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ORIGINAL ARTICLE

Contaminated Equipments: A Source of Hospital Acquired Infections among Patients at Critical Areas of Holy Family Hospital, Rawalpindi

IRUM ANWAR[1], KIRAN AHMAD[1], SHIREEN RAFIQ[1], TAQWEEM UL HAQ[2], ZOBIA ASLAM[3], SAEEDA[4]
[1]*Department of Microbiology, Holy Family Hospital Rawalpindi, Pakistan.*
[2]*Abbottabad International Medical Institute, Abbottabad, Pakistan.*
[3]*Department of Medical Laboratory Technology, Riphah International University, Meezan Campus, Rawalpindi, Pakistan.*
[4]*Department of Biosciences, COMSATS University Islamabad, Pakistan*
Correspondence to: Saeeda, Email: saeedakhan4383@gmail.com

ABSTRACT

Introduction: A nosocomial infection is contracted within a period of 48 hours following admission to a hospital or within 48 hours after being discharged from the hospital. Patients in the intensive care unit (ICU) are vulnerable to infections due to various factors, including their pre-existing medical conditions, medical procedures such as surgery, intubation, and catheterization, as well as their potential exposure to microorganisms from fellow patients. In addition to this, the presence of contaminated equipment represents a significant contributor to the occurrence of hospital-acquired infections caused by multidrug-resistant organisms among patients in critical areas.

Methods: This cross-sectional study was conducted in coronary care and critical areas of Holy Family Hospital, Rawalpindi. A total of 415 samples were processed at the microbiology laboratory over a 4 month period from which 112 were swabs taken from equipment of the Medical, Surgical and Pediatric intensive care Units (MICU, SICU, and PICU) and the Coronary Care Unit. The remaining 303 samples were blood, urine, tracheal secretions/tips, pus and Foley tip cultures received in the microbiology laboratory from MICU, SICU, CCU and PICU. Samples were cultured on the appropriate media and observed after the required period.

Results: High levels of contamination (58.03%) were identified on a wide range of healthcare equipment. The total of infected patients were 37.6%. Most common infection site was the respiratory tract. Acinetobacter spp. was the most predominant isolate among patients in MICU, SICU and CCU while Klebsiella spp. was the predominant isolate from the PICU.

Conclusion: A significant degree of contamination is observed across a diverse array of healthcare equipment. Nevertheless, the prevalence of contaminated instruments and the subsequent potential for acquiring a healthcare-associated infection (HAI) can be significantly mitigated through the consistent implementation of cleaning, disinfection, and sterilization protocols for medical equipment.

Keywords: hospital acquired infections, Contamination, equipment, pathogens.

INTRODUCTION

Hospital-acquired infection (HAI) denotes an infection that manifests either 48 hours subsequent to admission or within 48 hours subsequent to discharge from a healthcare facility (1, 2). The duration of this period is prolonged to 30 days in the event that the infection arises at the site of a surgical procedure, and is further extended to one year in cases involving the implantation of a foreign object such as a prosthesis (3), heart valve (4), pacemaker, and so forth. In modern healthcare, infections are frequently associated with the use of invasive devices such as catheters and ventilators. The heightened morbidity and mortality linked to healthcare-associated infections (HAIs) in the intensive care unit (ICU) is currently a significant concern among hospitalized individuals, potentially impacting approximately 10% of admitted patients (6). The most frequently observed types of healthcare-associated infections (HAIs) include bloodstream infections associated with central lines, urinary tract infections associated with catheters, surgical site infections, and pneumonia caused by ventilators. In order to successfully carry out the necessary precautions for infection control, it is crucial to determine the rate and identify the risk factors that result in the development of infections among intensive care unit (ICU) patients (7).

Patients who are critically ill and are being treated in intensive care units (ICUs) face an increased susceptibility to hospital-acquired infections (HAIs) as a result of various contributing factors (8). The introduction of endotracheal intubation and tracheostomy, urinary bladder catheterization, and central venous catheterization all present significant hazards in terms of the disruption of infection barriers. In addition to invasive medical procedures, research findings suggest that several factors contribute to an extended hospital stay (9). These factors include the patient's gender, the presence of intravenous lines and catheters, the occurrence of surgery since admission, intubation, mechanical ventilation, and the patient's age, particularly when the patient is 70 years or older. There are various types of hospitals, and among them, those that specialize in treating urinary catheter-related conditions and diseases such as acute renal failure, coma, or major trauma are particularly susceptible to hospital-acquired infections (10). On average, approximately 5-6% of patients receiving inpatient treatment experience a hospital acquired infection. However, in developing countries, this percentage can range from 10-30%. Therefore, the incidence of infection in developing nations is significantly greater, ranging from 2 to 20 times higher, when compared to developed nations. The mortality rate associated with healthcare-associated infections (HAI) can reach up to 70% in intensive care units (ICUs) (11).

Hospital-acquired infections can be attributed to a wide range of microorganisms, including bacteria, viruses, fungi, and parasites (2). The rates of antimicrobial resistance exhibited by microorganisms obtained from healthcare-associated infections (HAIs) are greater in comparison to those observed in outpatient settings or other hospital wards. Research indicates that healthcare equipment is a significant contributor to the occurrence of infections acquired within hospital settings. Nevertheless, effective preventive measures can be implemented to mitigate this issue (13). According to a study, it has been demonstrated that a significant proportion, specifically one third, of healthcare-associated infections (HAI) can be mitigated by implementing effective infection control measures and adhering to sound hospital practices (14).

METHODOLOGY

This cross-sectional descriptive study was conducted at the Microbiology Laboratory, Pathology Department of Holy Family Hospital, Rawalpindi over a period of 4 months. A total of 415 samples were processed out of which 112 were swabs taken from equipment at MICU, SICU, PICU and CCU. Sterile cotton swabs moistened in normal saline were rolled on the surface of laryngoscopes, beds, ventilators, suction machine, ambo bags and oxygen masks. The remaining 303 samples of blood, urine, tracheal secretions/ETT tips, pus and Foley's tip cultures were pre collected and received in the laboratory from the same areas.

The patient samples were appropriately labeled and subsequently inoculated onto pre-dried culture plates containing suitable agar media, such as MacConkey agar, blood agar, chocolate agar, or CLED agar. The plates were subsequently placed in an incubator set at a temperature of 37 degrees Celsius and left overnight. After an aerobic incubation period of 18 to 24 hours, the plates were examined. The samples obtained from the equipment were cultured on CLED agar plates and subjected to aerobic incubation at a temperature of 37°C for a duration of 48 hours. The plates were examined at two time points, specifically 24 and 48 hours after incubation. The identification of organisms was conducted through the examination of their colony morphology, gram staining, and biochemical tests, including catalase, citrate, oxidase, Triple Sugar Iron, and Sulfide Indole Motility, among others (15).

Sensitivity testing of the isolates was performed by the modified Kirby Bayer method. Antibiotics used were:

1 For Pseudomonas aeruginosa: Aztreonam, Ceftazidime, Cefepime, Ciprofloxacin, Imipenem, Cefoperazone/Sulbactam, Piperacillin/Tazobactam, Polymyxin B.

2 For Coliforms: Ceftriaxone, Ceftazidime, Ciprofloxacin, Imipenem, Cefoperazone/Sulbactam, Piperacillin/Tazobactam, Amikacin.

3 For Acinetobacter spp: Tigecycline, Piperacillin/Tazobactam, Ceftriaxone, Ceftazidime, Ciprofloxacin, Imipenem,

4 For Staphylococci: Cefoxitin, Gentamicin, Vancomycin, Teicoplanin, Erythromycin, Benzyl Penicillin, Clindamycin and Fusidic Acid.

Gram negative isolates which were resistant to all but one antimicrobial were considered as Multi Drug Resistant or MDR. While in the case of Staphylococcus, strains that were resistant to cefoxitin were identified as Methicillin resistant Staphylococcus aureus/ Methicillin resistant Staphylococcus species (MRSA/MRSS) . SPSS version 22 was used to calculate percentages and Chi- square test.

RESULTS

A total of 415 samples were processed. Of these 112 were instrument swabs (38 from MICU, 26 from SICU, 28 and 30 from CCU and PICU respectively) and 303 were patient samples (blood, urine, tracheal, pus and Foleys tip) received in the microbiology laboratory for culture from the same locations.

The total number of growths isolated was 226. Thus 65 out of the 112 equipment swabs (58.03%) and 114 out of 303 patients samples (37.6%) were growth positive. Maximum contaminated equipment was identified in the PICU while the largest number of infected patients was seen in the surgical ICU. Details are shown in table 1

Table 1:

Areas	MICU	SICU	CCU	PICU	Total Positive Growth N= 179 (100)%	Chi-Square Value
Total Contaminated Equipment	39.2%	53.8%	67.8%	70%	65/112= (58.03%)	13.7
Total Infected Patients.	35.8%	75.8%	16.2%	37.5%	114/303= (37.6%)	

Chi-Square test is significant calculated between contaminated and non-contaminated equipment and infected and non-infected patient's critical value was 3.87.

Table 2**:** Percentage of multi drug resistant organisms in the critical areas.

Resistant organisms	% of resistant organisms isolated from equipment				% of resistant organisms isolated from patients			
Areas	MICU	SICU	CCU	PICU	MICU	SICU	CCU	PICU
Mrsa/ Mrss	7.8%	33.3%	0%	15.7%	2.4%	0%	0%	0%
Acinatobacter species	13.1%	0%	15.7%	26.3%	73.1%	81.8%	50%	16.6%
Pseudomanas aurigenosa	7.8%	26.6%	31.5%	5.20%	21.9%	0%	16.6%	16.6%
Klebsiella species	5.2%	13.3%	10.5%	0%	19.5%	13.6%	33.3%	20.8%

The organisms isolated were Methicillin Resistant Staphylococci, Acinetobacter spp., Pseudomonas aeruginosa and Klebsiella spp. The percentage distribution of the multi-drug resistant organisms was calculated for different hospital locations and is given in comprehensive detail in table 2

Acinetobacter spp was the most resistant organism overall while the main offender was Staphylococcus in Surgical areas and Pseudomonas aeruginosa in the CCU. Further details maybe seen above

Healthcare equipment has been identified as a likely source of these infections as seen from the high levels of contamination present on a wide range of healthcare equipment.

The body sites/samples from which growths were isolated shows that respiratory infections were predominant in all areas, followed by drains and catheter tips. Detailed percentage of growth in different body sites is shown in table 3.

Table 3: Percentage of growths isolated from different body sites.

Infected sites	MICU	SICU	CCU	PICU
Respiratory	63.6%	79.1%	50%	60%
Urinary tract	34.3%	-	0%	50%
Blood stream	14.9%	0%	5.5%	33.3%
Miscellaneous (drains, tips etc)	42.8%	66.6%	50%	37.5%

DISCUSSION

Nosocomial pathogens can be acquired via transmission from the hands of hospital personnel as well as contaminated fomites, intravenous lines, fluids, and equipment (16). Equipment has been recognized as a potential source of hospital-acquired infections if they become colonized by fungi or bacteria. A recent review indicates that socio-economic status significantly influences the occurrence of healthcare-associated infections (HAI). In high-income countries, the prevalence rate is 7.5%, whereas in low and middle-income countries, it is 10.1% at the age of 19 (17). The documented literature supports the correlation between the utilization of invasive procedures, such as intubation and tracheostomy, urinary bladder catheterization, and central venous catheterization, and the heightened risk of infections in intensive care units (ICUs) (18, 19). The prevalence of hospital-acquired infections (HAIs) in intensive care units (ICUs) varies across different regions. In the United States, the HAI prevalence in ICUs is approximately 9.1%, while in Europe and England, it ranges from about 23.0% to 23.5% (20).

The study revealed a significantly higher prevalence of hospital-acquired infections in the surgical areas, reaching 75.8%, compared to the medical areas. This finding is of great concern and warrants attention. The rate of SICU infection in the mentioned country, Greece, was comparatively lower at 18.0% in the given timeframe, in contrast to the higher rate observed in the current context. One potential explanation for the elevated incidence of infection within our Surgical Intensive Care Unit (SICU) may stem from insufficiencies in the disinfection and sterilization procedures employed for invasive medical devices (21). The most frequently observed site of infection in the Medical Intensive Care Unit (MICU) and Surgical Intensive Care Unit (SICU) was the respiratory system, accounting for 63.3% of cases. This was followed by infections in the urinary tract, and subsequently the bloodstream. It is worth noting that the low positivity rate of blood

cultures can be attributed to the fact that patients in these units were already receiving high doses of multiple antibiotics. In both the Pediatric Intensive Care Unit (PICU) and the Cardiac Care Unit (CCU), the respiratory site exhibited the highest frequency of infection (22). The high incidence of respiratory tract infections is commonly attributed to the practice of endotracheal intubation and the utilization of mechanical ventilation devices, such as ambu bags. The aforementioned occurrences are frequently observed in individuals who experience post-surgical complications, severe road traffic accidents (RTAs), respiratory distress syndrome, and traumatic brain injury resulting from neurosurgical procedures. Consequently, individuals develop respiratory tract infections that are associated with the use of ventilators. Respiratory tract infection was found to be the most prevalent healthcare-associated infection (HAI) in the largest intensive care unit (ICU) in China, as indicated by previous studies (22, 23). The predominant microorganisms identified from endotracheal tip samples were Acinetobacter spp, Pseudomonas aeruginosa, and Klebsiella spp (23, 24). These causes of healthcare-associated infections (HAI) are widely recognized on a global scale and exhibit resistance to multiple drugs. The limited availability of antimicrobial agents due to the isolation of multi-drug resistant bacteria has had a significant impact on the treatment options for severe and life-threatening infections, leading to extended periods of hospitalization for patients in intensive care units. According to the findings of Richards et al. (year), as documented in the national nosocomial infections surveillance system (NNIS) database, urinary tract infections (UTIs) accounted for approximately 20-30% of hospital-acquired infections in the medical intensive care unit (MICU). The present study yielded comparable results. The study conducted at Holy Family Hospital in Rawalpindi determined that the overall infection rate among admitted patients was 37.6% (25). Similarly, a separate study conducted in Brazil reported an infection rate of 20.3% in an intensive care unit (ICU). In the largest ICU in Fiji, the rate of healthcare-associated infections (HAI) was found to be 17% (citation 25). Furthermore, the ICUs in Argentina had a HAI rate of 27% (26, 27). The observed counts are significantly lower in comparison to those observed in our institution (28).

CONCLUSION

Contaminated health care equipment is a main source of hospital acquired infection in critical areas. Pathogens are transferred directly from contaminated equipment and surfaces to susceptible patients. Total contamination in equipment was much greater in our study than studies conducted worldwide and it is associated with considerable mortality and lengthy stay in hospital. Routine cleaning of equipment items and other high-touch surfaces does not always remove pathogens from contaminated equipment's and surfaces. Improved methods of disinfection and sterilization in the hospital environment are needed.

Recommendations: The significant reduction of contamination and subsequent risk of acquiring a Healthcare-Associated Infection (HAI) can be achieved through the consistent practice of equipment cleaning. Healthcare institutions ought to develop comprehensive control programs to address the spread of these infections. It is imperative for the administration, employees, and individuals who are admitted or visiting a hospital to consider implementing relevant programs in order to effectively contribute to the prevention of infections. The education of healthcare professionals is an essential requirement.

REFERENCES

1. Ferrer M., Valencia M., Torres A. Management of ventilator associated pneumonia. In: Vincent J.L., editor. 2008 Year Book of Intensive Care and Emergency Medicine. Verlag Berlin Heidelberg: Springer; 2008. pp. 353–364.
2. Pittet D, Taraara D, Wenzel RP. Nosocomial bloodstream infections in critically ill patients. Excess length of stay, extra costs, and attributable mortality. JAMA, 1994, 271:1598–1601.
3. Jean-Louis Vincent, International Study of the Prevalence and Outcomes of Infection in Intensive Care Units JAMA. 2009;302(21):2323-2329. doi:10.1001/jama.2009.1754
4. Gravel D, Taylor G, Ofner M, Johnston L, Loeb M, Roth V, et al. Point prevalence survey for healthcare-associated infections within Canadian adult acute-care hospitals.J Hosp Infect. 2007;66: 243–248. pmid:17574304
5. Deptuła A, Trejnowska E, Ozorowski T, Hryniewicz W. Risk factors for healthcare-associated infection in light of two years of experience with the ECDC point prevalence survey of healthcare-associated infection and antimicrobial use in Poland. J Hosp Infect. 2015;90: 310–315. pmid:25933918
6. Habib MB, Anayyat U, Usmani F, Jafri AR, Ramzan A, Safdar N, Kamran M. Investigation Of Food Borne Pathogens, Coliforms And Fecal Coliforms In Raw Meat Samples Of Beef, Chicken And Fish. Journal of Pharmaceutical Negative Results. 2023 Jun 5:4044-54.
7. Gailienė G, Gierasimovič Z, Petruševičienė D, Macijauskienė A. The prevalence of health care-associated infections and risk factors in a university hospital. Med Kaunas Lith. 2012;48: 399–403.
8. A.Gikas[af2]J.Pediaditis Prevalence study of hospital-acquired infections in 14 Greek hospitals: planning from the local to the national surveillance level Journal of Hospital Infection Volume 50, Issue 4, April 2002, Pages 269-275
9. Liu JY, Wu YH, Cai M, Zhou CL. Point-prevalence survey of healthcare-associated infections in Beijing, China: a survey and analysis in 2014. J Hosp Infect. 2016;93: 271–279. pmid:27140419
10. Cuellar LE, Fernandez-Maldonado E, Rosenthal VD, Castaneda-Sabogal A, Rosales R, Mayorga-Espichan MJ, et al. Device-associated infection rates and mortality in intensive care units of Peruvian hospitals: findings of the International Nosocomial Infection Control Consortium. Rev Panam Salud Pública. 2008;24: 16–24. pmid:18764990
11. Kamran M, Iqbal U, Saleem M, Khan AA, Haq MU, Ahmad M, Shah NA. Antibiogram And Prevalence Of ESBL Genes In Escherichia Coli From Clinical Specimen. Journal of Pharmaceutical Negative Results. 2022 Dec 16:1915-24.
12. Moreno CA, Rosenthal VD, Olarte N, Gomez WV, Sussmann O, Agudelo JG, et al. Device-associated infection rate and mortality in intensive care units of 9 Colombian hospitals: findings of the International Nosocomial Infection Control Consortium. Infect Control Hosp Epidemiol. 2006;27: 349–356. pmid:16622811.
13. Kamran M, Choudary MA, Amin H, Asghar S, Shahid A, Zafar S, Javed H, Sarfraz MH, Khurshid M. Antimicrobial Susceptibility Pattern of Pseudomonas aeruginosa isolated from Clinical and Environmental Sources in Punjab, Pakistan: Antimicrobial Susceptibility Pattern of Pseudomonas Aeruginosa. Pakistan BioMedical Journal. 2022 Mar 31:34-8.
14. Magill SS, Edwards JR, Bamberg W, Beldavs ZG, Dumyati G, Kainer MA, et al., Multistate point-prevalence survey of health care-associated infections. N Engl J Med, 2014. 370(13): p. 1198–1208. Pmid: 24670166
15. Khorvash F, Mostafavizadeh K, Mobasherizadeh S, Behjati M. Susceptibility pattern of E. coli-associated urinary tract infection (UTI): a comparison of spinal cord injury-related and nosocomial. UTI Med Sci Monit. 2009;15(11):CR579–82.
16. .kesah c, ben redjeb S,Odugbemi TO ET AL.prevalence of methicillin –resistant staphylococcus aures in eight African hospitals and malta.clin microbial infect. 2003;9(2):153-6.
17. .harley RW,culver DH white JW, Morgan WM,Emori et al. the efficacy of infection surveillance and control programs in preventing nosocomial infection in US infection. Am j epidemiol. 1985;121(2):182-205.
18. Shannon S.C. Chronic critical illness. In: Jesse B.H., Gregory A.S., Lawrence D.H., editors. Principles of Critical Care. 3rd ed. McGraw Hill; 2005. pp. 207–215.
19. Vincent J.L., Bihari D.J., Suter P.M. The prevalence of nosocomial infection in intensive care units in Europe. Results of the European prevalence of infection in intensive care (EPIC) study. EPIC International Advisory Committee. JAMA. 1995; 274:639–644.
20. Hospital acquired infection, the Cochrane library, 2013
21. Erdem H, Inan A, Altindis S, Carevic B, Askarian M, Cottle L, et al., Surveillance, control and management of infections in intensive care units in Southern Europe, Turkey and Iran—a prospective multicenter point prevalence study. J Infect, 2014. 68(2): p. 131–140. Pmid: 24269951
22. Aodhán S.Breathnach Nosocomial infections and infection control Volume 41, Issue 11, November 2013, Pages 649-65
23. de Oliveira, Adriana Cristina; Tassone Kovner, Christine; Souza da Silva, Rafael Infecção hospitalar em unidade de tratamento intensivo de um hospital universitário brasileiro Revista Latino-Americana de Enfermagem, vol. 18, núm. 2, abril, 2010.
24. Eleni Apostolopoulou, Petros Bakakos, Theophanis Katostaras and Leonides Gregorakos Incidence and Risk Factors for Ventilator-Associated Pneumonia in 4 Multidisciplinary Intensive Care Units in Athens, Greece Respiratory Care July 2003, 48 (7) 681-688;.
25. .Richards M.J ,Edwards j.R et al. nosocomial infection in medical intensive care unit in united states. Crit care med.1999;27:887-892.
26. Keshni Naidu, Ilisapeci Nabose, A Descriptive Study of Nosocomial Infections in an Adult Intensive Care Unit in Fiji: 2011-12 Journal of Tropical Medicine Volume 2014, Article ID 545160
27. .Rosenthal VD (1), Guzman S, Ore IlanoPW. Department of Infectious Disease and Hospital Epidemiology, Bernal Medical Centre, Erratum in Am J Infect Control. 2003 Nov;31(7):409.
28. Anwar I, Rafiq S, Ahmad K, Mubeen MU, Mudassar A, Kamran M. Antimicrobial Susceptibility Pattern of E. Coli in Patients with Urinary Tract Infection at a Tertiary Care Hospital, Rawalpindi. Pakistan Journal of Medical & Health Sciences. 2022 Aug 31;16(06):967-.