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Original Article

Outcomes of Healthcare Associated Infection in Intensive Care Units of A Tertiary Care Hospital

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ABSTRACT

Objectives: To determine the extra costs, excess length of stay and mortality attributable to healthcare associated infection among critically ill patients.
Study Design: Prospective longitudinal study
Place and Duration of Study: Surgical, Medical and Cardiac Intensive Care Units of Combined Military Hospital, Lahore between January 2021 and December 2021.
Methodology: Successive 339 adult patients, having Simplified Acute Physiology Score II < 70, remained admitted to the intensive care units for a minimum of 48 hours were included. Patients were followed up for healthcare associated infections and related parameters on daily basis. Patients with and without healthcare associated infection were compared for mean age, gender, severity of disease score, length of stay, mortality and mean overall expenditures.
Results: Out of 339 total patients, 103(30.4%) acquired infection during their stay in intensive care unit. The patients with healthcare associated infections had 12 days longer mean overall length of stay, 21.9% higher mortality rate and $4340 extra overall cost per patient comparatively to patients without healthcare associated infection.
Conclusion: In this study, patients with healthcare associated infection experienced remarkable prolongation of hospitalization, higher attributable mortality and an increased use of healthcare costs. These outcomes indicate the necessity of implementation of efficient and flawless infection control program.

Keywords: Healthcare associated infection, health care costs, intensive care units, length of stay.

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INTRODUCTION

Healthcare associated infection (HAI) is a major global safety concern in healthcare delivery and may be manifested even after discharge from the hospitals. It is estimated that hundreds of millions of patients all over the world are affected by HAIs each year. In a prevalence survey, conducted in 199 hospitals, it was found that incidence of HAI is 3.2% in United States (US) hospitals.[1] Another prevalence survey, conducted in 1209 acute care hospitals, estimated prevalence of HAI as 6.5% in European countries.[2,3] A meta-analysis of 220 articles revealed that incidence of HAI is 15.5% in developing countries.[4] In Pakistan, limited data regarding HAIs is available. However, in a recent prevalence survey, the incidence of HAI was found 13.1% in peadiatrics of Pakistan. Pneumonia, bloodstream infections, urinary tract infections and surgical site infections (SSIs) account for the majority of HAIs.[5]

Increased usage of invasive medical devices in the intensive care units (ICUs), in particular, urinary catheters (UC), mechanical ventilators (MV) and central venous catheters (CVC); aggressive antimicrobial therapy and compromised immunity of host has raised the incidence of HAIs. World Health Organization (WHO) estimates the frequency of ICU acquired infection around 30% in developed countries while in developing countries the frequency is at least 2-3 folds higher6. Rates of device associated healthcare associated infection (DA-HAIs) including central-line associated bloodstream infection (CLABSI), ventilator associated pneumonia (VAP), and catheter associated urinary tract infection (CAUTI) are approximately 13 times higher in ICUs of developing countries than in US hospitals.[6]

HAIs are linked with a significant rise in morbidity and mortality. A patient with HAI has more than 3 times longer length of stay (LOS) in hospital than a patient without HAI.[7] In developed countries, HAI is the fifth leading cause of death while in developing countries the problem is even greater.[8] HAI also imposes an enormous financial burden on healthcare systems. In US healthcare systems, HAIs increase the cost of care and treatment by $ 7.2 – 14.9

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billion annually.[9] With the execution of precise and efficient infection control measures, the occurrence of HAI can be reduced. Surveillance, the fundamental component of infection control program, is essential to identify the problem and helps in the implementation and monitoring of corrective measures.

In developing countries, because of scanty data and limited awareness regarding HAIs' outcome, other health priorities take primacy over patient safety concerns. The study was conducted to determine the extra costs, excess length of stay, and mortality attributable to healthcare associated infection among critically ill patients.

METHODOLOGY

The Prospective longitudinal study was conducted at surgical, medical and cardiac ICUs of Combined Military Hospital, Lahore. Permission was obtained from the Institutional Ethical Review Board (IERB no. ACC/25/EC/22), and consent was taken from all the patients admitted in ICUs before collecting data. The study spanned over a period of 1 year from January 2021 to December 2021. Sample size was calculated by using WHO sample size calculator with the level of significance 5% and confidence level 95%, power of test 90%, precision (d) 5% and expected prevalence (P) 15.5%10. Sampling technique was non probability consecutive and among all the patients admitted in ICUs during the study period a total of 339 patients were selected and followed.

Inclusion Criteria: All the patients between the ages of 16 and 80 years, irrespective of gender, admitted to ICU for more than 48 hours were included in the study.

Exclusion Criteria: Patients having infection at the time of admission or onset of infection before 48 hours of admission were excluded. Patients admitted with Simplified Acute Physiology Score II (SAPS II) more than 70 were also excluded from the study.

A prospective surveillance was carried out in the ICUs. On admission day, details like name, gender, age, date of admission, diagnosis, and all variables necessary for calculating disease severity score i.e. SAPS II of all the adult patients were recorded. These patients were followed up every day for signs and symptoms of infection during their admission in ICU up to 48 hours after the discharge or shifting out of ICU. Any patient having sign or symptom of infection was investigated with the help of clinical, radiological and pathological expertise. Clinical samples of all these patients were collected aseptically and processed in the microbiology laboratory by using standard culture techniques. Diagnosis was made after identification of causative pathogen using standard biochemical reactions. All types of HAI were identified and categorized by using CDC-NHSN surveillance definitions.[11-14]

Total cost, incurred on therapeutic drugs, investigations, procedures, devices and ICU charges, was calculated at the time of discharge from ICU for each patient separately. The costs were converted from Pakistani Rupee to United States Dollar ($), as per conversion rate on that date, for comparison with regional and international studies.

The data obtained was entered in Statistical Package for Social Science (SPSS) version 22 software for statistical evaluation. For quantitative variables (age, SAPS II, LOS and hospital cost) Mean±SD was calculated while for qualitative variables (gender and mortality) percentage was calculated.

Patients with HAI and without HAI were compared for mean age, gender, SAPS II, LOS, mortality and total cost. Chi-square test was used to compare gender and mortality while t-test was used to compare age, SAPS II, LOS and cost between the two groups. The *p*-value of ≤ 0.05 was considered statistically significant.

Confounding variables including types of HAI were controlled by multivariate analysis. Effect modifiers, including age, gender and severity of disease (SAPS II), compared between the two groups were found statistically insignificant.

RESULTS

Out of total 339 patients, 103(30.4%) acquired infection during their stay in ICU. The basic characteristics like mean age, gender and disease severity score of patients with HAI had statistically no significant difference when compared with the patients without HAI (Table I).

Table-I: Baseline Attributes of The Patients (n=339)

	Control patients (n=236)	Cases of HAI (n=103)	*p*-value
Mean Age ±SD	54.61±18.22	51.28 ±18.3	0.1237
Male n (%) Female n (%)	132(55.9%) 104(44.1%)	64(62.1%) 39(37.9%)	0.2874
Mean SAPS II ±SD	29.10±15.23	28.99±12.44	0.9479

One hundred and fifty-eight HAIs were acquired by 103 cases. The leading HAI was VAP 49(31%), followed by CAUTI 40(25%), CLABSI 25(16%), SSI 16(10%), lower respiratory tract infection other than VAP 11(7%), and others including skin and soft tissue infections, upper respiratory tract infections and intra-abdominal infections 17(11%).

The mean overall LOS of control patients was 4.3±2.65 days, while the patients acquired infection in ICU had mean 12 days longer stay in ICU. The type of HAI with longest LOS in ICU was CLABSI followed by VAP and CAUTI (Table II).

Table-II: Extra Length of Stay (Days) In Icus (n=339)

	Mean LOS ±SD	Control (n=236) Mean LOS ±SD	Extra LOS	*p*-value
HAI (n=103)	16.33 ±13.4	4.31 ±2.65	12.02	<0.001
VAP (n=49)	22.47 ±15.43	4.31 ±2.65	18.16	<0.001
CLABSI (n=25)	28.96 ±18.76	4.31 ±2.65	24.65	<0.001
CAUTI (n=40)	18.38 ±15.76	4.31 ±2.65	14.07	<0.001

The average mortality rate of control patients was 16.9%, while the patients acquired infection in ICU had an average mortality rate of 38.8%. The type of HAI with highest mortality rate was CLABSI (Table III).The patients with HAI had a mean total extra cost of $4340 per patient. The type of HAI responsible for highest mean total cost was also CLABSI followed by VAP and CAUTI (Table IV).

Table III: Mortality Rate in Icus (n=339)

Mortality Alive	**HAI (n=103) 40 (38.8%) 63 (61.2%)**	**Control Group (n=236) 40(16.9%) 196(83.1%)**	**Extra Mortality 21.9%**	***p*-value <0.001**
Mortality Alive	VAP (n=49) 29(59.2%) 20(40.8%)	Control Group (n=236) 40(16.9%) 196(83.1%)	Extra Mortality 42.3%	*p*-value <0.001
Mortality Alive	CLABSI (n=25) 15(60%) 10(40%)	Control Group (n=236) 40(16.9%) 196(83.1%)	Extra Mortality 43.1%	*p*-value <0.001
Mortality Alive	CAUTI (n=40) 14(35%) 26(65%)	Control Group (n=236) 40(16.9%) 196(83.1%)	Extra Mortality 18.1%	*p*-value 0.0078

DISCUSSION

In resource constraint situations, there is massive economic pressure on healthcare systems and the cost-effectiveness of diverse strategies is critical to consider. Literature review estimated 4.3 fold more financial loss attributable to HAI than the cost of possible preventative efforts in hospital.[15] It suggests that expenditure on HAI prevention not only saves lives and available hospital days but would also result in savings of medical costs.

Table IV: Extra total cost / patient (in US $) (n=339)

	Mean ±SD	Control (n=236) Mean ±SD	Extra Total Cost	*p*-value
HAI (n=103)	5009 ±4442	669 ±469	4340	<0.001
VAP (n=49)	7273 ±4883	669 ±469	6604	<0.001
CLABSI (n=25)	9605 ±5741	669 ±469	8936	<0.001
CAUTI (n=40)	5408 ±4810	669 ±469	4739	<0.001

The overall frequency of HAI in our study (30.4%) was comparable with other local studies conducted in Karachi (39.7%).[16] and Hyderabad (29.13%).[17] The leading type of HAI in our study was VAP (31%) followed by CAUTI (25%), CLABSI (16%) and SSI (10%). Although the leading type of HAI in both the studies in Karachi and Hyderabad was CAUTI (44.6% and 39.1% respectively), however, the frequencies of VAP (21% and 30.1%) and CLABSI (27% and 23.7%) were also high. Frequencies of HAI in ICUs of India.[18] Poland.[19] and Ukraine20 were 58.86%, 18.69% and 23.1% respectively. In all these studies the most common infection was pneumonia.

The frequency of HAI in our study was analogous with the local and regional studies, maybe because of the similar setups and resources. However, the rate of HAI in our ICUs was much higher when compared with international studies. These findings emphasize upon unceasing surveillance for identification of problems and their elimination and rigorous infection control practices in our setup to limit the frequency of HAIs.

The extra LOS attributable to HAI was 12 days in our study which was shorter when compared with similar studies in Iran (25 days).[21] and Poland (15 days).[19] The extra LOS at ICU in our study, when compared with INICC data.[22] was longer in all three DA-HAIs i.e. for VAP (18.2 days vs 9.4 days), CLABSI (24.7 days vs 9.4 days) and CAUTI (14.1 days vs 9.5 days). Attributable LOS, when compared with another similar study in Saudi Arabia.[23] was longer in CLABSI (24.7 vs 14.8), comparable in VAP (18.2 vs 17.5) and shorter in CAUTI (14.1 vs 22.1).

The extra LOS in our study was comparable or slightly shorter when compared with regional or similar healthcare setups but in case of INICC data it is longer in all types of HAI, maybe due to better patient care facilities in United States, suggest the need to further enhance patient care.

The mortality attributable to DA-HAI in our study was higher in all three categories when compared with INICC 2012-2017 data.[22] i.e. for VAP (42.3% vs 23.1%), CLABSI (43.1% vs 28.1%) and CAUTI (18.1% vs 12.5%). The mortality was increased when acquired CLABSI by 40.9% and 54% in studies from Lebanon.[24] and India.[25] respectively.

Studies around the world revealed that the morbidity and mortality of the patients admitted to critical care units are heavily influenced by HAIs. The mortality rate in our study remained comparable with regional studies but higher when compared with United States' ICUs and enlightened the necessity to improve patient care.

In our study, we found total cost attributable to HAI was $ 4340 / patient while the same was lower ($ 3627) in a study in Iran.[21] but higher ($ 11475) in another study conducted in Poland.[19] When we compared attributable total cost/patient of CLABSI in our study ($ 8936), it was lower when compared with the studies in Mexico ($ 11590).[26] and India ($ 14818).[25]

In our study, costs attributable to HAI were comparable with regional study but less when compared with other international studies may be due to reduced costs in our region. However, the finding suggests a strong association of hospital cost with HAI i.e., restriction in HAI can result in large reduction in costs. Furthermore, the expenditure on surveillance and infection control measures can reduce HAI, hospital cost and ultimately reduce the financial burden on healthcare system and may help payers and providers to justify investing in HAI prevention.

In our country studies have been carried out to estimate HAI but none estimated its outcomes. Estimation of the disease burden and its related data helps decision makers to identify weaknesses and ultimately results in strengthening of systems. The study will encourage such surveillance which is essential to monitor the infection control program.

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CONCLUSION

High frequency of HAI in our setup demands that the efforts to reduce this hasten problem should be maximized. In our setup infection control programs should be flawless and efficient with continuous surveillance to monitor these infection control programs. HAIs are responsible for high morbidity, mortality and impose a huge financial burden on patients and healthcare systems and by precise and proficient infection control measures these outcomes can be reduced. Surveillance is mandatory to oversight the healthcare system, to identify problems, to implement and monitor corrective measures, to formulate antibiogram and to guide empirical therapy. Surveillance is an integral part of the infection control program and is crucial to restrict the incidence of HAI and its consequences.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

MR & AI: Data acquisition, data analysis, critical review, approval of the final version to be published.

MQAK & ZFG: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

MA & AB: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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