DOI: https://doi.org/10.54393/pjhs.v6i1.2611

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (E): 2790-9352, (P): 2790-9344
Volume 6, Issue 01 (January 2025)



Original Article

OPEN ACCESS

Prospective Study on the Incidence of Hospital Acquired Infections in Intensive Care Unit

Abdul Hayee Phulpoto[1*], Asif Aziz[2], Abdul Qayoom Memon[1], Munir Ahmed Channa[3], Safdar Ali Pervez[1] and Ratan Kumar Ramani[1]

[1]Department of Medicine, Khairpur Medical College, Civil Hospital, Khairpur Mirs, Pakistan
[2]Department of Medicine, Pir Abdul Qadir Shah Jilani, Institute of Medicine, Gambat, Pakistan
[3]Department of Medicine, Muhammad Medical College, Mirpurkhas, Pakistan

ARTICLE INFO

Keywords:

Hospital-Acquired Infections, Intensive Care Unit, Ventilator-Associated Pneumonia, Infection Control Practices

How to Cite:

Hayee Phulpoto, A., Aziz, A., Memon, A. Q., Channa, M. A., Pervez, S. A., & Ramani, R. K. (2025). Prospective Study on the Incidence of Hospital Acquired Infections in Intensive Care Unit: Incidence of Hospital Acquired Infections. Pakistan Journal of Health Sciences, 6(1), 124-129. https://doi .org/10.54393/ pjhs. v6i1.2611

***Corresponding Author:**

Abdul Hayee Phulpoto
Department of Medicine, Khairpur Medical College, Civil Hospital, Khairpur Mirs, Pakistan
abdulhayee648@gmail.com

Received Date: 29th November, 2024
Acceptance Date: 20th January, 2025
Pubished Date: 31st January, 2025

ABSTRACT

Hospital-Acquired Infections (HAIs) in the ICU significantly impact patient morbidity, mortality, and length of stay. **Objective:** To determine the incidence of HAIs, identify key risk factors, and analyze their impact on clinical outcomes in ICU patients. It was prospective observational study. **Methods:** A prospective observational study was carried out. A total of 220 ICU patients were included. Data on demographics, ICU stay duration, device use (e.g., central lines, ventilators, urinary catheters), comorbidities, and infection control practices were collected. HAIs were diagnosed based on CDC definitions and categorized as Ventilator-Associated Pneumonia (VAP), Central Line-Associated Bloodstream Infection (CLABSI), Catheter-Associated Urinary Tract Infection (CAUTI), and Surgical Site Infections (SSI). Incidence rates were calculated using descriptive statistics, and risk factors were identified through multivariate logistic regression. **Results:** Results showed that 150 (68.2%) patients developed HAIs, with VAP being the most common (30%), followed by CAUTI (16.7%), CLABSI (20%), and SSI (13.3%). Independent risk factors for HAIs included ventilator use ($p<0.001$), prolonged ICU stay ($p=0.004$), and use of urinary catheters ($p=0.002$) and central lines ($p=0.003$). Patients with HAIs had higher mortality (30% vs 12%, $p=0.003$) and longer ICU stays (21 days' versus 12 days, $p<0.001$). **Conclusions:** HAIs are frequent in ICU patients, particularly VAP. They significantly increase mortality and prolong ICU stays, highlighting the need for enhanced infection control practices, especially for patients with extended ICU stays or those requiring invasive devices.

INTRODUCTION

Conversely, Healthcare-Associated Infections (HAIs) pose a considerable hazard to patients and are linked with greater morbidity, mortality as well as health care costs [1, 2]. Due to the severity of their illness, prolonged hospitalizations and frequent use of invasive devices (e.g. ventilators or central lines), intensive care units are particularly susceptible for Healthcare-Associated Infections (HAIs). Understanding the burden, types and risk factors of HAIs is important for optimizing infection prevention efforts [3, 4]. Hospital-Acquired Infections (HAIs) are a major concern in health care settings, particularly among patients undergoing standard Intensive Care Units (ICUs), where the immune response of bedridden individuals is compromised and invasive therapeutic measures may be imperative leading to vulnerability from bacteria producing pathogens characterized by rapid growth within these environments [5]. Patients who get sick while being treated in a medical facility or become ill from the ICU are admitting Hospital-Acquired Infections (HAIs) also called nosocomial Infections [6]. These infections are an emerging menace to healthcare systems around the globe because of increase in patient morbidity, mortality and health care cost [7, 8]. The intensive care unit is one setting in which HAIs can

Copyright © 2025. PJHS, Published by Crosslinks International Publishers LLC, USA
This work is licensed under a Creative Commons Attribution 4.0 International License.

DOI: https://doi.org/10.54393/pjhs.v6i1.2611

develop and disseminate easily, due to an increasing number of critically sick patients today as well as extensive use of invasive devices. ICUs are usually looking after dysfunctional patients [9]. Long stays in hospital, multiple comorbidities and weak immune systems make them susceptible to infections. Some of the most common types of Healthcare-Associated Infections (HAIs) in intensive care units include Ventilator-Associated Pneumonia (VAP), Catheter-Associated Urinary Tract Infections (CAUTIs), central line associated bloodstream infections (CLABSIS, and surgical site infections). Not only do these infections persist, but they also spread really fast [10]. Moreover, to develop good preventative and control methods of HAIs we need to know the frequency, risk factors etiology and outcome related with these infections. Healthcare-Associated Infections (HAIs) are a major cause of morbidity and mortality in Intensive Care Units (ICUs), driven by factors like prolonged hospital stays, invasive procedures, and antimicrobial resistance. While studies have documented HAI prevalence and risk factors, limited data exist on comparing outcomes between patients with and without HAIs, particularly in specific region or population, if applicable. This study aims to bridge these gaps by evaluating HAI incidence, identifying key risk factors, and analyzing differences in outcomes, contributing to improved prevention strategies and patient care in ICUs.

Hospital-acquired infections (HAIs) represent a critical patient safety threat in intensive care units (ICUs), significantly increasing morbidity, mortality, and healthcare costs, particularly in resource-limited settings where immunocompromised patients undergo prolonged stays and frequent exposure to invasive devices such as ventilators, central lines, and urinary catheters. Despite the well-documented global burden of HAIs, limited data exist from lower-income regions like Pakistan comparing clinical outcomes between ICU patients with and without HAIs, and identifying population-specific risk factors that could inform targeted prevention strategies in settings with constrained healthcare infrastructure and rising antimicrobial resistance. This study therefore aimed to determine the incidence rate of HAIs in ICU patients, identify key independent risk factors, and analyze differences in clinical outcomes including mortality, ICU length of stay, and readmission rates, to generate evidence supporting enhanced infection control practices in resource-limited tertiary care settings.

METHODS

It was prospective observational study. It was conducted for six months from February 2024 to July 2024 at the department of Intensive Care Unit (ICU) of Khairpur Medical College Khairpur/KMC Civil Hospital Khairpur Mir's. Inclusion criteria: Patients' ages ranged from 18 to 55 years and included both males and females. Inclusion criteria: Patients hospitalized to the ICU for longer than 48 hours. Patients who informed consent or whose consent was gained from family members in the event that the patient was incompetent. Exclusion criteria: Patients stayed in the hospital for less than 48 hours. The ICU included patients who had active infections at the time of admission. To calculate the participant sample size formula: $n = Z2 \cdot p \cdot (1-p) / d2$, 95% confidence level with 10% margin of error is required and the predicted prevalence of HAIs is 50%. Information about demographics, length of stay, use of devices (e.g., central lines, ventilators, urine catheters), comorbidities, and infection control measures were gathered prospectively from every patient admitted to the intensive care unit. The following categories were used to classify hospital-acquired infections (HAIs): Ventilator-Associated Pneumonia (VAP), Central Line-Associated Bloodstream Infection (CLABSI), Catheter-Associated Urinary Tract Infection (CAUTI), and Surgical Site Infection (SSI), where appropriate. Infections were identified based on clinical symptoms and verified by microbiological testing. The consecutive sampling technique was used in this study. The CDC's definitions for each form of HAI were followed while making the diagnosis. Using SPSS version 23.0, statistical analysis of the gathered data was carried out. Multivariate logistic regression was used to determine the risk factors linked to HAIs, and descriptive statistics were used to determine the incidence rates of each type of HAI. This study was approved by the Institutional Review Board (IRB) reference number (KMC/RERC/100).

RESULTS

Table 1 outlined the important demographic characteristics of the ICU patient population investigated. The average age of the 220 patients was 36.5 ± 5 years, demonstrating that the participants were of various ages. The total number of HAIs patients was 68.18%. The gender shows that male patients account for 68% of the group, while females make up 31.8%. Patients stayed in the ICU for an average of 14 days, due to unique care needs. These demographics lay the groundwork for comprehending the research population's features.

Table 1: Participant's Demographics Variables

Variables	Value	% / Mean ± SD
Total Patients	220	-
Mean Age	18-55 Years	36.5 ± 5 Years
Gender Distribution	Male	68%
	Female	31.8%
Patients with HAIs	150	68.18%
Average Length of Stay	-	14 ± 7 Days

Figure 1 showed the distribution of various forms of Hospital-Acquired Infections (HAIs) among a total of 150

Copyright © 2025. PJHS, Published by Crosslinks International Publishers LLC, USA
This work is licensed under a Creative Commons Attribution 4.0 International License.

DOI: https://doi.org/10.54393/pjhs.v6i1.2611

patients. Ventilator-Associated Pneumonia (VAP) was the most common cause, accounting for 30% of cases (45 patients), followed by Central Line-Associated Bloodstream Infections (CLABSI) at 20% (30 patients). Catheter-Associated Urinary Tract Infections (CAUTI) accounted for 16.7% (25 patients), whereas Surgical Site Infections (SSI) made up 13.3% (20 patients). Other forms of HAIs accounted for an additional 20% (30 patients). The Chi-Square Test revealed statistically significant relationships between all infection types (p-values ranged from <0.001 to 0.020). This demonstrated the enormous burden of HAIs in the study population and stresses the importance of focused therapies in the ICU setting.

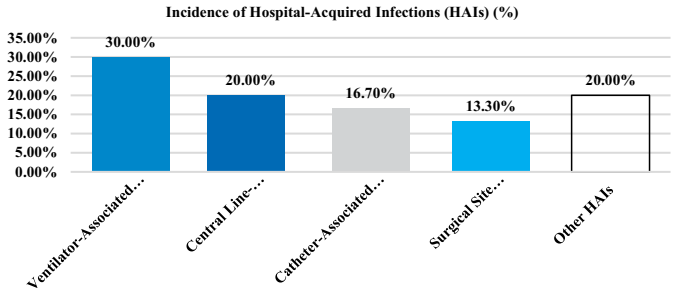


Figure 1: Incidence of Hospital-Acquired Infections (HAIs)

Table 2 showed the relationship between numerous risk variables and Hospital-Acquired Infections (HAIs), as well as the p-values. Ventilator use was identified as the most significant risk factor, with a p-value of less than 0.001 when examined using the Chi-Square Test, demonstrating a high connection with HAIs. Independent Samples t-Test showed a significant correlation with an extended ICU stay (p=0.004). In addition, diabetes and immunosuppression were significantly associated with HAIs ($P < 0.01$) by applying Logistic Regression Analysis, signifying that these comorbidities increase the risk of getting infected at most levels in an appreciable manner. Use of urinary catheter and central line was associated with HAIs, having $p = 0.02$), and ($p = 0.03$) as calculated by Chi-Square Test respectively. Taken together, these results may reflect some of the most important factors contributing to HAIs in ICUs and thus how targeted therapies may influence these risks.

Table 2: Risk Factors Associated with HAIs

Risk Factors	Association with HAIs (p-Value)
Ventilator Use	0.001
Prolonged ICU Stay	0.004
Diabetes	0.001
Immunosuppression	0.001
Urinary Catheter Use	0.020
Central Line Use	0.030

Table 3 compared outcome of 150 patients with Hospital-Acquired Infections (HAIs) to that in 70 not to have an HAI. Patients in the group developing HAIs were at a much higher risk of death (30% compared to 12%, p=0.003), which proved highly significant. Moreover the mean duration for stay in ICU was significantly higher among those patients with HAI (21 days) compared to their counterparts without one (12days), p-value > In addition, compared to community-acquired pneumonia patients, a greater proportion of HAI patients necessitated mechanical ventilation (65 versus 40%, p=0.001), and had higher rates of readmission within the study period length at least partially due to being discharged to long-term care facilities (18 versus 8%, p=0.001). These results highlight the considerable effects of HAIs on patient outcomes in ICU and, hence call for strict measures to incidence of their occurrence.

Table 3: Outcomes of Patients with and without Hospital-Acquired Infections (HAIs) (n=220)

Outcome Measure	Patients with HAIs Percentage % / Mean ± SD	Patients without HAIs Percentage %/Mean ± SD	p-value
Mortality Rate (%)	30%	12%	0.003
Average Length of ICU Stay (Days)	21 ± 8 days	12 ± 5 days	0.001
Mechanical Ventilation Use (%)	65%	40%	0.001
Readmission Rate (%)	15%	5%	0.001
Discharge to Long-Term Care (%)	18%	8%	0.001

DISCUSSION

Therefore, this study aimed to investigate the incidence and type of Hospital-Acquired Infections (HAIs) as well as its risk factors in a specific group with critical health status who are more likely to acquire infection because they need invasive procedures for treatment especially those patients who admitted at intensive care unit-ICU [11]. These results show the urgent need for effective infection control strategies in intensive care units and are consistent with findings from other investigations at different healthcare settings. Conclusions an overall HAI incidence rate of 68.18% is alarmingly high which also indicates that infection control protocols need to be further strengthened as well. The previous studies reported that shown high incidence of HAI in ICUs, and the further association between higher burden of infection to lower income settings. We suspect that the high incidence rates in the study reflect, on one hand the use of invasive devices and prolonged hospital stay; but also a very ill population with an important burden of comorbidity which, taken together increase risk for HAIs. Infection stands as an obvious target, which is corroborated by the overwhelming prevalence of certain types such as VAP and CLABSI thereby suggesting that if device-related infections are dealt effectively this may significantly reduce infection

Copyright © 2025. PJHS, Published by Crosslinks International Publishers LLC, USA
This work is licensed under a Creative Commons Attribution 4.0 International License.

DOI: https://doi.org/10.54393/pjhs.v6i1.2611

rates overall [12]. Ventilator-Associated Pneumonia (VAP) is a common and serious hospital-acquired infection in ICU patients, often linked to prolonged ventilator use. Interventions like early extubation, or minimizing the duration of mechanical ventilation, can significantly reduce the risk of VAP. Incorporating protocols like the "ventilator bundle," which includes head-of-bed elevation, daily sedation interruptions, and oral care with chlorhexidine, has been shown to reduce VAP rates. Regular monitoring for signs of infection and prompt weaning from the ventilator when appropriate can also minimize the risk. In this study, VAP was the most frequent HAI observed in 30% of ICU patients. The long-term artificial ventilation for critically ill patients, which impinges natural respiratory defense mechanisms may result in VAP leading to its predominance. There is a common perception that extensive intubation can help pathogenic organisms to colonize, leading delayed pneumonia. For example, mechanical ventilation has been identified as the primary risk factor for VAP in previous studies like that of Grasselli G *et al.*, in (2021) and Baccolini V *et al.*, in (2021) [13, 14]. In the ICU cohort an even larger proportion were HAIs, with CLABSI and CAUTI causing a sizeable percentage of these. This was because 20% of the CLABSI rate found is attributable to us failing to use central lines for patients requiring high frequency medications or fluids. According to Krauss DM *et al.*, in (2022), sterility breakdown during insertion or maintenance of a line, pathogens are able to enter the bloodstream. CAUTI, was also detected with the incidence rate of 16.7% in this study and it is resulted from a similar mechanism [15]. CAUTI promote bacterial colonization surface that leads to biofilm formation on the catheter. Central Line-Associated Bloodstream Infections (CLABSI) and Catheter-Associated Urinary Tract Infections (CAUTI) are closely associated with prolonged catheter use. Implementing best practices in catheter care, such as using the sterile insertion technique, ensuring proper maintenance, and removing catheters as soon as they are no longer necessary, can significantly reduce these infections. In particular, educating healthcare staff about the importance of catheter removal protocols and regular monitoring for any signs of infection can help minimize the incidence of these infections. This is in line with earlier studies, emphasized the significance of prolonged catheterization as a risk factor for CAUTI. A minority of cases were Surgical Site Infections (SSI), likely related to pre-existing infection [16]. We identified the use of ventilators, prolonged stays in ICU, comorbidities (diabetes and immunosuppression) and invasive devices like central lines or urine catheters to be among major risk factors for HAIs. To develop targeted prevention measures it is essential to be aware of all these elements as each contributes an increased infection risk for ICU patients. There was a consistent relationship between ventilator use and HAIs. This is similarly of a considerable magnitude to the effect reported by Despotovic A *et al.*, in (2020), who also identified mechanical ventilation as a major risk factor for intensive care unit acquired pneumonia Prolonged ventilation can result in complications, for instance including increased risk of ventilator-associated pneumonia and thus frequent monitoring for the possibility of weaning from a ventilator may also benefit outcomes [17]. Extended ICU stays (p=0.004) was also significantly associated with increased HAI rates in the higher group Full size table Longer hospital stays increase the risk of colonization and infection with organisms endemic to that facility for obvious reasons. This finding is in agreement with Peters L *et al.*, in (2019) who reported that hospital length of stay increases the likelihood of infection. For example, a longer ICU stay could reflect the presence of more severe underlying conditions with resultant increased risk for infection from invasive surgeries or other interventions [18]. HAIs were also associated with adverse clinical outcomes in ICU patients (with an average hospital stay of 21 days and overall mortality rate of approximately 30%) beyond the context of the investigation, as reported by us elsewhere [19]. This result is congruent with the studies of Harhay MO *et al.*, in (2019) and van Wagenberg L *et al.*, in 2020 indicated that adverse outcomes associated with HAIs include longer recovery times, increased risk of complications and higher costs. HAIs burden severely ill patients more, impacting negatively on the recovery mechanisms and increasing risk of adverse outcomes [20, 21]. Local factors contributing to the findings of Hospital-Acquired Infections (HAIs) may include healthcare infrastructure, such as staffing levels and available resources, which can affect infection prevention efforts. Infection control practices, including adherence to hand hygiene and sterilization protocols, are crucial in reducing HAIs. Additionally, local antibiotic resistance patterns may lead to more severe infections. Patient demographics, such as age and comorbidities, can increase susceptibility to infections, while ICU practices like mechanical ventilation and catheterization may raise HAI risk. Environmental factors, economic constraints, and cultural attitudes towards hygiene can also influence infection rates in a healthcare setting [22]. The findings of this study carried several implications for clinical practice. Tight infection control strategies required to lessen heavy burden of HAIs in an intensive care unit. Strategies should aim to minimize the utilization of invasive devices such as central lines, ventilators and urine catheters by standard assessment and timely removal. To focusing on strategies to reduce the incidence of HAIs in ICUs and improve patient outcomes.

This study is limited by its single-center, six-month design

Copyright © 2025. PJHS, Published by Crosslinks International Publishers LLC, USA
This work is licensed under a Creative Commons Attribution 4.0 International License.

DOI: https://doi.org/10.54393/pjhs.v6i1.2611

conducted at one tertiary hospital in Khairpur, which restricts generalizability across Pakistan's diverse healthcare settings, and its relatively modest sample size of 220 patients may underpower subgroup analyses of specific HAI types. The prospective observational design, while methodologically stronger than retrospective approaches, cannot establish causality, and the exclusion of patients with pre-existing infections at admission may underrepresent the true complexity of HAI risk in real ICU populations. Future research should employ larger, multi-center, longitudinal studies across public and private ICUs in both urban and rural Pakistani settings, incorporating microbiological profiling and antimicrobial resistance pattern analysis to better characterize pathogen-specific risks. Additionally, interventional studies evaluating the effectiveness of structured infection control bundles — including ventilator care protocols, catheter stewardship programs, and staff training on hand hygiene — should be rigorously conducted to reduce the alarmingly high HAI incidence and associated mortality in Pakistani ICUs.

CONCLUSIONS

HAIs are frequent in ICU patients, with VAP as the most common type. HAIs almost double mortality and extend ICU stay which thereby underscores the need for specific infection control measures, particularly in patients with long duration of ICU admissions or those requiring devices for vital functions.

Authors' Contribution

Conceptualization: AHP
Methodology: AA, AQM, MAC
Formal analysis: AQM, SAP
Writing and Drafting: RKR, SAP, AA, AQM, MAC
Review and Editing: RKR, SAP, AA, AQM, MAC

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

REFERENCES

[1] Baddal B, Taner F, Uzun Ozsahin D. Harnessing of artificial intelligence for the diagnosis and prevention of hospital-acquired infections: a systematic review. Diagnostics.2024Feb;14(5):484.doi:10.3390/diagnostics14050484.

[2] Nuckchady DC. Incidence, risk factors, and mortality from hospital-acquired infections at a hospital in Mauritius. Cureus. 2021 Nov; 13(11). doi: 10.7759/cureus.19962.

[3] Sahiledengle B, Seyoum F, Abebe D, Geleta EN, Negash G, Kalu A *et al.* Incidence and risk factors for hospital-acquired infection among paediatric patients in a teaching hospital: a prospective study in southeast Ethiopia. British Medical Journal Open. 2020 Dec; 10(12): e037997. doi: 10.1136/bmjopen-2020-037997.

[4] Voidazan S, Albu S, Toth R, Grigorescu B, Rachita A, Moldovan I. Healthcare associated infections-a new pathology in medical practice?. International Journal of Environmental Research and Public Health.2020 Feb; 17(3): 760. doi: 10.3390/ijerph17030760.

[5] Brinkwirth S, Ayobami O, Eckmanns T, Markwart R. Hospital-acquired infections caused by enterococci: A systematic review and meta-analysis, WHO European Region, 1 January 2010 to 4 February 2020. Eurosurveillance. 2021 Nov; 26(45):2001628.doi: 10.2807/1560-7917.ES.2021.26.45.2001628.

[6] Andersen BM. Prevention and control of infections in hospitals. Springer International Publishing; 2019. doi: 10.1007/978-3-319-99921-0.

[7] Haque M, McKimm J, Sartelli M, Dhingra S, Labricciosa FM, Islam S *et al.* Strategies to prevent healthcare-associated infections: a narrative overview. Risk Management and Healthcare Policy. 2020 Sep: 1765-80. doi: 10.2147/RMHP.S269315.

[8] Stewart S, Robertson C, Pan J, Kennedy S, Haahr L, Manoukian S *et al.* Impact of healthcare-associated infection on length of stay. Journal of Hospital Infection.2021 Aug; 114: 23-31. doi: 10.1016/j. jhin.2021.02.026.

[9] Shrestha SK, Trotter A, Shrestha PK. Epidemiology and risk factors of Healthcare-Associated infections in critically ill patients in a Tertiary Care Teaching Hospital in Nepal: a prospective cohort study. Infectious Diseases: Research and Treatment. 2022 Jan; 15: 11786337211071120. doi: 10.1177/11786337211071120.

[10] Tweddell S, Loomba RS, Cooper DS, Benscoter AL. Health care-associated infections are associated with increased length of stay and cost but not mortality in children undergoing cardiac surgery. Congenital Heart Disease. 2019 Sep; 14(5): 785-90. doi: 10.1111/chd.12779.

[11] Liu W, Guo T, Li H, Zhao Y, Zhang K, Hai Y *et al.* Healthcare-associated infection prevention and control management in a tertiary hospital and an overall evaluation. Annals of Palliative Medicine.2020 Jul; 9(4): 1536544-1544. doi: 10.21037/apm-20-65.

[12] Hagel S, Ludewig K, Pletz MW, Frosinski J, Moeser A, Wolkewitz M *et al.* Effectiveness of a hospital-wide infection control programme on the incidence of healthcare-associated infections and associated

Copyright © 2025. PJHS, Published by Crosslinks International Publishers LLC, USA
This work is licensed under a Creative Commons Attribution 4.0 International License.

DOI: https://doi.org/10.54393/pjhs.v6i1.2611

severe sepsis and septic shock: a prospective interventional study. Clinical Microbiology and Infection.2019 Apr;25(4):462-8.doi:10.1016/j.cmi.2018.07.010.

[13] Grasselli G, Scaravilli V, Mangioni D, Scudeller L, Alagna L, Bartoletti M *et al.* Hospital-acquired infections in critically ill patients with COVID-19. Chest.2021 Aug; 160(2): 454-65. doi: 10.1016/j.chest.2021.04.002.

[14] Baccolini V, Migliara G, Isonne C, Dorelli B, Barone LC, Giannini D *et al.* The impact of the COVID-19 pandemic on healthcare-associated infections in intensive care unit patients: a retrospective cohort study. Antimicrobial Resistance & Infection Control.2021 Jun; 10(1): 87. doi: 10.1186/s13756-021-00959-y.

[15] Krauss DM, Molefe A, Hung L, Hayes K, Gorman C, Latterner M *et al*. Emergent themes from a quality improvement programme for CLABSI/CAUTI prevention in ICUs amid the COVID-19 pandemic. British Medical Journal Open Quality. 2022 Nov; 11(4): e001926. doi: 10.1136/bmjoq-2022-001926.

[16] Blot S, Ruppé E, Harbarth S, Asehnoune K, Poulakou G, Luyt CE *et al.* Healthcare-associated infections in adult intensive care unit patients: Changes in epidemiology, diagnosis, prevention and contributions of new technologies. Intensive and Critical Care Nursing.2022 Jun; 70: 103227.doi: 10.1016/j.iccn.2022.103227.

[17] Despotovic A, Milosevic B, Milosevic I, Mitrovic N, Cirkovic A, Jovanovic S *et al.* Hospital-acquired infections in the adult intensive care unit-Epidemiology, antimicrobial resistance patterns, and risk factors for acquisition and mortality. American Journal of Infection Control.2020 Oct; 48(10): 1211-5. doi: 10.1016/j.ajic.2020.01.009.

[18] Peters L, Olson L, Khu DT, Linnros S, Le NK, Hanberger H *et al*. Multiple antibiotic resistance as a risk factor for mortality and prolonged hospital stay: A cohort study among neonatal intensive care patients with hospital-acquired infections caused by gram-negative bacteria in Vietnam. PLOS One. 2019 May; 14(5): e0215666.doi: 10.1371/journal.pone.0215666.

[19] Buetti N, Ruckly S, de Montmollin E, Reignier J, Terzi N, Cohen Y *et al*. COVID-19 increased the risk of ICU-acquired bloodstream infections: a case–cohort study from the multicentric OUTCOMEREA network. Intensive care medicine.2021 Feb; 47: 180-7. doi: 10. 1007/s00134-021-06346-w.

[20] Harhay MO, Ratcliffe SJ, Small DS, Suttner LH, Crowther MJ, Halpern SD. Measuring and analyzing length of stay in critical care trials. Medical Care. 2019 Sep; 57(9): e53-9.doi:10.1097/MLR.0000000000001059.

[21] van Wagenberg L, Witteveen E, Wieske L, Horn J. Causes of mortality in ICU-acquired weakness. Journal of Intensive Care Medicine.2020 Mar; 35(3): 293-6. doi: 10.1177/0885066617745818.

[22] Moolasart V, Srijareonvijit C, Charoenpong L, Kongdejsakda W, Anugulruengkitt S, Kulthanmanusorn A *et al.* Prevalence and Risk Factors of Healthcare-Associated Infections among Hospitalized Pediatric Patients: Point Prevalence Survey in Thailand 2021.Children. 2024 Jun; 11(6): 738. doi: 10.3390/children11060738.

Copyright © 2025. PJHS, Published by Crosslinks International Publishers LLC, USA
This work is licensed under a Creative Commons Attribution 4.0 International License.