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Research Article

Prevalence and Risk Factors of nosocomial infection in intensive care unit patients

Reddy A[1]*, Bose V[2] and Sharma S[3]

[1]Division of Clinical Bacteriology, Brahmaputra Research Center for Clinical Bacteriology, Nepal

[2]Department of Clinical Medical Microbiology, Tigris Academy of Medical Microbiology, Bangladesh

[3]Department of Medical Microbiology, Mackenzie Research Center for Clinical Bacteriology, Sri Lanka

*Address for Correspondence: Ananya Reddy, Division of Clinical Bacteriology, Brahmaputra Research Center for Clinical Bacteriology, Nepal; E-mail: ananya.reddy@brahmaputra.edu

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Abstract

Background: Nosocomial infections remain among the leading preventable complications of critical illness, disproportionately affecting intensive care unit (ICU) patients exposed to invasive devices, prolonged ventilation and impaired host defences. Local prevalence and risk-factor data are needed to target infection-control resources.

Methods: A prospective observational study was conducted over 12 months in a mixed medical-surgical ICU. Patients admitted for over 48 hours were screened daily using CDC/NHSN definitions for ventilator-associated pneumonia (VAP), central-line-associated bloodstream infection (CLABSI), catheter-associated urinary tract infection (CAUTI) and surgical-site infection. Multivariable logistic regression identified independent risk factors for infection.

Results: Of 412 patients, 118 (28.6%) developed nosocomial infection; VAP was commonest (41.5% of episodes), followed by CLABSI (23.7%), CAUTI (19.5%) and surgical-site infection (15.3%). Gram-negative organisms, led by *Acinetobacter baumannii*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*, predominated, with substantial multidrug resistance. Independent predictors were mechanical ventilation >5 days (aOR 4.2), central line >7 days (aOR 3.1), APACHE II >=20 (aOR 2.8), ICU stay >10 days (aOR 2.6) and prior antibiotics (aOR 1.9), all $p<0.05$. Infected patients had higher mortality (34.7% vs 14.1%, $p<0.001$).

Conclusion: Nosocomial infection affected over a quarter of this cohort and was independently linked to device duration, illness severity, stay length and prior antibiotics, supporting device-minimisation bundles, stewardship and continuous surveillance as priorities.

Keywords: Nosocomial infection; Intensive care unit; Risk factors; Prevalence; Ventilator-associated pneumonia

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1. Introduction

Nosocomial, or healthcare-associated, infections are among the most common and most preventable complications of critical care. Intensive care unit (ICU) patients are exposed simultaneously to invasive devices, impaired mucosal and immune defences, immobility and repeated antimicrobial exposure, on top of the illness that brought them to the unit. Large multinational point-prevalence studies show a substantial proportion of ICU patients are infected at any time, with an attributable mortality and length-of-stay burden beyond that explained by severity of illness alone [1,2].

The European Prevalence of Infection in Intensive Care (EPIC) and EPIC II studies found roughly one in five to one in two ICU patients infected on a given survey day, with respiratory tract infection the leading site [1,2,7]. Surveillance systems built on device-associated definitions -- the US National Nosocomial Infections Surveillance (NNIS) system and its successor the National Healthcare Safety Network (NHSN), and the International Nosocomial Infection Control Consortium (INICC) spanning dozens of low- and middle-income countries -- show that ventilator-associated pneumonia (VAP), central-line-associated bloodstream infection (CLABSI) and catheter-associated urinary tract infection (CAUTI) account for the great majority of ICU-acquired infection, with device-associated rates in resource-limited settings substantially exceeding those in high-income countries [3,4,5,6,32,33].

Pathogenesis is closely tied to the devices that make intensive care possible. Endotracheal intubation permits micro-aspiration of contaminated secretions around the cuff, the central mechanism of VAP [8,24,26]. Central venous and urinary catheters give skin or periurethral flora direct access to the bloodstream or bladder, with risk rising the longer the device stays in place [10,11,13]. Host and treatment factors -- age, comorbidity, immunosuppression, malnutrition, antibiotic exposure and severity of illness (e.g. APACHE II) -- further determine progression from colonisation to overt infection [20,21,25,29].

Because these contributions vary by unit type, case-mix and local practice, prevalence and risk-factor profiles from one setting cannot simply be extrapolated to another [22,23,30]. Local surveillance is therefore essential for benchmarking and for targeting hand hygiene, device-minimisation and stewardship interventions at the risk factors driving infection in a given unit [9,12,31]. This study determined the prevalence of nosocomial infection among patients in a mixed medical-surgical ICU, characterised infection sites and causative organisms, and identified independent risk factors using multivariable analysis.

2. Methods

This prospective observational cohort study ran for 12 months in a mixed medical-surgical ICU. Adult patients admitted for more than 48 hours were consecutively enrolled and followed to ICU discharge, death, or 30 days, whichever came first; patients admitted for under 48 hours were excluded, since infection manifesting in that window is conventionally attributed to the community or referring ward.

Nosocomial infection was classified using CDC/NHSN surveillance definitions for VAP, CLABSI, CAUTI and post-operative surgical-site infection [4,9]. Trained infection-control nurses, blinded to the study's risk-factor hypotheses, performed daily bedside surveillance with standardised case-report forms, supplemented by review of vital signs, laboratory, radiology and microbiology data. Device-days were recorded daily to calculate device-utilisation ratios and device-associated infection rates per 1000 device-days, following INICC/NHSN methodology [5,6].

For each patient the following were recorded at admission and daily: age, sex, admission category, comorbidities,

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APACHE II score, Glasgow Coma Scale, nutritional status, antibiotic exposure in the preceding 90 days, duration of ventilation and of central venous and urinary catheterisation, transfusion, and ICU/hospital length of stay. Clinically indicated cultures were processed by the institutional laboratory with organism identification and susceptibility testing per Clinical and Laboratory Standards Institute criteria.

The primary outcome was occurrence of at least one CDC/NHSN-defined nosocomial infection. Secondary outcomes were site-specific incidence, organism/resistance distribution, length of stay and mortality. Continuous variables were compared with Student's t-test or Mann-Whitney U, and categorical variables with chi-square or Fisher's exact test. Variables associated with infection at $p<0.10$ on univariable analysis entered a multivariable logistic regression model, reporting adjusted odds ratios (aOR) with 95% confidence intervals; $p<0.05$ was significant. The study was approved by the institutional ethics committee, with informed consent obtained from patients or representatives.

3. Results

Of 412 eligible patients, median age was 58 years and 56.3% were male; 61.4% were medical admissions, 28.2% surgical and 10.4% trauma. Median admission APACHE II score was 17 (IQR 12-23), and median ICU stay was 8 days.

At least one nosocomial infection developed in 118 of 412 patients (28.6%); 39 had infection at more than one site, giving 158 episodes overall. VAP was commonest (41.5% of episodes), followed by CLABSI (23.7%), CAUTI (19.5%) and surgical-site infection (15.3%) (Figure 1). Device-associated rates were 14.8 VAP episodes, 6.9 CLABSI episodes and 5.2 CAUTI episodes per 1000 device-days, broadly consistent with other INICC-network cohorts [5,6].

Of 172 organisms isolated, gram-negative bacilli accounted for 68.6%: *Acinetobacter baumannii* (19.8%), *Klebsiella pneumoniae* (17.4%), *Pseudomonas aeruginosa* (15.7%) and *Escherichia coli* (10.5%) led, followed by *Staphylococcus aureus* (14.0%, over half methicillin-resistant) and *Candida* species (8.7%) (Figure 2). Multidrug resistance (non-susceptibility in >=3 antimicrobial classes) affected 61.6% of gram-negative isolates, consistent with rates reported across INICC and other regional networks [5,6,16,35].

Table 1: Independent risk factors for nosocomial infection on multivariable logistic regression (n=412) [8,10,13,20,25].

Risk factor	Adjusted OR	95% CI	p-value
Mechanical ventilation >5 days	4.2	2.3-7.6	<0.001
Central venous catheter >7 days	3.1	1.7-5.6	<0.001
APACHE II score >=20 at admission	2.8	1.6-4.9	0.001
ICU length of stay >10 days	2.6	1.4-4.7	0.002
Prior antibiotic exposure (90 days)	1.9	1.1-3.3	0.02

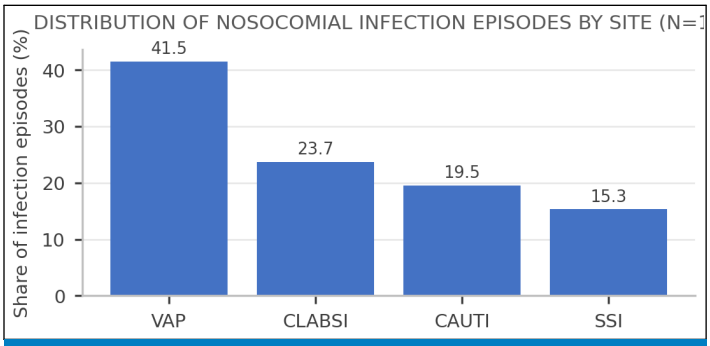

Figure 1: Distribution of 158 nosocomial infection episodes by site among 118 infected patients: ventilator-associated pneumonia (VAP) was the most frequent, followed by central-line-associated bloodstream infection (CLABSI), catheter-associated urinary tract infection (CAUTI) and surgical-site infection (SSI) [1,2,7].

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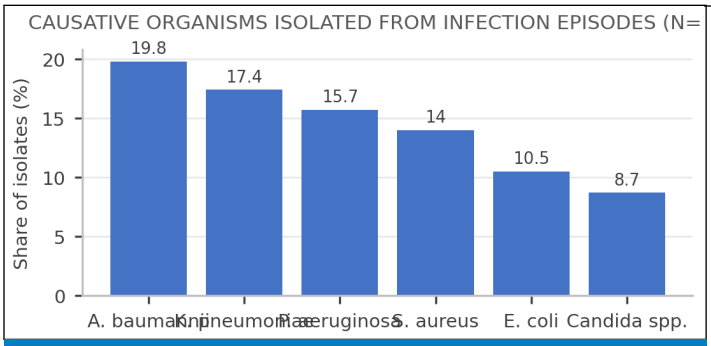

Figure 2: Distribution of 172 organisms isolated from nosocomial infection episodes. Gram-negative bacilli, led by Acinetobacter baumannii, Klebsiella pneumoniae and Pseudomonas aeruginosa, accounted for the majority of isolates [5,6,16].

Infected patients were older, more severely ill, and had longer device exposure and stay than non-infected patients (Table 1). On multivariable regression, five factors remained independent: ventilation >5 days (aOR 4.2, 95% CI 2.3-7.6), central line >7 days (aOR 3.1, 95% CI 1.7-5.6), APACHE II >=20 (aOR 2.8, 95% CI 1.6-4.9), ICU stay >10 days (aOR 2.6, 95% CI 1.4-4.7), and prior antibiotics (aOR 1.9, 95% CI 1.1-3.3), all p<0.05 (Table 1).

Infected patients had longer median ICU stay (14 vs 6 days, p<0.001) and hospital stay (21 vs 11 days, p<0.001), and higher crude ICU mortality (34.7% vs 14.1%, p<0.001) than non-infected patients.

4. Discussion

In this cohort of 412 ICU patients, nosocomial infection developed in 28.6%, within the range reported by multinational surveillance programmes, above the median for high-income ICUs and closer to other resource-limited-setting cohorts within INICC [1,2,5,6,34]. As in EPIC/EPIC II and NNIS/NHSN surveillance, respiratory infection was the commonest site, and gram-negative organisms -- led by *A. baumannii, K. pneumoniae* and *P. aeruginosa* -- dominated, with multidrug resistance mirroring patterns described across INICC countries and similar settings [1,2,5,6,16,22,23].

The independent risk factors here -- ventilation duration, catheter duration, illness severity, stay length and prior antibiotics -- reproduce the risk architecture of earlier device-focused and case-control studies of ICU-acquired infection [8,10,13,25,27,28,29]. The dose-response between device duration and risk is consistent with VAP pathogenesis, driven by cumulative micro-aspiration around the cuff biofilm, and with catheter-related bloodstream infection, where colonisation increases with dwell time [8,10,11,24,26]. The association with higher APACHE II reflects the bidirectional relationship between illness severity and infection: sicker patients need more invasive support and have weaker defences, and resulting infection worsens organ dysfunction and prolongs the stay that drives further exposure [20,21,25].

Prior antibiotic exposure as an independent risk factor, rather than protective, fits literature linking antimicrobial pressure to disruption of protective flora and selection of resistant organisms, plausibly underlying the high multidrug resistance seen here [14,15,35]. This makes stewardship a direct infection-prevention intervention, not only a resistance-containment measure.

The more-than-doubled mortality in infected patients is concordant with the attributable mortality burden described in international cohorts, notwithstanding the acknowledged difficulty of separating infection's contribution from that of the severity of illness that predisposed to it [1,2,7,20]. The association is large enough to make ICU-acquired infection a priority target for quality improvement rather than an accepted cost of critical care.

Practical implications follow. Bundles that minimise device-days -- daily weaning assessment, prompt catheter removal -- target the strongest risk factors identified [9,17,18,19]. Hand hygiene and aseptic device insertion/maintenance address the proximate mechanism of device-associated infection [11,12,13]. Continuous CDC/NHSN- or INICC-standard surveillance, as performed here, is itself an evidence-based intervention, since feedback of unit-specific rates drives practice

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change [4,5,6,9]. The high prevalence of multidrug-resistant gram-negatives argues for stewardship informed by unit-specific resistance data of the kind generated here [14,16,31,35].

This study has limitations: a single mixed ICU, where baseline risk and organism/resistance distribution may differ from other case-mixes [32,33]; reliance on clinically indicated rather than systematic cultures, which may underestimate incidence; and an observational design that identifies independent statistical association but not causality, with residual confounding possible [30]. The consistency of both prevalence and risk-factor profile with the wider literature nonetheless supports the findings' validity.

5. Conclusion

Nosocomial infection affected over one in four patients in this cohort, with VAP the leading site and multidrug-resistant gram-negative organisms the dominant pathogens. Ventilation duration, central-line duration, illness severity, ICU stay length and prior antibiotic exposure were independent predictors of infection, and infected patients had substantially longer stays and higher mortality. These findings support device-minimisation bundles, aseptic device practice, antimicrobial stewardship, and sustained CDC/NHSN- or INICC-standard surveillance as continuing priorities for reducing the burden of healthcare-associated infection in the ICU.

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