How to Cite:
Farooq, S., Rishi, S., Dewani, S., Bashir, L., & Mahnoor, M. (2022). Drug resistant bacterial contamination of inanimate surfaces, equipment and health care workers in ICU of a tertiary care Hospital in North India. *International Journal of Health Sciences*, *6*(S4), 4214–4220. https://doi.org/10.53730/ijhs.v6nS4.9227

Drug resistant bacterial contamination of inanimate surfaces, equipment and health care workers in ICU of a tertiary care Hospital in North India

Dr Shaika Farooq
Associate Professor, Department of Microbiology, Government Medical College, Srinagar

Dr Saqib Rishi*
Senior Resident Department Of Microbiology, Government Medical College, Srinagar
*Corresponding author

Dr Safura Dewani
Senior Resident Department Of Physiology, Government Medical College, Srinagar

Dr Lenah Bashir
Lecturer, Department of Microbiology, Government Medical College, Srinagar

Dr Mahnoor
Postgraduate Scholar, Department Of Microbiology, Government Medical College, Srinagar

***Abstract*---**ICU-acquired infections are a challenging health problem worldwide as the patient's immunity is already compromised and these infections are usually caused by MDR pathogens. In ICUs inanimate surfaces and equipment may be contaminated by bacteria. Cross-transmission of microorganisms from inanimate surfaces may have a significant role for ICU-acquired infections. Contamination may result from HCWs hands or by direct patient shedding of bacteria. This study was conducted to determine the rate of bacterial contamination on environmental surfaces and health care workers of ICU our hospital. Swabs from healthcare workers and surrounding environmental surfaces were collected randomly from Adult Intensive care units. Bacterial isolates were identified by standard microbiological techniques. Antibiotic sensitivity testing was performed by Kirby Bauer disc diffusion method and data was analyzed. A total of 35 samples were collected, of which 29 (82.8 %)

samples yielded positive bacterial growth. Of these 29-positive growth, 10 (34.1%) were from hand swabs of HCWs, 10(34.1%) were from nasal swabs and 9(31.0%) were from environment. Seven different bacterial isolates were identified. Coagulase Negative *Staphylococcus* (CONS) 10(28.5%), MRSA 5(14.2%) and Klebsiella spp 5(14.2%) accounted for majority of the isolates followed by MSSA 3(8.5%), Pseudomonas spp 1(2.8%), E.coli 1(2.8%) and ASB 4(11.4%). Screening of the swabs from the health care workers showed 20.83% (5/24) MRSA colonization .No growth was detected from–Nurses station,Anesthesia technician hands and nurses nasal swabs. Gram negative isolates were sensitive to most of the commonly used Antibacterial agents. Study results showed Intensive care unit staff and environmental surfaces as probable sources of bacterial contamination. HCWs should be aware of the risk of cross-transmission of microbes between them to inanimate surfaces and vice versa. The hospital infection control and prevention team should conduct periodic surveillance, and ensure strictly adhere to basic standard precautions at all the times during health care activities.

***Keywords*---**infection control ICU, drug resistant bacterial contamination ICU, MRSA, frequent touched surfaces.

Introduction

Nosocomial infections are a major threat in most of the hospitals and as high as 19% in the developing countries [1], especially in the Intensive Care Units (ICU), where number of direct contacts between the hands of Health Care Workers (HCW) and the patient occurs, which mandates the strict adherence to infection control practices and standards. The same standards are applicable for the equipment used, as many of the potential pathogens can survive for weeks on the inanimate surfaces. In the ICU, patients are often exposed to multiple procedures, invasive devices etc., increasing their chances of contracting such potential pathogens. Most of the times these potential pathogens exhibit Multiple drug resistance. Multiple Drug Resistant (MDR) organisms are microorganisms (predominately bacteria) resistant to more than one class of microbial agents. Even though MRSA (Methicillin Resistant *Staphylococcus aureus*) or VRE (Vancomycin Resistant Enterococcus) are resistant to only one class of antimicrobial agents they are frequently associated with resistance to other classes [2]. MRSA is worldwide a major cause for Hospital Acquired Infections (HAI). The prevalence of MRSA ranges from 20-80% in India [3]. Similarly, among the gram negative bacteria a major concern is the production of new beta-lactamases which are capable of degrading cephalosporins and carbapenams. Infections with such organisms increase the morbidity, mortality, hospital stay and cost of treatment. Patients are inevitably exposed to higher antibiotics and other drugs which may result in further complications. In view of the above factors, this study was undertaken to determine the rate of colonization of potential pathogens in the hands of HCWs and frequent touched surfaces of ICU environment.

Materials and Methods

A cross-sectional study was conducted from May 2022 at Adult Intensive Care Unit of SMHS Hospital Srinagar Kashmir India. Swabs from HCW's and environmental surfaces were collected randomly. A total of 35 samples were collected, 11 samples from environmental surfaces, 12 samples from anterior nares and 12 from hands of HCWs. Swabs from the both right and left anterior nares were collected. Swab samples were also collected randomly from ICU environmental surfaces and devices that were in close contact with the patient. 11 swabs were collected from: nursing station, ventilators controls, suction machine catheter tip, bed rails, ECG monitor and infusion Pump controls.

Collection and Processing

Swab sample

Prelabeled sterile swabs were moistened in nutrient broth and were rolled over the inanimate surfaces, equipment's, HCWs hands, anterior nares and were transported to the microbiology laboratory within 30 minutes at room temperature. The swabs were streaked on to Blood agar and MacConkey agar media and incubated at 37°C for 24 -48 hours after which plates were observed for any bacterial growth. Any bacterial growth was further identified using standard bacteriological methods and appropriate biochemical tests carried out based on the standard operating procedure (like Gram Stain, Catalase, Coagulase, Oxidase, Indole, Citrate, Urease, Motility and Triple Sugar Iron Tests)[4,5]

Antibiotic susceptibility testing

Susceptibility testing was done on Mueller Hinton agar for all isolates by Kirby Bauer disc diffusion method according to the latest CLSI guidelines. Cefoxitin disc was used for the screening of Methicillin Resistant *Staphylococcus aureus* (MRSA). [6]

Quality control

Escherichia coli ATCC 25922, Klebsiella pneumoniae ATCC 700603, Pseudomonas aeruginosa ATCC 27853, Staphylococcus aureus ATCC 25923 and Enterococcus faecalis ATCC29212 were used for Internal quality check.

Results

A total of 35 samples were collected in surveillance, of which 29 (82.8 %) samples yielded positive bacterial growth. Of these 29-positive growth, 10 (34.1%) were from hand swabs of HCWs, 10(34.1%) were from nasal swabs and 9 (31.0%) were from the ICU environment: further distribution can be seen in Table 1.Seven different bacterial isolates were identified. Coagulase Negative *Staphylococcus* (CONS) 10(28.5%), MRSA 5(14.2%) and Klebsiella spp 5(14.2%) accounted for majority of the isolates followed by MSSA 3(8.5%), Pseudomonas spp 1(2.8%), E.coli 1(2.8%) and ASB 4(11.4%) (Aerobic spore-bearers). Out of the 24 samples

taken from HCWs 5 were seen to be MRSA (20.8%). No growth was detected from– Nurses station, anesthesia technician hands and nurses nasal swabs. Gram negative isolates were sensitive to most of the commonly used Antibacterial agents. While as 14.2% isolates were found to be Methicillin Resistant Staphylococcus Aureus (MRSA).

Table: 1

SITE(N)	MRSA	MSSA	CONS	PSEUDOMONAS SPP	KLEBSIELLA SPP	E.COLI	ASB	TOTAL POSITIVES	NG
Nurses Hands(4)			2		2			4(13.7%)	
Nurses Nasal Swabs(4)			2					2(6.8%)	2
Doctors Hands(2)	1		1					2(6.8%)	
Doctors Nasal Swabs(2)	1		1					2(6.8%)	
Anesthetist Technicians Hands(4)					2			2(6.8%)	2
Anesthetist Technicians Nasal Swab(4)	2		2					4(13.7%)	
Dresser Hands (2)			1		1			2(6.8%)	
Dresser Nasal Swabs(2)	1		1					2(6.8%)	
Bed Rails(1)							1	1	
Ventilator Controls(2)		1					1	2(6.8%)	
Ecg Monitor(2)		1					1	2(6.8%)	
Suction Catheter Tip(2)				1		1		2(6.8%)	
Infusion Pump Controls(2)		1					1	2(6.8%)	
Nurses Station (2)								0	2
Total (35)	5 **14.2%**	3 8.5%	10 28.5%	1 2.8%	5 14.2%	1 2.8%	4 11.4%	29 **82.8%**	6 **17.1%**

Discussion

ICU acquired infections accounts for a major health problem globally leading to higher morbidity and mortality. The potential sources of ICU infections are patient's flora (40-60%) followed by health care workers and their accessories (20-40%) and contaminated environmental surfaces and equipment (20%). [7]The prevalence of ICU acquired infections in developed countries is around 5–10%, while their prevalence is 2–20 times higher in developing countries. [8] The results of our study showed higher contamination of the environmental surfaces and medical devices by Gram positive when compared to Gram negative organisms. Gram positive bacteria predominantly comprised of CONS, MRSA followed by MSSA. Gram negative bacteria included Klebsiella spp, E.coli, Pseudomonas spp.Our findings were concurrent with a study conducted by Tajeddin et al. which showed contamination is more with Gram positive than Gram negative (60.7% v/s 39.3 %).[9] This may be due to the better survival of Gram positive bacteria in contrast to the Gram negative bacteria in dry environment.[10,11] In

contrast to our findings, a study done by Jadhav et al. reported that Gram negative bacteria contributed a major proportion on the ICU inanimate objects than Gram positive.[12] This may be due to the intrinsic resistance exhibited by Gram negative bacteria to disinfectants as their cell wall is impermeable to active biocide agents and they also possess degradative enzymes.[13] Several studies document that hands of ICU staff accounts for 20-40% infections due to the cross transmission between colonized / infected patients.[14,15] A study conducted by Tajeddin et al. on the hands of ICU staff yielded *Acinetobacter baumannii* (1.4%), *Staphylococcus aureus* (5.9%), *epidermidis* (20.9%) and *Enterococcus* spp. (1%).[9] This was in concordance to our study which showed that a good number of HCWs hands are contaminated with gram positive as well as gram negative bacteria. This can be due improper hand hygiene practices. There are several studies confirming the nasal colonization of MRSA as a major risk factor for infections in ICU caused by the colonizing strain.[16-18] The study conducted by Joanchim et al. showed the prevalence of MRSA carriers among HCWs was (15.6%).[19] A study conducted by Warnke et al. revealed that bacterial detection depends on the uptake and release capacities of the swabs and the swabbing techniques.[20] In our study, screening of the swabs from the health care workers showed 20.83%(5/24) MRSA colonization. The antibiotic sensitivity pattern of our isolates showed low rates of multi drug resistance in contrast with other studies where they have reported high resistant patterns.[21,22] None of our isolates were resistant to reserve antibiotics like vancomycin, linezolid, piperacillin tazobactum and carbapenems. Our study yielded 14.2% MRSA which in concordance with some other studies where similar resistance patterns have been reported. This may be attributed to the selective pressure due to extensive use of broad spectrum antibiotics in ICU settings. [23]

Conclusion

Our study results showed ICU staff as well as environmental surfaces as probable sources of bacterial contamination. Bacterial contamination can contribute to ICU acquired infections. HCWs should be aware of the risk of cross-transmission of microbes between them to inanimate surfaces and vice versa. The hospital infection control and prevention team should conduct periodic surveillance, and ensure strictly adhere to basic standard precautions at all the times during health care activities.

References

1. Maheshwari V, Kaore NCM, Ramani VK, Gupta SK, Borle A, et al. A study to asses knowledge and attitude regarding hand hygiene amongst residents and nursing staff in a teritiary care setting of bhopal city. *J Clin Diagn Res*. 2014;8(8):DC04-07.
2. Siegel JD, Rhinehart E, Jackson M, Chairello L. Health care infection control practices [2] advisory committee. management of multidrug-resistant organisms in health care settings. *Centers for Disease Control and Prevention, Atlanta, GA* 2006.
3. Shanthi M, Uma S. Antimicrobial susceptibility pattern of methicillin resistant *Staphylococcus aureus* at sri ramachandra medical centre. *Sri Ramachandra Journal of medicine*. 2009;2(2):1-4.

4. Retty AF, Daniel FS and Aice SW. Bailey and Scotts of Diagnostic Microbiology. 14th ed. Press, Houston, Texas. 2017.
5. Nasser NE, Abbas AT, Hamed SL. Bacterial contamination in intensive care unit at Al-Imam Al-Hussein Hospital in Thi-qar province in Iraq. *Glob J Health Sci.* 2013;5(1):143-149. doi:10.5539/gjhs.v5n1p143
6. CLSI. Performance standards for Antimicrobial Susceptibility testing. 29th ed.CLSI supplement M100. Wayne P A: Clinical and Laboratory Standards Institute. 2019.
7. Weinstein RA. Epidemiology and control of Nosocomial infections in adult intensive care units. *Am J Med.* 1991;91(3 Suppl. 2)):179S-184S. doi: 10.1016/0002-9343(91)90366-6
8. Darge A, Kahsay AG, Hailekiros H, Niguse S, Abdulkader M. Bacterial contamination and antimicrobial susceptibility patterns of intensive care unit's medical equipment and inanimate surfaces at Ayder Comprehensive Specialized Hospital, Mekelle, Northern Ethiopia. *BMC Res Notes.* 2019;12:621. doi:10.1186/s13104-019-4658-5
9. Tajeddin E, Rashidan M, Razaghi M, et al. The role of the intensive care unit environment and health-care workers in the transmission of bacteria associated with hospital acquired infections. *J Infect Public Health.*2016;9(1):13-23. doi: 10.1016/j.jiph.2015.05.010
10. Dickgiesser N. Behaviour of gram-positive and gram-negative bacteria in dry and moist atmosphere (author's transl)]. *Zentralbl Bakteriol B.* 1978;167(12):48-62. PMID: 716702.
11. Kramer A, Schwebke I, Kampf G. How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. *BMC Infect Dis.* 2006;6:130. doi:10.1186/1471-2334-6-130.
12. Jadhav S, Sahasrabudhe T, Kalley V, Gandham N. The microbial colonization profile of respiratory devices and the significance of the role of disinfection: a blinded study. *J Clin Diagn Res.* 2013;7(6):1021-1026. doi: 10.7860/JCDR/2013/5681.3086
13. Russell AD. Bacterial resistance to disinfectants: present knowledge and future problems. *J Hosp Infect.* 1999;43(Suppl 1):S57-S68. doi: 10.1016/s0195-6701(99)90066-x
14. Tschudin-Sutter S, Pargger H, Widmer AF. Hand hygiene in the intensive care unit. *Crit Care Med.* 2010;38(8 Suppl):S299-S305. doi: 10.1097/ CCM.0b013e3181e6a23f
15. Birnbach DJ, Rosen LF, Fitzpatrick M, Arheart KL, Munoz-Price LS. An evaluation of hand hygiene in an intensive care unit: Are visitors a potential vector for pathogens? *J Infect Public Health.* 2015;8(6):570-574. doi: 10.1016/j.jiph.2015.04.027
16. Qiao F, Huang W, Cai L, Zong Z, Yin W Methicillin resistant *Staphylococcus aureus* nasal colonization and infection in an intensive care unit of a university hospital in China. *J Int Med Res.* 2018;46(9):3698-3708. doi: 10.1177/0300060518777812
17. Lucet J, Chevret S, Durand-Zaleski I, Chastang C, Regnier B, for the Multicenter Study Group. Prevalence and Risk Factors for Carriage of Methicillin-Resistant *Staphylococcus aureus* at Admission to the Intensive Care Unit: Results of a Multicenter Study. *Arch Intern Med.* 2003;163(2):181-188. doi: 10.1001/archinte.163.2.181

18. Sakr A, Bregeon F, Mege JL, Rolain JM, Blin O. *Staphylococcus aureus* Nasal Colonization: An Update on Mechanisms, Epidemiology, Risk Factors, and Subsequent Infections. *Front Microbiol.* 2018;9:2419. doi: 10.3389/fmicb.2018.02419
19. Joachim A, Moyo SJ, Nkinda L, et al. Nasal Carriage of Methicillin-Resistant *Staphylococcus aureus* among Health Care Workers in Tertiary and Regional Hospitals in Dar es Salam, Tanzania. *Int J Microbiol.* 2018;2018:5058390. doi: 10.1155/2018/5058390
20. Warnke P, Frickmann H, Ottl P, Podbielski A. Nasal Screening for MRSA: Different Swabs – Different Results. PloS one. 2014;9(10):e111627. doi: 10.1371/ journal.pone.0111627
21. Abubakar AS, Barma MM, Balla HJ, Tanimu YS, Waru GB, Dibal J. Spectrum of bacterial isolates among intensive care units' patients in a tertiary hospital in north eastern Nigeria. *Ind J Sci Res and Tech.*2014;2(6):42-47.
22. Montero JG, Lerma FA, Galleymore PR, et al. Combatting resistance in intensive care: the multimodal approachof the Spanish ICU "Zero Resistance" program. *Crit Care.* 2015;19(1):114. doi: 10.1186/s13054-015-0800-5
23. Karam G, Chastre J, Wilcox MH, Vincent JL. Antibiotic strategies in the era of multidrug resistance. *Crit Care.*2016;20(1):136. doi:10.1186/s13054-016-1320-7
24. Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2021). The COVID-19 pandemic. *International Journal of Health Sciences*, *5*(2), vi-ix. https://doi.org/10.53730/ijhs.v5n2.2937
25. Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2022). Post-pandemic health and its sustainability: Educational situation. *International Journal of Health Sciences*, *6*(1), i-v. https://doi.org/10.53730/ijhs.v6n1.5949
26. Alamsyah, T., Marianthi, D., Hayati, W., & Usrina, N. (2021). Drug user behavior about the development and rehabilitation process in Banda Aceh correctional institution. *International Journal of Health & Medical Sciences*, *4*(1), 88-94. https://doi.org/10.31295/ijhms.v4n1.1348