Annals of R.S.C.B., ISSN:1583-6258, Vol. 26, Issue 1, 2022, Pages. 2829 - 2837
Received 08 November 2021; Accepted 15 December 2021.

Nosocomial Infection Rate and the Causative Organisms among In-Patients of Medical and Surgical Intensive Care Units in a Tertiary Health-Care Facility in Rawalpindi

Mubashra Mehmood[1], Kiran Fatima[2], Sonia Tahir[3], Ishtiaq Ahmed[4], Mehak Ali[5], Kiran Shafiq Chughtai[6].

1. Laboratory Scientist at ICSI (Islamabad Clinic serving infertile couples) Pvt Ltd.
2. Assistant Professor, Rawalpindi Medical University)
3. Assistant Professor, Department of pathology, Lahore Medical and Dental College, Lahore
4. Director corporate business development at Metropole Laboratories Pvt. Ltd
5. Laboratory Scientist at ICSI (Islamabad Clinic serving infertile couples) Pvt. Ltd.
6. Lab Technologist and QA Assistant at Metropole Laboratories pvt, Ltd.

Corresponding Author: Mubashra Mehmood[1]

ABSTRACT

INTRODUCTION:

A nosocomial infection is acquired 48 hours after hospital admission or within 48 hours of discharge. ICU (Intensive Care Unit) patients are susceptible to infection because of their underlying diseases and medical interventions such as surgery, intubation or antibiotic use, and their exposure to micro-organisms from other patients, the hospital environment or hospital staff. Most of these infections fall into one of five categories: line-associated infections and bacteremia, surgical wound infection, nosocomial pneumonia, catheter-associated urinary tract infection, and gastrointestinal infection including Clostridium difficile infections (CDI). This may lead to higher infection rate among in-patients of Intensive Care Units.

METHODOLOGY:

In this cross-sectional descriptive study, different culture samples from patients admitted in medical and surgical ICUs were collected at Microbiology laboratory of Holy Family Hospital. The objective of our study was to determine predominant pathogens, and the infection rate in patients admitted in medical and surgical ICUs. Inoculation of samples was done on appropriate media by using inoculating loop. Samples were cultured by using the streaking method. The inoculating loop was first sterilized by flaming followed by its cooling. Sufficient quantity of sample was taken in a loop and a well was made on the appropriate agar plate with the help of it. Starting from this well, primary streaking followed by secondary and tertiary streaking was done in such a way that loop was re-sterilized before each streaking. Streaked plates were then incubated overnight at 37 degrees and were observed after 18-24 hours of aerobic incubation.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 26, Issue 1, 2022, Pages. 2829 - 2837
Received 08 November 2021; Accepted 15 December 2021.

RESULTS:

A total of 224 patients were observed. Out of them, 112 were studied in each ICU.Infected patients in MICU were found to be 20 (17.8%) and in SICU, infected patients were 58 (51.7%). Thus, the total infected patients were found out to be 78 (34.8%).

CONCLUSION:

Nosocomial infection is associated with considerable mortality and excess length of stay. Moreover, NI rate in our country is multi-fold greater than other countries as their health-care hospitals are facilitated by every equipment for proper infection control measures and care of patient in ICUs. This indicates that we should maintain a standardized environment in ICUs of our hospitals by limiting the risk of endogenous infections using sterilized equipment, minimizing invasive procedures, identifying and controlling infection by infection control committee, minimizing exposure of ICU patients to visitors, using aseptic measures by health-care staff during invasive procedures and proper disposal of wastes.

KEY WORDS:

Nosocomial infection, Intensive care unit, Infection control committee and infection control measures, Clostridium*difficile,* endogenous infection, aseptic procedures.

INTRODUCTION:

A nosocomial infection is defined as an infection that is not present when the patient is admitted to the hospital or any other health care facility (1). This infection primarily occurs after 48 hours of patient's admission in hospital or within 48 hours after being discharged from hospital (2). It has been reported that the incidence of nosocomial infections in the intensive care unit (ICU) is about 2 to 5 times higher than in the general in-patient hospital population (3) and it may affect about 1 in 10 patients admitted in hospital (4). Studies indicate that longer hospital stays (5)(6) gender (7)(8), intravascular catheter (9), surgery since admission (10), intubation (11), mechanical ventilation (12), age of the patient especially when patient reaches up to 70 years (13), type of hospital (14), urinary catheter and diseases like acute renal failure, coma or any major trauma are some of the risk factors for hospital acquired infections. The most common reported nosocomial infection in ICUs is urinary tract infection, followed by pneumonia and primary blood stream infection (15).In a multicenter study of tertiary care hospitals, HAI contributed to the death of 2.8% of patients that died 48 h after admission (16). Although only 5–10% of all hospitalized patients are treated in ICUs, they account for approximately 25% of all NIs (17). Initial antimicrobial treatment should be targeted against the most likely local pathogens when a NI is suspected.Nosocomial infections are usually caused by highly resistant bacteria. The most common causes include Pseudomonas, Acinetobacter spp. and methicillin resistant *Staphylococcus aureus*(18). The major concern of our study will be the prospective

Annals of R.S.C.B., ISSN:1583-6258, Vol. 26, Issue 1, 2022, Pages. 2829 - 2837
Received 08 November 2021; Accepted 15 December 2021.

assessment of the nosocomial infection rate and identification of microbes involved in etiology of infection in admitted patients of medical and surgical intensive care units.

METHODS:

STUDY DESIGN: It was a Cross-sectional descriptive studywhich was conducted at Microbiology Lab, Pathology Department, Holy Family Hospital, Rawalpindi, Pakistan.The duration of our study was 4 months. The minimally required sample size was calculated to be 224 using WHO sample size calculator (i.e. n=224 where 1-α (level of significance)=95%, confidence interval=5% and d=0.05). Institutional consent from the ethical committee was taken before start of the research work. All adult patients (above 15) admitted directly in medical and surgical ICUs with infections which developed after 48 hours of admission were included in the study.

LAB PROCESSING:

Day 1:Samples were labeled properly and then inoculated on pre-dried culture plates of appropriate agar media i.e. MacConkey agar, blood agar, chocolate agar, CLED (cystine lactose electrolyte deficient) agar etc.
Plates were then placed in incubator for 18-24 hours at 37 degrees centigrade.

Day 2:After 18-24 hours of aerobic incubation, plates were read, and organisms were identified from their colony morphology, gram staining and biochemical tests.
A single isolated colony of the organism was picked from plate and smears prepared, Gram/ZN stained and then identified by microscopy at 100x power.
Further organism identification was done using appropriate biochemical tests (catalase, coagulase, DNase, Triple Sugar Iron(TSI), Sulphide Indole Motility (SIM), citrate, urease etc. Analytical profile index (API) was used when required. The results were
entered in patient Performa.

DATA ANALYSIS:

A total of 224 patients (112 from each ICU) admitted in medical and surgical ICUs were included in this study. After filling the patient Performa (Surveillance Form), the infection rate and causative organisms were analyzed. This analysis was done for the patient's entire duration of ICU stay. Patients were visited daily and any change in patient's status was noted. Surveillance form was filled after 48 hours, then 5 days and so on until the patient will get discharged. If any other variation in patient's status was observed on daily basis, that was also mentioned in the patient Performa.Statistical analysis of data was performed using Statistical Package for Social Sciences (SPSS version22) software. Frequencies and percentages of age, gender, rate of infection, causative organisms and infection sites were calculated for categorical variables. Bar charts (Component sub-divided, Multiple bar chart and 3-D Column) were used for age, gender and sites of infection. Pie chart was used to elaborate rate of infection.

RESULTS:

Annals of R.S.C.B., ISSN:1583-6258, Vol. 26, Issue 1, 2022, Pages. 2829 - 2837
Received 08 November 2021; Accepted 15 December 2021.

A total of 224 patients were included in this study. 112 patients were included from each ICU (medical and Surgical),. 49 male and 63 female patients were from MICU while 52 male and 60 female patients were from the SICU. Of the 101 male patients, 31 were infected based on culture results. Similarly, of the 123 female patients, 47 were infected based on culture. Female to male ratio was high in both ICUs as chronic disorders were the cause of prolonged stay in most of the admitted female patient in Intensive Care Units. To see the correlation between infection and age, patients were divided into 3 age groups. 33 infected patients (42%) were in age group 20-40yrs, 30(38.4%) were in age group 40-60yrs and 15 were in age group of 6080yrs (19.5%). Of the 112 MICU patients, total infected sites were 20. Most common was respiratory tract (9/20 or 45%), followed by Blood stream (7/20 or 35%) and urinary tract (4/20 or 20%). Of the 112 patients from the SICU, total infected sites were 58. The commonest was again respiratory (34/58 i.e. 58.6%) followed by pus/wound swabs (15/58 or 26%) and Blood stream (7/58 or 35%). A total of 78 isolates were identified in this study. The most common was *Acinetobacter spp.* (28.2%) followed by *Pseudomonas aeruginosa* (21.7%) and *Klebsiella pneumoniae* (19.2%) (see Table below). Total infection rate was calculated as 34.8%. Out of this, infected patients in MICU were 20 (17.8%) and the infected patients in SICU were found to be 58(48.2%). This shows that the infection rate in SICU is much higher than that of MICU.

Table: Distribution of Pathogens in different infection sites

Isolate	No. of infection sites (%age)						
	Total	**Respiratory (ETT)**	**Blood stream**	**GIT**	**Urinary Tract/folly's Tip**	**Pus/wound swabs**	**Any other Drain/tip**
Pseudomonas aeruginosa	**17 (21.7%)**	**4 (23.5%)**	**4 (23.5%)**	**-**	**1 (5.88%)**	**7 (41.1%)**	**1 (5.88%)**
Klebsiella pneumoniae	**15 (19.2%)**	**5 (33.3%)**	**3 (20%)**	**-**	**5 (33.3%)**	**1 (6.66%)**	**1 6.66%)**
Escherichia coli	**9 (11.5%)**	**2 (22.2%)**	**-**	**-**	**4 (44.4%)**	**2 (22.2%)**	**1 (11.1%)**
Acinetobacter Spp.	**22 (28.2%)**	**17 (77.2%)**	**3 (13.6%)**	**-**	**-**	**2 (9.09%)**	**-**
Proteus spp.	**2 (2.5%)**	**1 (50%)**	**-**	**-**	**-**	**1 (50%)**	**-**
Staphylococcus aureus	**9 (11.5%)**	**4 (44.4%)**	**1 (11.1%)**	**-**	**-**	**4 (44.4%)**	**-**
MRSA	**2 (2.5%)**	**1 (50%)**	**1 (50%)**	**-**	**-**	**-**	**-**

Annals of R.S.C.B., ISSN:1583-6258, Vol. 26, Issue 1, 2022, Pages. 2829 - 2837
Received 08 November 2021; Accepted 15 December 2021.

Staphylococcus epidermidis	**2 (2.5%)**	**1 (50%)**	**1 (50%)**	**-**	**-**	**-**	**-**
Total	**78**	**42 (53.8%)**	**13 (16.6%)**	**-**	**10 (12.82%)**	**17 (21.7%)**	**3 (3.8%)**

DISCUSSION:

This study provides original descriptive data from a Tertiary Health-care facility of Rawalpindi about common nosocomial bacterial infections in Intensive Care Units (MICU and SICU). In our study, the incidence of nosocomial infection was much higher in the surgical (48.2%) as compared to medical areas (17.8%). This finding is quite alarming compared to infection in surgical ICUs of other countries as in the SICU of Greece, infection rate was 18.0% (19). The reason for higher infection in SICU might be due to improper monitoring of disinfection and sterilization, improper disposal of syringes/invasive devices and exposure of patients to infection from visitors, hospital staff and other patients. Another cause of greater infection rate in SICU is that patients in SICU have open wounds which are more exposed to infectious agents and lead to increased NI.

The commonest infection site was found to be respiratory/ETT. The predominant respiratory tract infection is attributed to endotracheal intubation, use of mechanical ventilation in patients of post-surgical complications, in patients of severe RTA (road traffic accidents), patients with respiratory distress syndrome and patients of neurosurgery with traumatic brain injury. Hence, they acquire ventilator-associated respiratory tract infections/ventilator-associated pneumonia(VAP). This finding is not that surprising as ventilator support is an invasive procedure and most commonly documented as a major cause of NI in many studies worldwide. In the study of largest ICU of China, respiratory tract infection was the commonest of all HAIs (49.43%) (20). The most common pathogens isolated from ETT (respiratory) were *Acinetobcter spp., P. aeruginosa and K. pneumoniae,* which are gram negative rods. These are well-known cause of nosocomial infections and are multi-drug resistant.

However, it is notifiable that catheter related urinary tract infection (CAUTI) is the most common and frequent nosocomial infection seen in critically ill patients as reported in various studies (21)(22). In our study only 5(8.6%) patients were diagnosed to acquire urinary tract infection while Richards and colleagues reported in the National Nosocomial Infections Surveillance System (NNIS) database that UTI was responsible for 20–30% of nosocomial infections in medical/surgical ICUs (15). The lower rate of UTI in our ICUs might be due to prompt changing of urine bags of admitted patients.

Most commonly isolated organism causing NI in our study was found to be *Acinetobacter spp.* being isolated from 22 different sites (28.2%) followed by *P. aeruginosa* (21.7%). Emergence of these multi-drug resistant bacteria has limited the choice of antimicrobial agents to treat serious

Annals of R.S.C.B., ISSN:1583-6258, Vol. 26, Issue 1, 2022, Pages. 2829 - 2837
Received 08 November 2021; Accepted 15 December 2021.

life-threating infections and resulted in prolonged stay of patients in ICUs. As in our Hospital the average stay of patients in ICUs was 9-11 days but it reached up to 20 days for patients with severe trauma and sepsis.

Total infection rate among 224 admitted patients was calculated as 34.8%(calculated by taking mean of MICU which was 17.8% and SICU which was 48.2%)at Holy Family Hospital, Rawalpindi. Nosocomial infection rate in an Intensive Care Unit of University of Brazil was 20.3% (23).In the largest ICU in Fiji, NI was calculated as 17% (24) and hospital-acquired infection in ICUs of Argentina was 27% (25). These counts are much lesser than our institute.

The reason for greater infection rate in our institute is due to economic burden and work load in our hospitals. Another major cause of increasing nosocomial infection in our ICUs is extensive and prolonged use of mechanical devices such as endotracheal intubation, tracheostomy, urinary bladder catheterization and intravenous catheterization which rupture the barrier of defense in critically ill patients. Similarly, debilitated and immunocompromised patients with low cell-mediated immunity cannot resist the pathogens present in hospital environment. So, they should be kept in isolation rooms with aseptic environment, which is not possible in our hospital because of increased patient population and low patient-capacity in ICUs. Moreover, NI rate in our country is multi-fold greater than other countries as their health-care hospitals are facilitated by every equipment for proper monitoring and care of patient in ICUs. This indicates that we should maintain a standardized environment in ICUs of our hospitals by limiting the risk of endogenous infections using sterilized equipment, minimizing invasive procedures, identifying and controlling infection by infection control committee, minimizing exposure of ICU patients to visitors, using aseptic measures by health-care staff during invasive procedures and proper disposal of waste.

ACKNOWLEDGEMENT:

Special thanks to Dr.Naeem Akhtar and Dr.Sophia Khan for their support throughout the journey of research. I'm also thankful to Pathology Department, holy family Hospital, without which this study was not possible

CONFLICT OF INTEREST:

None

FUNDING

None

REFERENCES:

1. Garner JS, Jarvis WR, Emori TG, Horan TC, Hughes JM. CDC definitions for nosocomial infections, 1988. Am J Infect Control [Internet]. 1988 Jun [cited 2018 Apr 27];16(3):128–40. Available from: http://www.ncbi.nlm.nih.gov/pubmed/2841893

2. Singh S, Chaturvedi R, Garg SM, Datta R, Kumar A. Incidence of healthcare associated infection in the surgical ICU of a tertiary care hospital. Med journal, Armed Forces India [Internet]. Elsevier; 2013 Apr [cited 2018 Apr 27];69(2):124–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24600084

3. Ak O, Batirel A, Ozer S, Çolakoğlu S. Nosocomial infections and risk factors in the intensive care unit of a teaching and research hospital: a prospective cohort study. Med Sci Monit [Internet]. International Scientific Information, Inc.; 2011 May [cited 2018 Apr 27];17(5):PH29-34. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21525819

4. Revelas A. Healthcare - associated infections: A public health problem. Niger Med J [Internet]. Wolters Kluwer -- Medknow Publications; 2012 Apr [cited 2018 Apr 27];53(2):59–64. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23271847

5. Al-Rawajfah OM, Cheema J, Hewitt JB, Hweidi IM, Musallam E. Laboratory-confirmed, health care-associated bloodstream infections in Jordan: A matched cost and length of stay study. Am J Infect Control. 2013;41(7):607–11.

6. Gravel D, Taylor G, Ofner M, Johnston L, Loeb M, Roth VR, et al. Point prevalence survey for healthcare-associated infections within Canadian adult acute-care hospitals. J Hosp Infect. 2007;66(3):243–8.

7. 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 [Internet]. Elsevier; 2015 Aug 1 [cited 2018 Apr 27];90(4):310–5. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25933918

8. Durlach R, McIlvenny G, Newcombe RG, Reid G, Doherty L, Freuler C, et al. Prevalence survey of healthcare-associated infections in Argentina; comparison with England, Wales, Northern Ireland and South Africa. J Hosp Infect [Internet]. 2012;80(3):217–23. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22230102

9. Gailienė G, Gierasimovič Z, Petruševičienė D, Macijauskienė A. The prevalence of health care-associated infections and risk factors in a university hospital. Medicina (Kaunas) [Internet]. 2012;48(8):399–403. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23128459

10. Humphreys H, Newcombe RG, Enstone J, Smyth ETM, McIlvenny G, Fitzpatrick F, et al. Four Country Healthcare Associated Infection Prevalence Survey 2006: risk factor analysis. J Hosp Infect. 2008;69(3):249–57.

11. 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(3):271–9.

12. 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 [Internet]. Organización Panamericana de la Salud; 2008 Jul [cited 2018 Apr 27];24(1):16–24. Available from:

http://www.scielosp.org/scielo.php?script=sci_arttext&pid=S1020-49892008000700002&lng=en&nrm=iso&tlng=en

13. Yallew WW, Kumie A, Yehuala FM. Risk factors for hospital-acquired infections in teaching hospitals of Amhara regional state, Ethiopia: A matched-case control study. [cited 2018 Apr 27]; Available from: http://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0181145&type=printable

14. Moreno CÁ, 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 [Internet]. 2006;27(04):349–56. Available from: https://www.cambridge.org/core/product/identifier/S0899823X00194991/type/journal_article

15. Richards MJ, Edwards JR, Culver DH, Gaynes RP. Nosocomial infections in medical intensive care units in the United States. National Nosocomial Infections Surveillance System. Crit Care Med [Internet]. 1999;27(5):887–92. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10362409

16. Vincent JL, Bihari DJ, Suter PM, Bruining HA, White J, Nicolas-Chanoin MH, et al. 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 [Internet]. 1995;274(8):639–44. Available from: http://jama.ama-assn.org/cgi/reprint/274/8/639.pdf

17. Eggimann P, Pittet D. Infection control in the ICU. Vol. 120, Chest. 2001. p. 2059–93.

18. Leone M, Garnier F, Avidan M, Martin C. Catheter-associated urinary tract infections in intensive care units. Vol. 6, Microbes and Infection. 2004. p. 1026–32.

19. Markogiannakis H, Pachylaki N, Samara E, Kalderi M, Minettou M, Toutouza M, et al. Infections in a surgical intensive care unit of a university hospital in Greece. Int J Infect Dis [Internet]. Elsevier; 2009 Mar 1 [cited 2018 Apr 27];13(2):145–53. Available from: https://www.sciencedirect.com/science/article/pii/S1201971208013799#!

20. Tao X, Qian L, Li Y, Wu Q, Ruan J, Cai D, et al. International Journal of Infectious Diseases Hospital-acquired infection rate in a tertiary care teaching hospital in China : a cross-sectional survey involving 2434 inpatients. Int J Infect Dis [Internet]. International Society for Infectious Diseases; 2014;27:7–9. Available from: http://dx.doi.org/10.1016/j.ijid.2014.05.011

21. K.B. L, D.A. Z, H.D. D, D.L. C, T.J. L, C.J. D. Incidence and risk factors for acquiring nosocomial urinary tract infection in the critically ill [Internet]. Vol. 17, Journal of Critical Care. 2002. p. 50–7. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed5&NEWS=N&AN=2002184829

22. Erbay H, Yalcin AN, Serin S, Turgut H, Tomatir E, Cetin B, et al. Nosocomial infections in intensive care unit in a Turkish university hospital: A 2-year survey. Intensive Care

Annals of R.S.C.B., ISSN:1583-6258, Vol. 26, Issue 1, 2022, Pages. 2829 - 2837
Received 08 November 2021; Accepted 15 December 2021.

Med. 2003;29(9):1482–8.

23. Cristina De Oliveira A, Kovner CT, Souza R, Silva D. Nosocomial Infection in an Intensive Care Unit in a Brazilian University Hospital. [cited 2018 Apr 27];18(2):233–9. Available from: www.eerp.usp.br/rlae

24. Naidu K, Nabose I, Ram S, Viney K, Graham SM, Bissell K. A descriptive study of nosocomial infections in an adult intensive care unit in fiji: 2011-12. J Trop Med [Internet]. Hindawi; 2014 Sep 17 [cited 2018 Apr 27];2014:545160. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25309601

25. Rosenthal VD, Guzman S, Orellano PW. Nosocomial infections in medical-surgical intensive care units in Argentina: attributable mortality and length of stay. Am J Infect Control [Internet]. 2003 Aug [cited 2018 Apr 27];31(5):291–5. Available from: http://www.ncbi.nlm.nih.gov/pubmed/12888765