample	Pre cleaning Cfu/ml	Post cleaning cfu/ml	log reduction	Percent kill after disinfection (%)	Sample	Pre cleaning cfu/ml	Post cleaning cfu/ml	log reduction	Percent kill after disinfection (%)
Bedrail No 1	12.5x 10^5	4.0 x 10^2	3.4943	57.3	Monitor 1	$1.8x10^4$	Nil	4.2553	100
Bedrail no 3	13.2x 10^5	Nil	6.1206	100	Monitor 2	$2.2x10^4$	Nil	4.3424	100
Bedrail No4	$1.4x10^2$	Nil	2.1461	100	Monitor 3	$1x10^2$	Nil	2.00	100
Bedrail No5	$2.91x10^4$	Nil	4.4639	100	Monitor 4	$2.3x10^4$	Nil	4.3617	100
Bedrail no 6	17.6x 10^6	0.8 x 10^2	5.3424	73.70%	Monitor 5	$3.2x10^3$	Nil	3.5051	100
Bedrail No 8	$2.3x10^3$	Nil	3.3617	100	Monitor 8	$2x10^3$	Nil	3.301	100
Bedside table no 2	$8.2x10^7$	Nil	7.9138	100	Ventilator No 1	$5.7x10^6$	$0.1x10^2$	5.7559	85.10%
Bedside table 5	$0.9x10^2$	Nil	1.9542	100	Ventilator No 3	$2.4x10^4$	Nil	4.3802	100
Bedside table 6	$10.2x10^2$	Nil	3.0086	100	Ventilator No 4	$3x10^3$	Nil	3.4771	100
Bedside table 7	$7.6x10^3$	Nil	3.8808	100	Suction port 1	1.2x 10^3	Nil	3.0792	100
Bedside table 8	$1x10^3$	Nil	3.00	100	Suction port 2	$11.6x10^5$	Nil	6.0645	100
Cardiac table1-	$1.8x10^4$	Nil	4.2553	100	Suction port 3	$9.1x10^5$	Nil	5.959	100
Cardiac table 2	$2.1x10^4$	Nil	4.3222	100	Suction port 4	$1.9x10^6$	Nil	6.2788	100
Cardiac table3	$6x10^4$	Nil	4.7782	100	Suction port 5	$3.4x10^5$	Nil	5.5315	100
Cardiac table4	$2.8x10^5$	Nil	5.4472	100	Suction port 6	$0.67x10^2$	Nil	1.8261	100
Cardiac table5	$1x10^4$	Nil	4.00	100	Suction port 7	$3.6x10^7$	$0.3 x10^2$	6.0792	80.40%
Cardiac table6	1.2 $x10^4$	Nil	4.0792	100	IV stand 3	$1.02x10^3$	Nil	4.0086	100
IV stand 2	$1x10^2$	Nil	2.00	100	IV stand 4	$5.6x10^5$	$0.76x10^2$	3.8674	67.2

Average log value pre cleaning 4.4458, Average log value post cleaning 1.3946, Average log reduction in bacterial growth post cleaning 4.212, Percent kill after disinfection 94.6%

DISCUSSION

The association between the contaminated non-invasive devices serving as a reservoir for nosocomial infections has been demonstrated in several studies (Falk *et al.* 2000, Kirk Huslage *et al.)*. Although these are high touch surfaces, they are defined as noncritical environmental surfaces by CDC and intermediate level disinfectants like chlorine and chlorine compounds are recommended for their effective cleaning. Prior to the onset of COVID19 pandemic our hospital used a combination of Glutaraldehyde and quaternary ammonium compounds which are now replaced by 1% sodium hypochlorite solution. This was done in order to decrease errors in reconstitution of the in use disinfectant solution.

As there has been no consensus opinion about any particular cleaning technique being most effective in disinfecting non critical surfaces, we emphasized greatly on the cleaning by one cloth-one dip method. This method ensured minimal spread of bacteria by mop and absolute no contamination of disinfectant solution used during cleaning. Microfiber products are claimed to be more efficacious than cotton cloth (L. Cobrado *et al.,* 2017), our practice of using cotton cloth had turned out to be equally effective. Microfiber products appeared to be too expensive for single use. They tend to get damaged with frequent exposure to disinfectants and bleach. Use of pre impregnated wipes is another method used for cleaning. Though effective in reducing the bacterial load to great extent, its environmental impact owing to enormous waste generation and cost effectiveness should be taken into consideration (Beatrice Casini *et al.*, 2018). As the cotton mops used were procured from left over linen from linen supply department, it was readily available, replaceable and cost effective.

It was interesting to note that the devices which were almost exclusively handled by the HCW were the most contaminated. Our findings were similar to those noted by Kirk *et al*. wherein hands of HCW formed a major vector in cross transmission of pathogens with an estimate of approximately 20 to 40% of nosocomial infections. Daily and frequent disinfection practices like ours have shown to reduce the acquisition of the pathogens on hands after contacting high-touch surfaces and reduced contamination of hands of healthcare workers caring for the patients (Sirisa Kundrapu *et al*. 2018). We believe that simultaneous sample collection from hands of HCW working in PICU would have been an important supportive evidence for our practice.

We have identified few limitations in our study; one of them was the use of 1% sodium hypochlorite which was in fact more concentrated in comparison to the recommended concentration (1:100 dilution of 5-6.5% solution). It may have been one of the factors responsible for significantly reducing the bio burden. Although we identified 10 high touch surfaces, they were not utilized uniformly for every patient's care. That explains the small sample size of this study. Application of frequent cleaning protocol could appear as a potential limitation to individual institutions based on their budget allocation, resources, staff availability and patient volume.

CONCLUSION

Our study data can have future implications in evaluating application of such simple, efficient and effective cleaning practices to reducing the incidence of nosocomial infections, overall cost analysis and waste generation in a resource limited setting.

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