Clinico-microbiological profile and outcomes of nosocomial sepsis in an Indian tertiary care hospital – a prospective cohort study

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Background: Nosocomial infections are linked to rising morbidity and mortality worldwide. We sought to investigate the pattern of nosocomial sepsis, device usage, risk factors for mortality and the antimicrobial resistance pattern of the causative organisms in medical intensive care units (ICUs) in an Indian tertiary care hospital.

Methods: We conducted a single-centre based prospective cohort study in four medical ICUs and patients who developed features of sepsis 48 hours after admission to the ICUs were included. Patients' demographics, indwelling device usage, microbiological culture reports, drug resistance patterns and the outcomes were recorded. The Acute Physiology and Chronic Health Evaluation (APACHE) III score and the relative risk of variables contributing towards non recovery were calculated.

Results: Pneumonia (49%) was the commonest nosocomial infection resulting in sepsis, followed by urosepsis (21.8%), bloodstream infection (BSI) (10.3%) and catheter-related bloodstream infection (CRBSI) (5%). Sixty three percent of the *Acinetobacter baumannii* and 64.4% of the *Pseudomonas aeruginosa* were multidrug-resistant (MDR). Seventy percent of the *Klebsiella pneumoniae* were extended spectrum beta-lactamase producers and 7.4% were resistant to carbapenems. Forty three percent of the *Staphylococcus aureus* were methicillin-resistant *S. aureus*. Resistance to carbapenems was 35.2% in this study. High APACHE III scores ($P=0.006$ by unpaired *t*-test) and chronic kidney disease ($P=0.023$) were significantly associated with non-recovery.

Conclusions: A high degree of multidrug resistance was observed among both Gram-positive and -negative organisms in nosocomial sepsis patients. Carbapenem resistance was a common occurrence. Chronic kidney disease and high APACHE III scores were significantly associated with non-recovery. Male gender and sepsis leading to cardiovascular failure were the independent predictors of mortality.

Keywords: Nosocomial sepsis, ICU sepsis, Ventilator associated pneumonia, Urosepsis, *Acinetobacter baumannii*, Multidrug-resistant Gram-negative organisms, Carbapenem resistance

Introduction

Nosocomial infections represent a significant problem to patients admitted to health care institutions. Hospital acquired infections are associated with high level of morbidity and mortality and increase the economic burden to the patient and governing establishments.¹ Patients admitted to intensive care units (ICUs) are at greater risk of developing nosocomial infections than patients admitted to other hospital wards. Hospital acquired infections affect both developed and resource poor nations. A prevalence study conducted by the World Health Organization

(WHO) in 55 hospitals of 14 nations revealed that an average of 9% of hospital patients acquired nosocomial infections.² The highest rate of nosocomial infections was reported from hospitals in the Eastern Mediterranean (12%) and South East Asia (10%). Rate of healthcare-associated infections among ICU admitted patients across seven different cities in India have been reported to be up to 4.4% including 61.3% central line associated bloodstream infection, 29.6% ventilator associated pneumonia and 9.0% catheter associated urinary tract infections.³

Occurrence of sepsis is one of the most frequently observed complications among ICUs' patients. Clinical sepsis itself increases the risk of mortality in such patients.⁴ Like other infectious diseases, the clinico-microbial epidemiology of nosocomial

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infections and related sepsis is dynamic and subject to constant improvements in healthcare system. Therefore, a coherent intensive care of sepsis necessitates having ample acquaintance with the prevailing aetiologic organisms and their antimicrobial susceptibility profile within healthcare sectors of respective geography.

This study was conducted to investigate the pattern of nosocomial sepsis in ICUs, the antimicrobial resistance pattern of the pathogens and the prognostic factors influencing the outcome of the patients.

Material and Methods

This study was conducted in four medical ICUs in a tertiary care hospital from January 2012 to December 2013. Patients who developed features of sepsis 48 hours after admission to ICU were included. Patients who already had a focus of infection before admission to the ICU were excluded. Written informed consents were obtained from all patients before inclusion in the study. An approval was obtained from the institutional ethics committee prior to commencement of the study.

Standard definitions of infections were followed as formulated by the International Sepsis Forum Consensus Conference (2005).⁵ Sepsis was defined as presence of any two or more of the following conditions along with proven or suspected microbial aetiology: (1) hyperthermia (oral temperature $>38^{\circ}\text{C}$) or hypothermia ($<36^{\circ}\text{C}$); (2) tachypnoea (>24 breaths/min); (3) tachycardia (heart rate >90 beats/min); (4) leucocytosis ($>12\,000/\mu\text{l}$), leucopenia ($<4,000/\mu\text{l}$), or $>10\%$ bands.⁶ All patients were followed up either until discharge from the hospital or death. Data abstraction tool was used to capture the following details of the patients: age, sex, reason for ICU admission, comorbid conditions like diabetes mellitus, chronic liver disease (CLD), chronic kidney disease (CKD), chronic obstructive pulmonary disease (COPD), human immunodeficiency virus (HIV) infection, details of chemotherapy, steroids or immunosuppressants in the past 6 months and coma (Glasgow Coma Scale <6). The use of endotracheal tubes, urinary catheters, central venous catheters, haemodialysis catheters and the number of days of usage prior to onset of sepsis were also noted.

The source of infection for the development of sepsis was identified whenever possible. Ventilator associated pneumonia (VAP) was diagnosed if pneumonia developed 48 hours after mechanical ventilation.

Cultures of the relevant clinical specimens were done and interpreted as recommended.⁷ The culture technique used for catheter tip was Roll-flush-plate

technique.⁸ Sensitivity was done by disc diffusion method⁹ according to Clinical and Laboratory Standards Institute guidelines. Multidrug-resistant (MDR) and pandrug-resistant (PDR) *Pseudomonas aeruginosa* and *Acinetobacter baumannii* were defined based on a review by Falagas et al.¹⁰

The patients were started on empirical antibiotic therapy while awaiting culture reports. Based on the organisms isolated and antimicrobial susceptibility profile specific treatments were initiated. Acute Physiology and Chronic Health Evaluation (APACHE) III¹¹ scores were calculated for the worst recorded variables within 24 hours of the onset of sepsis. Multi-organ dysfunction after onset of sepsis and the outcomes of the patients were documented.

Statistical Analysis

The variables were presented as mean $\pm$ standard deviation, median and interquartile range, frequency and percent as appropriate. The association of the different categorical variables, such as, comorbidities, source of infection and microorganism, with non-recovery was assessed and the relative risk (RR) was calculated. The correlation between APACHE III scores and outcome was assessed by unpaired *t*-test. Univariate logistic regression analysis was done to determine the risk factors of mortality. Further, multivariate logistic regression analysis was carried out using 'Forward Wald' method to ascertain the independent predictors of mortality. All tests of significance were two sided with *P*-value <0.05 having statistical significance. Data was analysed using the Statistical Package for Social Sciences (SPSS) version 16.0 (Chicago, IL, USA).

Results

Out of the 174 patients of nosocomial sepsis 62.6% (109 patients) were males and 37.4% (65 patients) were females. The mean age of males was 53 years (± 16.25) and of females was 59 years (± 16.10). The patient demographics are listed in Table 1. A majority of the patients (77%) had at least two indwelling devices.

Distribution of nosocomial sepsis

The pattern of nosocomial sepsis in this study is presented in Fig. 1. The usage of indwelling devices is represented in Fig. 2. Ventilator-associated pneumonia accounted for 56% (48/85) of pneumonia. Catheter-associated urinary tract infections accounted for 72% (33/46) of urosepsis.

Microbiological profile of nosocomial sepsis

Relevant biological samples for microbiological evaluation were sent e.g. in patients suspected to have pneumonia (as per the CPIS scoring), either sputum or ETA or broncho-alveolar lavage (BAL)

Table 1 Demographic and clinical description of the study cohort.

Parameters	Median	Interquartile range
Age	56 years	45–67 years
Time of onset of sepsis	4 days	3–7 days
ET usage prior to VAP	6 days	3–9 days
Urinary catheter usage prior to onset of UTI	6 days	3–11 days
Catheter days prior to onset of CRBSI	11 days	4–14 days
Hospital stay	19 days	11–28 days
ICU stay	11 days	7–19 days
Age distribution	Subgroups	Number (proportions)
	< 55 years	76 (43.7%)
	55–70	71 (40.8%)
	> 70 years	27 (15.5%)
Sex distribution	Males	109 (62.6%)
	Females	65 (37.4%)
Reason for ICU admission	Respiratory distress	54 (31%)
	Metabolic encephalopathy 30 (17%)	
	Cerebrovascular accident	35 (19.5%)
	Seizures	14 (8%)
	Poisoning	14 (8%)
	Hypoxic ischaemic encephalopathy	8 (4.6%)
	Others	19 (11%)
No. of patients admitted directly to ICU		
Comorbidities	Diabetes mellitus	46 (26.4%)
	Chronic kidney disease	15 (8.6%)
	Chronic liver disease	18 (10.3%)
	Chronic lung disease	23 (13.2%)
	HIV	4 (2.3%)
	Chemotherapy	11 (6.3%)
	Steroids	14 (8%)
	Comatose	34 (19.5%)
	Aspiration	26 (14.9%)
Outcome	Recovered	109 (63%)
	Discharged against medical advice	26 (15%)
	Expired	39 (22%)
Supportive measures	Haemodialysis	32 (18%)
	Blood products	45 (26%)
	Mechanical ventilation	58 (33%)
	Inotropes	67 (39%)

ET: endotracheal tube; VAP: ventilator associated pneumonia; CRBSI: catheter related blood stream infections; UTI: urinary tract infections; HIV: human immunodeficiency virus.

specimens. In patients with fever and pyuria, urine was sent for culture. Positive cultures were seen in 63.8% (111/174) of the patients. Gram-negative organisms accounted for 75.3% (110 out of 146 micro-organisms)

of the infections. Among the patients, 13.8% (24 patients) had at least two organisms grown in culture. The pathogens and their antimicrobial resistance pattern are displayed in Table 2.

Figure 1 Distribution of nosocomial sepsis.

Figure 2 Indwelling device usage in the patients with nosocomial sepsis. ET: endotracheal tube; HD: hemodialysis.

Pneumonia

The most common organisms causing pneumonia were *A. baumannii* 24.7% (21/85), *P. aeruginosa* 24.7% (21/85) and *K. pneumoniae* 23.5% (20/85). Most of the MDR *A. baumannii* 89.5% (17/19) were sensitive to either cefepime and/or netilmicin.

Urosepsis

Urosepsis was predominantly caused by *Enterobacteriaceae* 36% (12/34). The commonest organism was *Escherichia coli* 26% (9/34). Two thirds of *E. coli* (6/9) was Extended spectrum beta-lactamase (ESBL) producers. All patients with *K. pneumoniae* and *Enterobacter* spp. causing urosepsis were ESBL producers. All *Enterococcus* spp. were sensitive to vancomycin, teicoplanin, ampicillin and linezolid. The details of the fungal isolates in the study are as follows. Twelve patients diagnosed as UTI (based on Centers for Disease Control and Prevention – National Healthcare Safety Network [CDC-NHSN] guidelines) had grown *Candida* spp. in urine culture. These patients had shown improvement with empirical antibiotics given for the UTI. Since they recovered without antifungals, the candidal isolate was considered as a coloniser. Four patients in the study had candidemia. Two patients with candidemia died despite treatment.

Catheter related blood stream infections

A. baumannii, *P. aeruginosa*, *Staphylococcus aureus* and *Candida* spp. accounted for the eight patients with catheter-related bloodstream infections (CRBSI). The two patients with coagulase negative *Staphylococcal* bacteraemia were methicillin sensitive. There were two deaths in CRBSI patients. Both had *A. baumannii* infection.

Organ system dysfunction

Organ system dysfunctions occurred as follows: renal dysfunction in 27% (47 patients), respiratory failure in 23% (41 patients) and metabolic acidosis in 6.9% (12 patients). Fifty seven patients (32.8%) developed septic shock.

Multidrug-resistant organisms

Multidrug-resistant organisms were common in this study. Among *S. aureus* isolates, 43% (6 out of 14 isolates) were MRSA. Multidrug resistance was seen in 63.3% (19/30) of the *A. baumannii* infections. Eighteen were MDR and one was PDR. Multidrug resistance was seen in 64.4% (21/33) of the *P. aeruginosa* infections. Sixteen were MDR and five were PDR.

Among the *E. coli*, 66.7% were ESBL (6/9) producers. Among *K. pneumoniae*, 70% were ESBL producers (19/27). Among Gram-negative isolates resistance to carbapenems was 35.2% (37/105) in this study. Carbapenem resistance was seen in 66.7% (20/30) *A. baumannii* isolates, 42.4% (14/33) *P. aeruginosa* isolates, 7.4% (2/27) *K. pneumoniae* isolates and 20% (1/5) *Enterobacter* spp. isolate. Tigecycline resistance was seen only in 3.3% (1/30) *A. baumannii* isolates (PDR *A. baumannii* by definition).

Outcomes

In this study, mortality was 22% (39/174). Sepsis with *A. baumannii* had a mortality of 40% (12/30). However, as we had a high rate (15%) of discharge against medical advice (DAMA), we calculated non-recovery as a composite of death and DAMA. Sixty three percent (109/174) had recovered and the non-recovery rate was 37%. There was no difference in non-recovery rate between culture negative sepsis (38.1%) and culture positive sepsis (36.9%). The mean APACHE III scores of recovery and non-recovery groups were 38.6 (± 18.7) and 81.9 (± 26.3), respectively. High

Table 2 Distribution of isolated organisms and their antibiotic sensitivity profile.

Organisms (number)	HAP	VAP	UTI	CRBSI	Primary BSI	MRSA	ESBL	MDR	PDR
<i>Klebsiella pneumoniae</i> (27)	6 (22.2%)	14 (51.9%)	5 (18.5%)	—	2 (7.4%)	—	19 (70.4%)	—	—
<i>Escherichia coli</i> (9)	—	—	9 (100%)	—	—	—	6 (66%)	—	—
<i>Enterobacter</i> spp. (5)	—	2 (40%)	3 (60%)	—	—	—	5 (100%)	—	—
<i>Citrobacter</i> spp. (1)	—	1 (100%)	—	—	—	—	—	—	—
<i>Pseudomonas aeruginosa</i> (33)	7 (21.2%)	14 (42.4%)	9 (27.3%)	1 (3.0%)	2 (6.1%)	—	—	16 (48.5%)	5 (15.2%)
<i>Acinetobacter baumannii</i> (30)	4 (13.3%)	18 (60%)	2 (6.7%)	3 (10%)	3 (10%)	—	—	18 (60%)	1 (3.3%)
<i>Staphylococcus aureus</i> (14)	2 (14.3%)	4 (28.6%)	—	2 (14.3%)	6 (42.9%)	6 (42.9%)	—	—	—
<i>Coagulase negative Staphylococcus</i> spp. (4)	—	—	2 (50%)	—	2 (50%)	—	—	—	—
<i>Enterococcus</i> spp. (7)	—	—	4 (57.1%)	—	3 (42.9%)	—	—	—	—
<i>Candida</i> spp. (4)	—	—	—	2 (50%)	2 (50%)	—	—	—	—

ESBL: extended spectrum beta-lactamases; PDR: pandrug resistant;¹⁰ MDR: multidrug resistant;¹⁰ MRSA: Methicillin resistant *Staphylococcus aureus*; VAP: ventilator associated pneumonia; UTI: urinary tract infections; CRBSI: catheter related blood stream infections; BSI: bloodstream infection.

APACHE III scores were associated with non-recovery and this was statistically significant ($P=0.006$, mean difference = -35.3 , 95% CI: $-41.7-28.1$). Patients with CKD had significantly higher non recovery rate than non-CKD patients ($P=0.023$, RR=1.731, 95% CI 1.0–2.9). Diabetes mellitus and CLD were also associated with high non recovery rate but this was not statistically significant.

Risk factors of mortality

Univariate logistic regression analysis showed male gender, rising APACHE score, underlying chronic kidney disease as comorbidity, sepsis leading to cardiovascular failure or renal failure or respiratory failure or metabolic acidosis or circulatory collapse to have statistically significant higher odds of mortality. Multivariate logistic regression analysis further endorses a significant independent association of male gender and sepsis causing cardiovascular failure with mortality. (Table 3)

Discussion

Nosocomial infections are several times more common in ICU patients. Frequent use of invasive devices, underlying comorbidities, poor immunity and altered sensorium predispose these patients to nosocomial infections. Most patients admitted to ICUs have more than one underlying predisposing condition, which alters immunity and makes them vulnerable to acquire infections from the hospital setting. In this study, 26.4% of the patients had diabetes mellitus type II. Diabetes has been proven to produce dysfunction of both cellular and humoral innate immunity.¹²

Microbiological culture forms an integral part of treating any infection. The identification of the micro-organism proves invaluable in effective treatment. In the case of nosocomial infections, it may throw light on the environmental source of the infection, which could prevent further spread. This study had 63% culture positivity, which was comparable to large epidemiological studies (Sepsis Occurrence in Acutely Ill Patients [SOAP] study,¹³ 60% and EPIC II study,¹⁴ 69%). Gram-negative organisms are on the rise in corroboration with the previous study.¹⁴ In this study, Gram-negative organisms predominated (75.3%). Multi-drug resistance is of particular concern among Gram-negative organisms. The most frequently isolated Gram-negative organism was *A. baumannii* whereas in the EPIC II study it was *P. aeruginosa*.¹⁴

Interestingly, *A. baumannii* was involved in 18.8% of the infections, which was much more than the observations by the EPIC II¹⁴ (both 9%) and the relatively older SOAP study (3.6%).¹³ There is a wide variation in prevalence of *A. baumannii*

Table 3 Risk factors of mortality*.

Parameters	Odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Age		
< 55 years	Reference	
55–70 years	1.74 (0.80–3.78), $P=0.16$	
> 70 years	1.01 (0.33–3.12), $P=0.99$	
Gender		
Female	Reference	
Male	3.44 (1.42–8.35), $P=0.01$	3.62 (1.30–10.12), $P=0.01$
APACHE/10 score	1.94 (1.56–2.41), $P<0.001$	Went out of equation
Comorbidities		
Diabetes mellitus	1.12 (0.51–2.49), $P=0.78$	
Chronic renal failure	3.47 (1.17–10.29), $P=0.03$	Went out of equation
Chronic liver disease	1.86 (0.65–5.34), $P=0.25$	
Chronic lung disease	2.07 (0.80–5.31), $P=0.13$	
HIV	1.16 (0.12–11.45), $P=0.90$	
Chemotherapy	0.33 (0.04–2.65), $P=0.30$	
Steroids	1.43 (0.42–4.83), $P=0.57$	
Comatose	1.08 (0.45–2.63), $P=0.86$	
Aspiration	1.68 (0.67–4.22), $P=0.27$	
Culture site		
Urine	Reference	
Respiratory tract	3.72 (0.98–14.05), $P=0.05$	
Blood	3.45 (0.72–16.55), $P=0.12$	
Catheter tip	4.83 (0.61–38.39), $P=0.14$	
Complications		
Cardiovascular failure	22.00 (8.37–57.84), $P\leq 0.001$	22.46 (8.34–60.46), $P<0.001$
Renal failure	2.33 (1.10–4.96), $P=0.03$	Went out of equation
Respiratory failure	6.71 (3.05–14.76), $P\leq 0.001$	Went out of equation
Haematological failure	1.66 (0.54–5.10), $P=0.38$	
Metabolic acidosis	5.69 (1.69–19.10), $P=0.005$	Went out of equation
Shock	20.11 (7.97–50.77), $P<0.001$	Went out of equation

* Confidence intervals which do not overlap with null value of odds ratio i.e. one are shown in bold typeset; HIV: human immunodeficiency virus; APACHE: acute physiology age chronic health evaluation.

infections. This has several implications. One is the prevalent local infection control measures and its efficacy. The knowledge of the pattern of infection in each region can guide empirical antibiotic therapy.

The commonest organisms causing pneumonia, in this study were *P. aeruginosa* (29%) and *A. baumannii* (29%), whereas in other studies they were *P. aeruginosa* and *S. aureus*.^{5,15} *P. aeruginosa* and *A. baumannii* also accounted for most of the cases of VAP in this study.

The commonest organisms causing urosepsis in the current study was *Enterobacteriaceae* in 36% cases, similar to the results of Rosenthal *et al.*² *S. aureus* was the commonest organism causing nosocomial blood stream infections in this study. In a study on blood stream infections by Hugonnet *et al.*,¹⁶ coagulase negative *Staphylococcus* was the most common isolate.

Nowadays, the epidemiology of infections in ICUs has centred on the emergence of MDR organisms. In this study, 63.3% of the *A. baumannii* and 64.4% of the *P. aeruginosa* isolated were MDR, 70% of the *K. pneumoniae* were ESBL and 43% of the *S. aureus* were MRSA.

Carbapenem resistance is on the rise world-wide.¹⁷ In 'Meropenem Yearly Susceptibility Test Information Collection Program', meropenem resistance among isolates of *K. pneumoniae* increased from 0.6% in 2004 to 5.6% in 2008.¹⁸ In this study, the prevalence of Carbapenem-resistant

K. pneumoniae is 7.4% (2 out of 27 isolates). Carbapenem-resistant *Enterobacteriaceae* (CRE) infections have limited treatment options. Recently, other carbapenemase subtypes including New Delhi metallo beta-lactamase have posed a great challenge. This emphasises the urgent need to step up measures preventing CRE transmission.

The mortality of patients with nosocomial sepsis in the current study was 22%, as against 14.6% in a study by Januel *et al.*,¹⁹ 25% in the EPIC II study¹⁴ and 33% in a study by Naidu *et al.*²⁰ In this study, 15% of patients (who were severely ill) opted to get discharged against medical advice, because of financial constraints and the guarded prognosis offered. The non-recovery rate of 37% was comparable to previous studies.

Predictors of mortality

APACHE III score is widely used in predicting ICU mortality. Considering its advantages, we decided to use it. In this study, the mean APACHE III score of patients who recovered was 38.6 and mean score of those who expired was 74.2. High scores were significantly associated with non-recovery ($P=0.006$). Male gender and sepsis leading to cardiovascular failure were the independent predictors of mortality.

In the present study, *Acinetobacter* infections had an attributable mortality of 15.3%. Case-control

studies, which studied in particular, the effect of *A. baumannii* bactremia on outcome of ICU patients conducted by Grupper *et al.* ($N=104$)²¹ in Israel and Playford *et al.* ($N=120$)²² in Australia, revealed an attributable mortality of 36.5 and 20%, respectively. In a commentary by Falagus and Rafailidis,²³ it was suggested that attributable mortality due to *A. baumannii* should no longer be a controversial issue and measures should be directed to the development of new antibiotics against MDR and PDR *A. baumannii* and implementation of infection control.

Till date, APACHE III scoring system has not been used in the setting of nosocomial sepsis. A high APACHE II score was found to be associated with mortality by Agarwal *et al.*²⁴ ($N=201$) (OR=1.1; 95% CI: 1.0–1.1).

In treating nosocomial infections, the clinician faces two conflicting issues: (1) an appropriate adequate antimicrobial therapy and (2) limiting excessive antimicrobial use to prevent the emergence of antimicrobial resistance. Some strategies adopted by institutions to decrease MDR include decreased duration of therapy, hospital formulary-based or targeted antimicrobial restrictions, use of antimicrobial protocols and guidelines, scheduled antimicrobial rotation or ‘cycling’. The most effective strategy would be to inculcate among all doctors, an urgent need to refrain from antibiotic use in unwarranted situations. It would be ideal, if the antibiotic use in institutions is monitored, to curb the excessive unwanted use of higher antibiotics. Another preventive measure is to de-escalate the broad spectrum empiric antibiotic to a limited spectrum antibiotic, once the culture and drug sensitivity pattern is available. Diligent use of these various approaches, in combination with frequent reviews of the nosocomial infection spectra, along with strict policies to prevent transmission of health-care associated infections will go a long way in decreasing the burden of nosocomial infections.

Strengths and limitations

This study has highlighted several significant observations. It has prospectively discerned the pattern of nosocomial infections in medical ICUs contributing to sepsis, the associated device utilisation and their microbiological profile with 63% culture positive rates. Such single-centre studies, which evaluate the spectra of pathogens and their antimicrobial resistance patterns will provide a quality check on infection control. We have also investigated APACHE III score as a prognosticating tool, unlike previously studied APACHE II scores. Future scope of the study is to deal with the correlation of prior antibiotic usage and emergence of MDR organisms. Such an effort would help to curtail the MDR

burden. Tactlessly, data on number of individuals excluded, ICU admissions and beds available in ICUs during the study period were not captured. This study included only medical ICUs and the pattern of infection cannot be generalised to surgical and cardiac ICUs.

Conclusions

Nosocomial infections remain a challenging problem in management of severely ill patients in ICUs. Multidrug resistance was detected in more than half the isolated strains, especially amongst the predominant microorganisms (*A. baumannii*, *P. aeruginosa*, *S. aureus* and *K. pneumoniae*). Carbapenem resistance is alarming. It could become a global threat unless measures are taken to curb it. Indwelling devices are channels for spread of resistant organisms in ICUs. Limiting their usage is primordial. Chronic kidney disease and high APACHE III scores were significantly associated with high non recovery. Male gender and sepsis leading to cardiovascular failure were the independent predictors of mortality. Simple preventive measures and periodic review of drug resistance patterns of nosocomial infections will be beneficial for hospitals with significant load of medically ill patients in ICUs.

Disclaimer Statements

Contributors

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Conflicts of interest

None.

Ethics approval

An approval was obtained from the Kasturba Medical College and Kasturba Hospital, institutional ethics committee prior to commencement of the study.

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