INCIDENCE AND PREDICTORS OF INTENSIVE CARE UNIT-ACQUIRED URINARY TRACT INFECTIONS AMONG CATHETERIZED PATIENTS ADMITTED AT KENYATTA NATIONAL HOSPITAL CRITICAL CARE UNIT
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INCIDENCE AND PREDICTORS OF INTENSIVE CARE UNIT-ACQUIRED URINARY TRACT INFECTIONS AMONG CATHETERIZED PATIENTS ADMITTED AT KENYATTA NATIONAL HOSPITAL CRITICAL CARE UNIT

E. G. Mwangi, S. M. Karanja, P. Wanzala and Z. W. Ngumi

ABSTRACT

Objective: **To determine the incidence and predictors of hospital acquired catheter associated urinary tract infections among catheterized patients admitted at Kenyatta National Hospital Critical Care Unit**

Study Design: **Prospective Cohort Study**

Setting: **Kenyatta National Hospital Critical Care Unit**

Subjects: **the study population was two hundred and thirty-eight patients admitted in the critical care unit between January 2019 and January 2020 and were put on urinary catheter**

Main Outcome Measures: **Incidence of hospital acquired urinary tract infection, patient level and hospital level risk factors associated with catheter associated urinary tract infections.**

Results: **the incidence density of hospital acquired catheter associated urinary tract infection was 32 per 1000 Catheter-days in the critical care unit. The cumulative incidence was 28.7%. Patients having other comorbidities had a higher risk to acquire catheter associated urinary tract infection; risk ratio of 1.669. Failure to observe aseptic techniques during emptying of the urine bag had a higher risk to acquire catheter associated urinary tract infection; risk ratio of 3.392. Failure to secure the urinary catheter on the patient's thigh had a higher risk to acquire catheter associated urinary tract infection; risk ratio of 1.836.**

Conclusion: **the incidence of intensive care acquired catheter associated urinary tract infection at the critical care unit is relatively high compared to other jurisdictions. The risk factors associated with the high incidence of the urinary tract infection are comorbidities, failure to observe aseptic techniques**

during emptying of the urine bag and failure to secure the urinary catheter on the patient's thigh.

INTRODUCTION

The World Health Organization (WHO) defines nosocomial or hospital associated infections (HCAI) as infections appearing in a patient undergoing medical care in the hospital or other health care facility and the infection was not present on admission [1]. The WHO states that the infection can occur during the time the patient is receiving health care for other diseases and even after the patient is discharged from the facility. They comprise infections among medical staff acquired while delivering health care [1]. According to Centers for Disease Control and Prevention (CDC), these infections are associated with devices that are invasive, such as catheters and respiratory ventilators employed in modern health care [2].

The most common nosocomial infection is urinary tract infections (UTI), majority (80%) of which are associated with utilization of the indwelling catheter devise in the health facilities to drain urine [3]. Catheter-acquired urinary tract infections (CAUTI), contributes about 20% of healthcare acquired bacteremia events in acute care facilities, and over 50% of the episodes in the long-term care facilities [4].

Incidence of CAUTI

A surveillance cohort study done in Calgary Health region in Canada reported the incidence density for intensive care unit UTI as 9.6 -11.3 per 1000 ICU days [5]. Infection rates of CAUTI as reported by the National Healthcare Safety Network (NHSN) in the year 2010 was between 4.7 infections per 1000 in Burn ICUs and 1.3 infections per 1000 catheter-days in medical /surgical ICUs [6]. A study done in a post-operative patients admitted in the pediatric cardiac intensive care unit at King Abdulaziz Medical City, Riyadh, Saudi Arabia,

reported an incidence density rate of 18 per 1000 catheter-days [7]. A study done at Kenyatta National Hospital ICU in the year 2011 reported the cumulative incidence of CAUTI to be18% [8].

Risk factors

Studies show that women are at a higher risk of developing an ICU-acquired UTI [5, 9]. The study done in Calgary Health region reported a risk ratio of 1.58 (95% CI 1.43 - 1.75; P <0.0001). Non-modifiable patient level risk factors for CAUTI are female gender, severe underlying illness, non-surgical disease, age greater than 50 years, Diabetes Mellitus and Serum creatinine levels greater than 2 mg/dL. Modifiable risk factors were Duration of catheterization Adherence to aseptic catheter care, catheter insertion after the sixth day of hospitalization and catheter insertion outside the operating room [9].

MATERIALS AND METHODS

Study site: This study was conducted at the Kenyatta National Hospital (KNH) Main critical care unit. It is the largest teaching and national referral hospital in East and Central Africa. The hospital was established in the year 1901 and became a corporate in 1987. It has a bed capacity of 1800 patients. Kenyatta National Hospital is situated in Dagoretti constituency, Nairobi County, about 3 km from the city center, off Ngong' Road on Hospital road and borders Mbagathi way to the south. The CCU is situated at the first floor of the old hospital neighboring the renal unit, burns unit, cardiology unit, and the main theatres. The CCU is the largest in the country with a 21-bed capacity. The Unit is multidisciplinary and admits patients of all ages. The average monthly admission is 50 to 60 patients.

Study Design: The study design used was prospective cohort design.

Study Population: All patients admitted to the CCU who met the inclusion criteria were recruited in the study.

Sampling: The patients were recruited consecutively for the period of the study (one year).

Sample size was determined using Fleiss (1981) formulae.

$$N = \frac{r+1}{r} \times \left(\frac{Z_{1-\alpha/2} + Z_{1-\beta}}{p_1 - p_2} \right)^2 \times \overline{p} \times \left(1 - \overline{p}\right)$$

$$= \frac{1+1}{1} \times \left(\frac{1.96 + 0.84}{0.75 - 0.25} \right)^2 \times 0.5 \times \left(1 - 0.5\right)$$

$$= 28.88$$

$$approxmatdy = 29\, patients$$

$$total = 58\, patients$$

The sample size was taken as the minimum sample size. Census was adopted whereby 238 participants were recruited consecutively over a period of one year.

Inclusion criteria: For a patient to be included in the study they had to be free from UTI on admission to the CCU, have an indwelling urinary catheter fixed, a Glasgow Coma Scale of 15 to enable them give consent or have a next of kin consent on their behalf if the Glasgow Coma Scale (GCS) was below 15.

Exclusion criteria: Patients who were admitted being unknown persons were not recruited. Patients who were discharged before the third day (before the second urine sample was collected) were removed from the study. Patients whose GCS was below 15 and had no next of kin to give consent were excluded from the study.

Data collection Procedure: After consent was obtained, a patient was assessed via history taking and physical examination. Data was collected using data collection forms, lab records and an observational checklist for recording information on each of the subjects. Urine samples were collected following the prescribed procedure to avoid contamination and to ensure whatever organism cultured were not a contaminant. The results were entered in a form. The first urine specimen was collected within the first twelve (12) hours, second urine specimens at 72 hours, third specimen at 7 days and the fourth specimen at 14 days of a patient's admission.

Urine collection procedure: The equipment (sterile gloves, Alcohol swabs, twenty milliliter syringe, Urinalysis indicator strip, blunt cannula (G21), Catheter clamp, a sterilized specimen jar, Patient label, lab request form, plastic biohazard bag and a sterilized trolley) were prepared before the procedure. Informed consent was obtained from the patient if conscious and if not from the next of kin (this is after the procedure and rationale is explained). The investigator checked to make sure that the indwelling catheter possess a rubber port for specimen collection. The equipment was organized, and patient screened for privacy. The investigator washed his hands (Moment 1), clamped the catheter below the rubber and allowed at least twenty (20) minutes for urine to collect. Then he washed his hands again (Moment 2) and put on a gown and sterile gloves. He put together a syringe and a sterile needle, then clean the catheter tubing with alcohol swab and allow thirty seconds for it to dry. The investigator would insert the needle carefully into the port and withdraw twenty (20) milliliters of urine, he transferred most of the urine into sterile specimen jar (taking care not to contaminate jar), transfer the remaining urine onto the urinalysis indicator strip and put the sharps in the sharps container for disposal. He then removed the clamp to release the catheter and appropriately dispose of other equipment. He ungloved and hand washed (Moment 3), attached patient address label to specimen jar and indicate time, date and specimen. The specimen was placed in biohazard bag (sealed plastic bag) and the

request form sent to the laboratory without delay. Testing was done within two hours of collection. Chemical preservatives (boric acid used for culture and sensitivity) was used in the instance the specimen was not be processed within 2 hours of collection. This type of specimens was refrigerated at 2-8°C.

Urine culture: The cultures were identified by standard microbiology techniques. Urine specimens were processed as per KNH Microbiology procedure for urine culture and antimicrobial susceptibility testing.

Inoculation and Isolation Techniques: CLED/MacConkey agar plate was labeled with laboratory identification number. A sterile calibrated loop of 1µl was dipped vertically into a well-mixed specimen. One loopful was streaked down the center of a CLED/ MacConkey agar plate. Without flaming, cross-streaks at a 90-degree angle were made perpendicular to the original streak. Inoculated plates were incubated inverted at 35°C for 18 hours.

Bacterial identification and Interpretation of Cultures: The plates were read for growth and determined the colony count. If confluent/ heavy growth of pure culture was obtained report $> 10^5$ per ml, it was considered significant. More than two colonies were considered as contaminants and repeat sample was requested. In children below five (5) years, all colony counts were reported regardless of pyuria. In antenatal women, all colony counts were reported.

Data processing and analysis: After data collection, data cleaning and coding was done and then prepared for analysis. Statistical analysis was done using Statistical Package for Social Sciences (SPSS) version 23.0. The incidence density of intensive care unit- catheter acquired UTI was calculated as the number of patients with new UTI episodes per total number of days the patients were catheterized and admitted in the ICU during the study period. Cumulative incidence was calculated as the new UTI episodes per the total number of patients who were recruited in the study and the patient that had undergone not less than two sample tests. Normally distributed variables were reported using means and standard deviations, and variables which are not normally distributed reported using medians with inter-quartile ranges (IQRs). To assess the differences in proportions between categorical data, the researcher utilized the χ2 and Fisher's exact test. Risk ratios were calculated to identify the risk factors associated with the infection.

Ethical considerations: Ethical approval was granted by UoN/KNH Ethical Review committee. In addition, permission to conduct the study was also sought from the management of Kenyatta National Hospital specialized Unit department and the research department. Patient's consent was obtained before recruitment to the study and where not possible due to patient's level unconsciousness, relatives. For patients aged below 18 years parents/guardian were requested to give consent. Confidentiality of responses was emphasized. The respondents were informed about the risks they are exposed and the expected benefits of the study.

RESULTS

A total of 238 patients were recruited into the study. Thirty-four patients (34) had UTI as indicated by the first sample. A total of 174 patients had two or more samples collected and analyzed. Men were 162, making a proportion 68%. Majority (157; 66%) were on Foley's catheter. Those on silicon catheter were 26 (10.9%, while those on silicon coated catheters were 55 (23.1%). Of the 238 patients, 180 (75.6%) were aged below 50 years while those aged above 50 years were 58 (24.4%). Central Nervous System conditions contributed a total of 144 (60.5%) patients. Other systemic conditions were; musculoskeletal conditions 26 (10.9%),

gastrointestinal illnesses 22 (9.2%), cardiovascular conditions; 11 (4.6%), Multisystem; 10 (4.2%), gynecological conditions; 10 (4.2%), Respiratory conditions; 7 (2.9%), endocrine; 4 (1.7%), Ear

Nose and Throat 2 (0.8%), and genital urinary tract 2 (0.8%). Approximately 25% (60) had comorbid conditions. Table 1 displays the demographic data.

Table 1
Demographic Information

		Frequency	Percent	95% Confidence Interval	
				Lower	Upper
Patient's Gender	Female	76	31.9	26.1	37.4
	Male	162	68.1	62.6	73.9
Type of catheter	Silicon	26	10.9	7.1	15.1
	Silicon coated	55	23.1	17.7	28.2
	Foley's Catheter	157	66	60.1	71.8
Age group	below 50 years	180	75.6	69.7	81.1
	Above 50 years	58	24.4	18.9	30.3
Systemic diagnosis	Cardiovascular	11	4.6	2.1	7.6
	Respiratory	7	2.9	0.8	5
	Neural	144	60.5	54.6	66.4
	Musculoskeletal	26	10.9	6.7	15.1
	Gastro-intestinal	22	9.2	5.9	13
	Genital urinary	2	0.8	0	2.1
	Multisystem	10	4.2	1.7	6.7
	Endocrine	4	1.7	0.4	3.4
	ENT	2	0.8	0	2.1
	Gynae/obstetric	10	4.2	1.7	7.1
Comorbidity	Present	60	25.2	19.7	30.7
	Absent	178	74.8	69.3	80.3

Incidence of Intensive Care Unit- Acquired Urinary Tract Infection: A total of fifty (50) patients developed CAUTI in 1576 person-days @risk hence the incidence density of 32 per 1000 catheter-days (95% CI 24/1000 to 42/1000 catheter days).

The cumulative incidence was calculated using the 50 new cases over the 174 patients who had two or more sample collected and analyzed hence 28.7% (287 per 1000 patients (95%CI 21.1% to 36.1%). The results were statistically significant.

Risk Factors associated with CAUTI
Patient Level Factors:

Gender: The risk ratio of female to male was 1.098 (95% CI 0.654 to 1.843) p-value 0.724 hence not statistically significant. Therefore, gender was not associated to the development of CAUTI.

Age: Age was divided into two groups; those aged below 50 years and above 50 years. The Risk Ratio for the age was 1.207 (95% CI 0.702, 2.075) p-value 0.5. Hence not statistically significant. Therefore, difference in age was not associated with to development of CAUTI.

Comorbidity: Patients with comorbid conditions were at a higher risk of developing CAUTI. The Risk Ratio was

1.669 (95% CI 1.014, 2.745) p-value 0.04.
Table 2 shows the patient level factors

associated with CAUTI

Table 2
Patient Level Factors and Risk Ratio

Risk Factor		Developed UTI (Positive)	UTI Absent (Negative)	Total Number of patients	RR	95% Confidence Interval	
						Lower Limit	Upper Limit
Gender	Female	17	59	76	1.098	0.654	1.843
	Male	33	129	162			
	Total	50	188	238			
Age	Above 50 years	14	44	58	1.207	0.702	2.075
	Below 50 years	36	144	180			
	Total	50	188	238			
Comorbidity	Present	18	42	60	**1.669**	**1.014**	**2.745**
	Absent	32	146	178			
	Total	50	188	238			

Facility Level Factors
Adherence to aseptic technique while emptying the Urine bag: Urine bag emptying procedure was monitored continuously on each patient. The CAUTI buddle protocol by CDC was used to monitor the emptying procedure. The aseptic technique was observed among 141 patients (59.2%) and not observed in 97 (40.8%) cases. The Risk Ratio for cases where asepsis was not observed during urine bag emptying to those where asepsis was observed was 3.392 (95% CI 1.963, 5.86). Meaning the risk of the patients where asepsis was not observed during urine bag emptying was 3.4 times more than where asepsis was observed. Table 3 illustrates the RR.

Securing the catheter on the patient's thigh: CDC recommends that the urinary catheter should secured on the patient's thigh. One hundred and thirty-one (131, 55%) patients had their catheters secured on their thighs throughout the study period. One hundred and seven (107, 45%) patients had their catheters not secured on their thighs. The risk ratio for not securing the catheter to securing the catheter was 1.836 (95% CI 1.108, 3.043). Meaning that the risk for patients whose catheters were not secured were 1.84 times more compared to those whose catheters were secured. Table 5 below illustrates the risk ratio.

Table 3
Facility Level Factors

Risk Factor		Developed UTI (Positive)	UTI Absent (Negative)	Total	RR	95% Confidence Interval	
						Lower Limit	Upper Limit
Asepsis during Urine Bag Emptying	Not Observed	35	62	97			
	Observed	15	126	141			
	Total	50	188	238	3.392	1.963	5.86
Securing the Urinary Catheter	Not secured	30	77	107			
	Secured	20	111	131			
	Total	50	188	238	1.836	1.108	3.043

DISCUSSION

The study showed the incidence density of Intensive Care Unit-acquired urinary tract infection at the Kenyatta National Hospital Critical Care Unit was 32 per 1000 catheter days. This was noted to be high as compared to similar studies done in other jurisdictions. A study done in an intensive Care Unit in Bahrain established an overall rate of 5.8 per 1000 catheter days [10]. Another study conducted at a tertiary care University hospital concluded that the rate of infection of CAUTI was 11.5±3.1 [11]. Health Safety Network (NHSN) in 2010 reported a CAUTI rate of 1.3 infections per 1000 catheter-days in medical/surgical ICUs [6]. The cumulative incidence of CAUTI was established to be 28.7%. This was an increase from 17.8% as noted in a study done in 2011 in the same unit ([8].

In the case of patient level factors, the study established infections among the female were not significantly different from the male gender (RR: 1.098 (95%CI 0.654, to 1.843). Other studies shows that women are at a higher risk of developing an ICU-acquired UTI [5, 9]. The study done in Calgary Health region reported a risk ratio of 1.58 (95% CI 1.43 -1.75: P value <0.0001). Another study in Bahrain showed that the male were at a higher risk than the female (Male: Female relative risk [RR] 2.9; (95%CI) 1.4016 to 6.2461; P = 0.011)) [10]. The results of the study suggesting that patients aged above 50 years were at a higher risk than those aged below 50 years were not statistically significant [1.207 (95% CI 0.702, 2.075) p-value 0.5].

Other studies indicate that age greater than 50 years is a risk factor [9]. Presence of comorbidities was established to be a risk factor in this study [RR: 1.669 (95%CI 1.014 to 2.745)]. The comorbidities studied were, Diabetes mellitus, retro viral disease, cardiac disease and renal diseases. This agrees with other studies; Diabetes Mellitus and Serum creatinine level greater than 2 mg/dL [9]; the Bahrain study showed that medical cases had higher risk than surgical cases [10].

In the case of facility level factors, the study established that failure to observe aseptic technique during emptying the urine bag was increasing the risk of acquiring CAUTI [RR: 3.392 (95%CI 1.963 to 5.86)]. Adherence to aseptic catheter care is a known factor reducing the risk of acquiring CAUTI [9]. Catheter insertion after the sixth day of hospitalization and Catheter insertion outside the operating room [9]. The CDC CAUTI prevention Bundle recommends asepsis during insertion, sample removal and bag emptying [12]. CDC recommends securing of the urinary catheter on the patient's thigh [12]. The study looked at this issue by calculating the risk ratio of patients

who had their catheters secured on the thigh to those whose catheters were not secured. The results indicated that patients whose catheters were not secured at the thigh increased the risk of developing UTI [RR: 1.836 (95%CI 1.108 to 3.043)]. This suggest that securing the urinary catheter is very important.

CONCLUSION

The incidence of Intensive Care Unit-Acquired urinary tract infection at the hospital's Main Critical Care Unit is high (32 per 1000 catheter days. The factors contributing to the high incidence are the presence of comorbid conditions, failure to observe aseptic technique during emptying of the urine bag and failure to secure the patient's catheter on the thigh.

RECOMMENDATIONS

To reduce the incidence rate of the infections the following recommendations are suggested:

(a) The health-care staff to be trained on CAUTI prevention Bundle by CDC

(b) A standard Operation Procedure to be prepared using the CDC's CAUTI Prevention bundle/ current evidence. This will enhance strict observance of the aseptic technique.

(c) The Health-care staff to have regular refresher course on Infection prevention and control. This is to ensure the staff are updated on the current evidence on infection prevention and control

(d) The Unit management to consider protective isolation (reverse barrier Nursing). (Patients with comorbid conditions to be isolated).

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