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Research Article

ANALYSIS OF THE INCIDENCE OF NOSOCOMIAL INFECTIONS IN THE MEDICAL ICU – PREDISPOSING FACTORS AND MICROBIOLOGICAL PROFILE

Sartaj Hussain[1]., Kamal K. Sawlani[2]., Suraj S. Yadav[1]., Manish Bajpai[3]., Sanjay Khattri[1]*

[1]Department of Pharmacology, King George's Medical University, Lucknow
[2]Department of Medicine, King George's Medical University, Lucknow
[3]Department of Physiology, King George's Medical University, Lucknow

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A B S T R A C T

Background: Nosocomial infections are a serious problem in the Intensive Care Unit (ICU) setup. They not only increase health care cost and duration of hospital stay but also affect outcome of patients.

Methods: A prospective observational study conducted in Intensive Care Unit (ICU) of the Department of Medicine at a tertiary care teaching hospital. The patients stayed for more than 48 hours were included in the study. A total 74 patients were recruited. The CDC/ NHSN surveillance definition of health care associated infection were followed for nosocomial infections.

Results: The nosocomial infection developed in 43.24% of patients. The ventilator associated pneumonia (VAP) developed in 40.62% patients followed by urinary tract infection (UTI) (25%), VAP and UTI both (25%), VAP and bloodstream infection (BSI) (9.38%). The patients who developed nosocomial infection were having significantly higher age, APACHE II Score and length of stay in compare to those not developed. Most frequently isolated microorganisms were Klebsiella pneumoniae and Acinetobacter baumannii. The mortality rate was significantly higher in patients with nosocomial infections. The major determinant for the development of nosocomial infections were ventilation and length of stay.

Conclusions: The incidence of nosocomial infections is higher as compared to other studies. The hospital acquired infection control program and monitoring system, well trained staff with continued education may reduce the rates of nosocomial infection.

INTRODUCTION

Nosocomial infections are directly affect the morbidity and mortality of patients admitted in ICU. Nosocomial infections increase health care cost and prolong duration of hospitalization[1]. The Centre for Disease Control and Prevention (CDC) defines the intensive care unit associated infections as those that occur after 48 hours of ICU admissions or within 48 hours after the transfer of the patients from the ICU[2].

The patients admitted in ICU are prone to develop nosocomial infections as they are seriously ill, exposed to various invasive procedures like central venous line, urinary catheterization ventilation, use of immunosupressors, prolonged hospitalization and presence of multidrug resistant microorganisms in ICU[3,4].

The aim of this study was to determine the nosocomial infection incidence in an ICU, to identify independent predictors for the development of the nosocomial infection and culture sensitivity of isolated microorganisms. To compare the age, APACHE II score, length of stay, drug number, DDD and cost in patients who developed nosocomial infection and those not.

METHODS

This study was a prospective observational study conducted in 12 bedded Intensive Care Unit (ICU) of the Department of Medicine at King George's Medical University, Lucknow. The study was initiated after obtaining ethical clearance from the institutional ethics committee. The patients stayed for more than 48 hours were included. The patients, parents or guardians not willing to give informed consent and incomplete data were excluded from the study. A total 74 patients were recruited on the basis of exclusion and inclusion criteria over a period of 3months.

The baseline demographic variables, vitals, APACHE II score at admission, duration of hospital stay and clinical diagnosis were recorded on the case record form. DDD of each prescribed was calculated based on WHO-ATC classification[6].

Ventilator associated pneumonia (VAP), bloodstream infection (BSI) and CA-UTI (Catheter-associated Urinary Tract Infections) were defined as per the CDC/ NHSN surveillance definition of health care associated infection and criteria for specific types of infections in the acute care setting.[5]

Statistical Analysis

The data are presented as mean (95% confidence interval [CI]) and were analyzed using Mann–Whitney U test. A multiple regression binary logistic with forward conditional elimination was used to examine covariate effects of each factor on nosocomial infection development and to identify independent predictors of nosocomial infection development. Covariates with a univariate $p \leq 0.25$ in the respective univariate analysis were entered into these models. Results are reported as adjusted odds ratio with corresponding 95% confidence intervals. A two-tailed $p<0.05$ was considered statistically significant. All analyses were performed with SPSS statistical software package (version 20, IBM Inc., Armonk, NY, USA).

RESULTS

The table 1 shows characteristics of the study sample.The patients who developed nosocomial infection were having significantly higher age, APACHE II Score and length of stay (vs. not developed nosocomial infection). The total drug & antimicrobials DDD, number and cost per patient were significantly higher in patients developed nosocomial infection (vs. not developed nosocomial infection). [Table 2]
The nosocomial infection developed in 32 (43.24%) patients. The ventilator associated pneumonia (VAP) developed in 13 (40.62%) patients followed by urinary tract infection (UTI) 8 (25%), VAP and UTI both 8 (25%), VAP and bloodstream infection (BSI) 3 (9.38%) were reported in 32 patients. The 40 microorganism was isolated in 32 patients. Most frequently isolated microorganisms were Klebsiella pneumoniae 8 (20%), Acinetobacter baumannii 8 (20%), Enterococcus 7 (17.5%), E.coli 7 (17.5%), Candida 6 (15%) Elizabethkingia meningoseptica 2 (5%), MRSA 1 (2.5%) and P.aeruginosa 1 (2.5%).

Table 1 Characteristics of the study sample (N=74)

Parameters	N (%)
Gender	
Male	44 (59.46)
Female	30 (40.54)
Age (years), mean (95% CI)	38.55 (33.88-43.23)
APACHE II score, mean (95% CI)	18.31 (16.26-20.36)
Length of ICU stay, mean (95% CI)	9.12(7.41-10.83)
Comorbidity	
Absent	37 (50.0)
Present	37 (50.0)
Ventilated at any time	
Yes	50 (67.57)
No	24(32.43)
Nosocomial infection develops	
Yes	32 (43.24)
No	42 (56.76)
Outcome	
Survived	41 (55.41)
Expired	33(44.59)
Total Drug DDD	72.09 (55.12-89.06)
Antimicrobials DDD	27.67 (20.40-34.95)
Total Drug No.	65.05 (48.74-81.36)
Antimicrobials No	24.54 (18.53-30.56)

Table 2 Comparison of various parameters on the basis of Nosocomial infection developed or not

	Nosocomial infection developed (N=32)	Nosocomial infection not developed (N=42)	P value
Age (years)	44.00 (36.51-51.49)	34.40 (28.52-40.29)	0.042*
APACHE II Score	22.75 (19.91-25.59)	14.93 (12.40-17.46)	<0.001*
Length of stay	13.81 (10.57-17.05)	5.55 (4.79-6.31)	<0.001*
Total drug DDD per patient	113.97 (81.01-146.93)	40.18 (31.24-49.11)	<0.001*
Antimicrobials DDD per patient	46.12 (31.88-60.36)	13.61 (10.35-16.88)	<0.001*
total no of drugs per patient	105.75 (73.48-138.02)	34.05 (27.16-40.94)	<0.001*
Antimicrobial no per patient	40.56 (28.90-52.22)	12.33 (9.99-14.67)	<0.001*
Total drug cost per patient (INR)	61,454 (44,426-78,483)	21,344 (13,439-29,249)	<0.001*
Antimicrobials cost per patient (INR)	54,668 (38,522-70,814)	18,691 (11,126-26,256)	<0.001*

*Significant

On univariate analysis, the significant factors for the development of nosocomial infection was age, APACHE II score at admission, ventilation and length of stay. The multivariate analysis showed that the independent predictor for the development of nosocomial infection was ventilation and length of stay. [Table 3]

The patients who developed nosocomial infection were having significantly higher mortality incompair to those who was not developed nosocomial infection. [Table 4]. The table 5 shows resistance patterns of isolated micro-organisms.

DISCUSSION

During 3 months of the study period, the incidence of nosocomial infections was 43.24%. In other Indian studies, the incidences of nosocomial infections were in the range of 16 to 33.5%[7,8,9]. These rates are higher as compared to other studies. But a study conducted from Puducherry by Bammigatti *et al*. the incidence of nosocomial infections were 50.2%.[10] In this study, ventilator associated pneumonia (VAP) was the most common nosocomial infection followed by UTI and bloodstream infections. It is similar to Habibi *et al*.,[11] Singh *et al*.[12] and Bammigatti *et al*[10] but in studies conducted by Mohanasoundaram[7] and Datta *et al*.[13] incidence of UTI was followed by pneumonia.

Most frequently isolated microorganisms were Klebsiella pneumoniae and Acinetobacter baumannii. Klebsiella pneumoniae were most commonly isolated microgranism in the studies conducted by Mohanasoundaram[7] and Shalini*et al*.[8]in previous studies. Acinetobacter baumannii was the most common isolated microorganism in study done by Bammigatti *et al*.[10] and Habibi *et al*[11].

In this study, the mortality was significantly higher in patients with nosocomial infections. This is similar to other studies where nosocomial infections is associated with increased mortality[14,15].

The nosocomial infections rate was higher, this may be because we recruited patients only from medical ICU and different clinical profiles of patients. There is no hospital acquired infection control program in our hospital.

Table 3 Predictors of nosocomial infection development using binary logistic regression analysis

Predictors	Antimicrobial Prescriptions		Univariate		Multivariate	
	Nosocomial infection developed (N=32)	Nosocomial infection not developed (N=42)	OR (95% CI)	p value	OR (95% CI)	p value
Age						
≤45	16 (50.0%)	32 (76.19%)	0.31 (0.12-0.84)	0.022*	2.30 (0.47-11.31)	0.31
>45	16 (50.0%)	10 (23.81%)				
Gender						
Male	22 (68.75%)	22 (52.38%)	0.50 (0.19-1.31)	0.158	1.17 (0.29-4.71)	0.826
female	10 (31.25%)	20 (47.62%)				
APACHE II ≤15						
>15	6 (18.75%)	24 (57.14%)	0.17 (0.06-0.51)	0.001*	1.58 (0.32-7.76)	0.571
>15	26 (81.25%)	18 (42.86%)				
Comorbidity						
Present	17 (53.13%)	20 (47.62%)	1.25 (0.50-3.13)	0.639	--	--
Absent	15 (46.87%)	22 (52.38%)				
Ventilated Yes	30 (93.75%)	20 (47.62%)	16.50 (3.49-78.06)	<0.001*	0.10 (0.02-0.61)	0.013*
No	2 (6.25%)	22 (52.38%)				
Length of stay						
≤7	6 (53.13%)	34 (80.95%)	0.05 (0.02-0.18)	0.054	11.06 (3.05-40.15)	0.001*
>7	26 (46.87%)	8 (19.05%)				

Logistic regression analysis with stepwise forward method was used with an entry criteria of $p \leq 0.25$ and a removal criterion of $p > 0.25$.*Significant OR=odd's ratio, CI=confidence interval, *Pvalue<0.05 is considered significant.

Table 4 Effect of nosocomial infection on outcome

Outcome	Survived	Expired	χ2 (df)	P value
Nosocomial infection developed (N=32)	12 (29.27%)	20 (62.5%)	7.32 (1)	0.007*
Nosocomial infection not developed (N=42)	29 (70.73%)	13 (37.5%)		
Total	41 (100%)	32 (100%)		

Chi-square test *Significant

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Declarations

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Conflict of interest: None

Table 5 Resistance patterns of isolated micro-organisms
No. of specimens resistant/ No. of specimens tested (% resistant)

Organism Iisolated	Elizabethkingia meningoseptica	Enterococcus	Klebsiella	A.baumani	E.coli	MRSA	P.aeruginosa
No. Isolates	2	7	8	8	7	1	1
Amoxicillin-clavulanate	2/2 (100)	3/7 (42.86)	8/8 (100)	8/8 (100)	7/7 (100)	nt	1/1 (100)
Piperacillin/tazobactam	2/2 (100)	2/7 (28.57)	7/8 (87.5)	6/8 (75)	5/7 (71.43)	nt	1/1 (100)
Ceftriaxone	2/2 (100)	7/7 (100)	8/8 (100)	7/7 (100)	7/7 (100)	nt	1/1 (100)
Cefotaxime	nt	7/7 (100)	8/8 (100)	4/6 (66.67)	5/5 (100)	nt	nt
Ceftazidime	nt	7/7 (100)	6/6 (100)	7/7 (100)	5/6 (83.33)	nt	nt
Cefoperazonesulbactam	0/2 (0)	7/7 (100)	7/8 (87.5)	6/6 (100)	5/7 (71.43)	nt	1/1 (100)
Imipenem	1/1 (100)	0/2 (0)	6/8 (75)	6/8 (75)	2/6 (33.33)	nt	1/1 (100)
Meropenem	2/2 (100)	2/4 (50)	6/8 (75)	6/8 (75)	2/6 (33.33)	nt	1/1 (100)
Amikacin	2/2 (100)	5/5 (100)	7/8 (87.5)	7/8 (87.5)	5/7 (71.43)	nt	1/1 (100)
Gentamicin	2/2 (100)	7/7 (100)	8/8 (100)	8/8 (100)	7/7 (100)	1/1 (100)	1/1 (100)
Ciprofloxacin	1/2 (50)	5/6 (83.33)	8/8 (100)	6/6 (100)	5/5 (100)	1/1 (100)	1/1 (100)
Levofloxacin	nt	6/7 (85.71)	7/8 (87.5)	5/7 (71.43)	5/6 (83.33)	1/1 (100)	nt
Tigecycline	1/2 (50)	0/1 (0)	1/6 (16.67)	0/6 (0)	0/3 (0)	0/1 (0)	1/1 (100)
Colistin	2/2 (100)	nt	0/4 (0)	0/6 (0)	0/3 (0)	nt	0/1 (0)
Vancomycin	nt	nt	nt	nt	nt	0/1 (0)	nt

nt = Not tested * 34 specimens were collected for culture and sensitivity

CONCLUSION

The nosocomial infection rates were higher in the studied medical ICU. There was significant difference in age, APACHE II score and length of stay in patients with nosocomial infection. The major determinant for the development of nosocomial infections were ventilation and length of stay. The mortality rate was significantly higher in patients with nosocomial infections.

The hospital acquired infection control program and monitoring system, well trained staff with continued education may reduce the rates of nosocomial infection.

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