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Original Article

Prolonged Urinary Catheterization – A Risk Factor for Intensive Care Unit Infections and Mortality: A Clinical Study in Tertiary Teaching Hospital of Northern Kerala

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Abstract

Background: The major cause of mortality and morbidity in intensive care units (ICUs) are health care-associated infection (HCAI), especially nosocomial infection (NCI). HCAI and NCI are key factors determining the clinical outcome among patients admitted in critical care areas. Few hospitals in India perform regular surveillance for HCAI and NCI in ICUs.

Aim of the study: This study aims to study the incidence of HCAI and NCI as risk factors associated with mortality and morbidity ICUs.

Materials and Methods: A total of 624 patients hospitalized in six different ICUs of a large teaching hospital in Northern Kerala were assessed between April 2016 and March 2018. NCI was defined as the presence of clinical signs and symptoms of infection in patients at least 48 h after their hospitalization, confirmed by positive cultures of specimens taken from the patients' blood, urine, wounds, respiratory secretions, and other body fluids. A checklist comprising 109 questions were used to assess the presence of HCAI and NCI as factors of increased mortality and morbidity.

Observations and Results: Among the 624 patients, 364 (58.33%) were male and 260 were female (41.66%). The youngest patient was aged 16 years and the eldest one was aged 87 years with a mean age of 49.78 ± 11.30. The mean age of patients who had NCIs was 57.68 ± 09.45 when compared to the mean age of 52.39 ± 8.20 in patients without NCIs with $P = 0.781$ (statistically not significant). The mean age of patients who died with NCIs was 76.15 ± 6.29 and the mean age of patients with NCIs who survived was 63.20 ± 7.70 with $P = 0.021$ (statistically significant). Culture positivity of specimens collected and analyzed was observed in 195 (31.25%) patients. The overall rate of confirmed NCI in the studied patients was 241/624 (38.61%) (confidence interval 95% = 13.25–21.50). General ICU was the most crowded ward consisting of 237/624 admissions (37.98%) and had the highest rate of NCIs 72/159 (38.81%).

Conclusions: The patients with prolonged urinary catheterization were prone to NCIs and deaths in ICUs, and hence, they should be treated intensively.

Key words: Health care-associated infections and microorganism, Intensive care units, Nosocomial infections

INTRODUCTION

Review of literature shows 30% of ICU patients suffer from one or the other kinds of infections and these patients will encounter increased ICU length of stay, morbidity, mortality, and cost.[1] The most common pathogens isolated among NCIs were *Staphylococcus aureus* and *Acinetobacter* species with the rates of 30.9% and 26.8%, respectively.[2] *Acinetobacter* was considered as the most common Gram-negative organism colonized on the skin of hospital care providers, including ICU nurses and respiratory therapists.[3] Urinary tract infection (UTI) has been reported as the most common type of NCIs.[4,5] ICU infection was associated with multiple known risk factors such as prolonged ICU stay, different and multiple device insertions, prolonged mechanical ventilation, and colonization with micro-

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organisms in the environment.[6] Meric *et al.* in their study proposed certain risk factors related to increased mortality which was as follows: age over 60, intubation, and central venous (CV) catheterization.[2] Reade *et al.* based on their study stated: "Anemia was associated with illness severity and more common in those with comorbid illnesses, female gender, and resulted in poor outcomes."[7,8] In the present study, the incidence of HCAIs, NCIs, and deaths associated factors was assessed in ICUs of a large referral hospital complex in northern part of Kerala.

Type of Study

This was a prospective, cross-sectional, and descriptive analytical study.

Institute of Study

This study was conducted at Kannur Medical College, Anjarakandy, Kannur, Kerala, India.

Period of Study

This study duration was from April 2016 to March 2018.

MATERIALS AND METHODS

In this descriptive-analytical prospective study, 624 patients admitted to various ICUs were studied. An ethical committee clearance was obtained before the commencement of the study. An ethical committee approved consent form was used in this study.

Inclusion Criteria

1. Patients hospitalized in six ICUs of Kannur Medical College Hospital were included in this study
2. Patients who were followed up from the time of admission to discharge/death were included
3. Patients of all age groups were included
4. Patients irrespective of their disease status or severity or critical illness were included
5. Patients who develop NCIs or HCAIs 48 h after their admission were included.

Exclusion Criteria

(1). Patients who are critically infected before the admission to the ICUs were excluded. (2). Patients who died after the first 24 h of admission to ICUs were considered as ICU mortalitys during ICU hospitalization. (3). Critically ill patients who were not able to answer the questions at all and the patients who died during the first 24 h of admission to ICUs were excluded from the study due to the possibility of other causes of their mortality rather than infection. Kannur Medical College Hospital was tertiary teaching hospital with 750 beds located in a large hospital complex in a rural setting. It has 32 different types of wards and 250 physician/surgeon faculty members affiliated to Kerala University of Health Sciences. The total number of beds including all the ICUs (general ICU, pre-operative surgical ICU, intensive coronary care unit, respiratory ICU, post-operative surgical ICU, and emergency medicine ICU) was 95. The study was carried out from April 2016 to March 2018. NCI was defined as the presence of clinical signs and symptoms of infection in the patients for at least 48 h after their hospitalization, confirmed by positive cultures of blood, urine, wounds, respiratory secretions, and other body fluid specimens. For all the patients, the data of the factors associated with NCIs and deaths were collected according to a 109-item researcher-administrated checklist including nine segments which are as follows: demographic factors (7 questions), hospitalization situations (6 questions), underlying diseases (10 questions), laboratory test results (12 questions), administered drugs (11 questions), usage of therapeutic instruments (15 questions), personal performance (9 questions), outcomes (7 questions), and environmental structure (32 questions). The other patients who died after the first 24 h of admission to ICUs were considered as ICU mortality during ICU hospitalization. The regular protocol for infection control in ICU wards included was as follows: hand washing before and after each visit, use of protective equipment such as surgical masks – gloves – goggles – shields and gowns in each visit, patient isolation in case of infectious state, environmental cleansing and disinfection (floors, walls, and roofs), use of antibiotics or probiotics based on physician prescription, use of non-silicon catheters, and periodic personnel education. By applying standard statistical methods, at the first descriptive statistics, was used to analyze the gathered data. Then, Chi-square and *t*-test were used, respectively, to test the associations between both qualitative and quantitative variables and outcomes. $P < 0.05$ was considered statistically significant.

OBSERVATIONS AND RESULTS

Among the 624 patients, 364 (58.33%) were male and 260 were female (41.66%). The youngest patient was aged 16 years and the eldest one was aged 87 years with a mean age of 49.78 ± 11.30. There was no statistically significant difference between patients' ages and their genders, according to NCI status. The mean age of patients who had NCIs was 57.68 ± 09.45 when compared to the mean age of 52.39 ± 8.20 in patients without NCIs with $P = 0.781$ (statistically not significant). The mean age of patients who died with NCIs was 76.15 ± 6.29 and the mean age of patients with NCIs who survived was 63.20 ± 7.70 with $P = 0.021$ (statistically significant). Culture positivity of specimens collected and analyzed was observed in 195 (31.25%) patients. The overall rate of confirmed NCI in the studied patients was 241/624 (38.61%)

(confidence interval [CI] 95% = 13.25–21.50). General ICU was the most crowded ward consisting of 237/624 admissions (37.98%) and had the highest rate of NCIs 72/159 (38.81%). The distribution of NCIs in other various ICUs was different from general ICU, as shown in Table 1.

According to univariate analysis, the patients' mean age and gender had no statistically significant relationship with NCIs ($P > 0.05$), but the education level lower than diploma, increased length of stay in ICU, longer duration of antibiotic administration, combined antibiotic therapy, increased catheter stay, and the presence of chronic diseases had statistically significant association with increased rates of NCIs. The incidence of NCIs and mortality was significantly higher in 60 years and older age group [Table 2].

Among 195 positive cultures, *Acinetobacter* was isolated in 43/195 (22.05%) positive specimens. The most common site of infection was respiratory tract 86/195 (44.10%). The most common antibiotic prescribed for 74/195 (37.94%) culture positive cases was vancomycin. The overall mortality rate was 46/624 (7.69%) (CI 95% 5.3%–11.4%). The results of univariate analysis demonstrated that higher ages, education level lower than diploma, and combination antibiotic therapy were associated with the higher rate of mortality ($P < 0.05$). Gender and the presence of NCIs showed no statistically significant association with mortality [Table 2]. According to multivariate logistic regression analysis, the statistically significant variables in the model for increased rate of NCIs were prolonged urinary catheterization (more than 7 days), combination antibiotic therapy, NG tube insertion, intubation, education level lower than diploma, and tracheostomy. Furthermore, the factors significantly associated with mortality in the model were the age more than 60, prolonged urinary catheterization (more than 7 days), CV line duration <7 days, education level lower than diploma, and NG tube insertion [Table 2].

Table 1: The number of admissions in various intensive care units (*n*=624)

Different ICUs	Positive culture, *n* (%)	CI 95%	Total, *n* (%)
General ICU	72 (38.81)	15.1–15.4	237 (37.98)
Pre-operative surgical ICU	54 (22.78)	08.2–10.3	127 (20.35)
Intensive coronary care ICU	33 (13.92)	04.1–07.5	096 (15.38)
Respiratory ICU	29 (12.23)	03–07.5	075 (12.01)
Post-operative surgical ICU	26 (10.97)	03.2–12.2	065 (10.41)
Emergency ICU	23 (09.70)	07.3–11.5	024 (03.84)
Total	237 (100)	-	624 (100)

ICU: Intensive care unit, CI: Confidence interval

DISCUSSION

In this prospective study, NCI with culture positivity of specimens collected and analyzed was 195 (31.25%). The overall confirmed NCIs observed in the ICU patients was 241/624 (38.62%) (CI 95% = 13.25–21.50). In a similar study by Appelgren *et al*., approximately 30% of patients admitted to ICUs were affected by NCIs.[9] The average of NCIs in this study was 26.28% which is less than the reported rate based on 95% CIs. Review of literature shows that immune suppression and other related changes to aging as the risk factors for increase in the incidence of NCIs in people older than 65.[10] However, in this study, patient's ages showed no statistical significance correlating with NCIs, in multivariate logistic regression analysis. However, in this study, patient's ages showed no statistical significance correlating with NCIs, in multivariate logistic regression analysis, although there was statistically significant increased rate of NCIs observed in patients 60 years old and above, in univariate analyses. This may be because the numbers of patients with younger age were more in this study in comparison with other studies. The average age of the patients in this study was <65. Like the other studies, there was no statistical significance in relationship between the gender and NCIs.[11] Although obesity and overweight were important factors associated with NCIs,[12] there was no measure to analyze these variables in the present study and it can be considered as a limitation to this study. The main reason of this limitation was that the height and weight could not be measured easily and accurately in critically ill patients. The findings showed that the education level lower than Xth standard had statistically significant relationship with increased rate of NCIs and deaths, based on univariate and multivariate analyses. This may be due to better personal hygiene in patients with higher education or some other associated socioeconomic factors which play important roles in the higher rates of these outcomes. The present study showed that increased length of stay in ICUs to more than 7 days was associated with increased incidence of NCI similar to the study by Crooks *et al*.[1] However, multivariate analysis indicated that certain other factors also were associated with NCIs. Accordingly, one of the most important factors associated with both NCIs and ICU mortality was prolonged urinary catheterization (more than 7 days), which is compatible with the study by Rudman *et al*. study.[13] The mechanisms associated with UTIs and increased mortality was revealed in the past in literature.[14,15] In the present study, the most common isolated pathogen in patients with NCI was *Acinetobacter*. The findings of this study showed that 12% of isolated *Acinetobacter* were resistant to all routinely prescribed antibiotics.[16] This recent emergence of drug-resistant *Acinetobacter* has caused a great concern worldwide[16] and

Table 2: Different associated factors with nosocomial infections and death (*n*=624)

Variables	States (%)	Positive culture (%)	*P*	OR	Death	*P*	OR
Age							
>60	254 (40.70)	54 (27.69)	0.013	3.25	13	0.001	5.21
<60	370 (59.29)	52 (14.05)					
Gender							
Male	364 (58.33)	91 (25)	0.217	-	18	0.553	4.02
Female	260 (41.66)	48 (18.46)					
Education							
< tenth standard	297 (47.59)	84 (28.28)	0.010	-	17	0.023	4.28
> tenth standard	327 (52.40)	57 (17.43)					
CV line duration (days)							
>7	234 (37.50)	11348.29 ()	0.031	-	24	0.001	-
<7	300 (48.07)	021 (07)					
ICU stay							
>7	240 (38.46)	128 (53.33)	0.005	-	29	0.020	-
<7	384 (6153)	11 (02.86)					
Antibiotic duration							
>7	179 (28.68)	99 (55.30)	0.019	-	19	0.027	-
<7	445 (71.31)	21 (04.71)					
Urinary catheterization							
>7	221 (35.41)	118 (53.39)	0.028	-	129	0.001	-
<7	403 (64.68)	010 (02.48)					
Tracheostomy							
Yes	108 (17.30)	48 (45.37)	0.001	-	12	0.011	
No	516 (82.69)	103 (19.96)					
Intubation							
Yes	293 (46.55)	83 (28.32)	0.041	-	15	0.039	
No	331 (53.04)	44 (13.02)					
NG tube							
Yes	388 (62.17)	114 (29.38)	0.038	-	08	0.040	
No	236 (37.82)	126 (53.38)					
IV catheter duration							
Yes	119 (19.07)	61 (51.26)	0.021	-	06	0.017	
No	505 (80.92)	19 (03.76)					
Antibiotic therapy							
Combined	409 (65.54)	131 (32.02)	0.010	-	07	0.019	
Single	215 (34.45)	10 (04.65)					
Culture results							
Positive	195 (31.25)		0.001	-	14	0.001	
Negative	429 (68.75)						

CV: Central venous, ICU: Intensive care unit, OR: Odds ratio, NG: Naso gastric, IV: Intra venous

it seems that this matter should be paid special attention in these ICU settings. In this study, multiple antibiotics were prescribed for 192 patients and just 215 patients were treated using a single antibiotic. The statistical significance of association between combination antibiotic therapy and mortality indicates that increased drug resistance and ineffectiveness of different antibiotics may have inevitable role in mortality. In addition, certain special side effects of few antibiotics and immune system impairment may be another reason for the higher rate of mortality. The quality of prescribed antibiotics was also another important factor for increased mortality. Therefore, the effectiveness of antibiotics should regularly be investigated in both *in vitro* and *in vivo* settings. The UK Intensive Care Society has suggested that crowded ICUs, especially those with more than 8 beds, will face managerial problems,[17] and this fact may explain the higher rates of infections observed in general ICU. The most crowded ICU in the present study was with 20 beds and it was general ICU. According to the above findings, NG tube insertion was associated with NCIs and deaths and this is consistent with the findings of the other studies in literature.[18] Lower gastric PH and aspiration during gavages and NG tube insertion may play roles in NCIs and the deaths subsequent to NCIs.[18]

CONCLUSIONS

The patients with prolonged urinary catheterization were prone to NCIs and deaths in ICUs, and hence, they should be treated intensively.

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