Nosocomial urinary tract infection

Risk factors, rates and trends

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ABSTRACT

Objective: This report aims at both estimation of the rates of overall nosocomial and urinary tract infection (UTI) and their linear trends as well as studying the potential risk factors of patients admitted to Al-Hada, Rehab and Prince Sultan military hospitals and developed nosocomial UTIs (NUTIs).

Methods: A case-control study on 206 discharged patients with confirmed UTI and 618 controls without UTI was caried out between August 2001 through to July 2003 to study risk factors for nosocomial UTI as well as hospital records during the period (1998-2002) were reviewed for calculation of the overall annual nosocomial infection and nosocomial UTI rates.

Results: Multiple logistic regression analysis showed that duration of hospital stay, unit of admission, history of diabetes mellitus or debilitating diseases, and duration and number of urinary catheters were independently associated with increased risk of NUTIs. The mean incidence rate of overall nosocomial infection along the study period (1998-2002) was 2.82, while the mean incidence rate of UTI nosocomial infection was 0.85 per 100 discharged patients. Urinary tract infection represents approximately 31.7% of overall nosocomial infection throughout the study period.

Conclusion: Urinary tract infections comprise approximately one third of nosocomial infections. The results, thus, indicated that to reduce the incidence of UTI nosocomial infection, it was important to take factors that can be managed into consideration. Therefore, the involved persons should pay more attention and set practical and effective guidelines for the hospital.

Saudi Med J 2004; Vol. 25 (7): 895-900

In developing countries, nosocomial infection is increasingly being recognized as a significant problem. Considering the economic burden of each day of hospitalization and the more expensive therapy required as well as its important contribution to the morbidity and mortality of hospitalized patients.[1-2] Up to 10% of all hospital patients develop nosocomial infection.[3-4] Urinary tract infections (UTI) are the most common type of nosocomial infection accounting for 40% of all infections in hospitals and 34% in nursing homes.[5-6] Normal host defenses against UTI are the unobstructed urethra, the voiding process, and the normal bladder mucosa.[7] The insertion of a urinary catheter by passes these defenses and provides a conduit for organisms to reach the bladder. Once in place, manipulation of the closed catheter system can introduce bacteria, resulting in a nosocomial urinary tract infection (NUTI).[8] In hospitals, 80-90% of nosocomial UTIs are associated with the use of urinary catheters and an additional 5-10% with other genitourinary manipulations.[6,9-10] Prevention and management of such infections require an intimate knowledge of the epidemiology

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Received 8th December 2003. Accepted for publication in final form 29th February 2004.

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including risk factors.[11-12] Hospital infection control programs can prevent 33% of nosocomial infections including NUTI.[13] This report aims at both the estimation of the rates of overall nosocomial and UTI infection and their linear trends over the last 5 years (1998-2002) as well as the studying of the potential risk factors of patients admitted to Al-Hada, Rehab and Prince Sultan military hospitals and developed NUTIs.

Methods. To fulfill the objectives of this study, 2 methodological strategies were adopted: 1. A case-control strategy: "to study risk factors." This was carried out between August 2001 and July 2003 at Al-Hada (351 beds), Al-Rehab (100 beds) and Prince Sultan (50 beds) military hospitals. These 3 hospitals are under the same administrative program. All patients hospitalized at these hospitals for at least 72-hours throughout the study period were considered eligible for the study. Among those, patients proved to have UTI were considered cases. The diagnosis of UTI was carried out according to the 2 criteria defined by the CDC (Centers for Disease Control and Prevention) in the United States of America[14] that are: Criterion 1. Patient has at least one of the following signs or symptoms with no other recognized cause: fever (>38^{o}C), urgency, frequency, dysuria, or suprapubic tenderness and patient has a positive urine culture that is >105 microorganisms per cm^{3}. Criterion 2. Patient has at least 2 of the following signs or symptoms with no other recognized cause: fever (>38^{o}C), urgency, frequency, dysuria, or suprapubic tenderness and at least one of the following: 1. Pyuria (urine specimen with >10 wbc/mm^{3}). 2. Organisms seen on gram stain of unspun urine. 3. Physician diagnosis of a UTI. 4. Physician institutes appropriate therapy for a UTI.

After exclusion of patients who did not fulfill eligibility criteria, 3 controls for each case were enrolled by simple random selection from list of patients hospitalized for more than 72 hours. For all participants (cases and controls), the following information was collected: patient's age, sex, unit of admission, presence of catheter, duration of catheterization, number of catheters, diabetes mellitus, history of immunosuppressive drug intake, history of debilitating diseases (cancer, liver failure, uremia….) as well as duration of hospital stay. The data from the patients records were collected during the hospital stay of the patients by a trained nosocomial infection surveillance team from the Preventive Medicine Department. 2. Record review "To calculate nosocomial UTI rates." Hospital records, providing monthly the number of hospitalized patients and the numbers of nosocomial infections (crude and site-specific), were reviewed. The overall annual nosocomial infection and

Table 1 - Baseline characteristics of participants in the case-control study.

Baseline characteristics	Cases (n=206) n (%)	Controls (n=618) n (%)	Total (824)
Age in years*			
≤15	33 (16.1)	156 (25.2)	**189 (22.9)**
>15-45 years	53 (25.7)	162 (26.2)	**215 (26.1)**
>45-65 years	40 (19.4)	133 (21.5)	**173 (21)**
>65 years	80 (38.8)	167 (27.1)	**247 (30)**
Mean	46.8 years	38.7 years	**408 years**
SD	29.3 years	29.4 years	**29.6 years**
Median	50 years	45 years	**45 years**
Range	2 days-95 years	2 days-87 years	**2 days-95 years**
Sex†			
Male	104 (50.5)	330 (53.4)	**434 (52.7)**
Female	102 (49.5)	288 (46.6)	**390 (47.3)**

*p <0.05, †p>0.05

Table 2 - Risk factors (univariate analysis).

Risk factors	Crude OR	95% CI
Age in years		
<15‡	1.0	
>15-45	1.55	0.92-2.59
>45-65	1.42	0.82-2.46
>65	2.26	1.40-3.69*
Sex		
Male‡	1.0	
Female	1.12	0.81-1.56
Duration of stay in hospitals		
<one week‡	1.0	
1-3 weeks	1.09	0.74-1.22
>3 weeks	5.12	2.15-11.72
Unit of admission		
Medical‡	1.0	
Surgical	2.15	1.02-5.22*
Intensive care unit	4.31	2.15-11.02*
Burn	3.62	1.85-7.24*
Others	1.05	0.57-1.74
Number of urinary catheters		
No‡	1.0	
Once	2.01	1.09-4.25*
Twice	2.31	1.13-5.11*
More than twice	6.23	2.48-10.26*
Urinary catheter duration		
<=3days‡	1.0	
>3days	1.97	1.24-3.57*
Diabetes mellitus		
No‡	1.0	
Yes	7.32	3.01-24.05*
Underlying debilitating disease†		
No‡	1.0	
Yes	4.11	2.32-16.23*
Immunosuppressive drug		
No‡	1.0	
Yes	3.06	1.95-18.02*

† Cancer, liver failure, uremia, ‡reference category
OR - odds ratio
CI - confidence interval
*p<0.05

Table 3 - Risk factors (multivariate analysis)

Risk factors	Adjusted OR	95% CI
Duration of stay in hospitals		
<one weekR	1.0	
1-3 weeks	1.06	0.68-2.14
>3 weeks	2.18	1.24-3.29*
Unit of admission		
MedicalR	1.0	
Surgical	1.91	0.96-4.01
Intensive care unit	2.73	1.68-4.01*
Burn	3.05	1.74-4.13*
Other	1.16	
Number of urinary catheters		
NoR	1.0	
Once	1.99	0.92-3.72
Twice	2.18	1.22-5.14*
More than twice	4.56	2.04-6.28*
Urinary catheter duration		
<=3 daysR	1.0	
>3 days	3.01	1.7-6.21*
Diabetes mellitus		
NoR	1.0	
Yes	6.27	2.22-9.52*
Underlying debilitating disease*		
NoR	1.0	
Yes	3.11	1.29-8.18*

*$P<0.05$, ** Cancer, liver failure, uremia, R reference category
OR - odds ratio, CI - confidence intervals
Terms of age and history of immunosuppressive drugs intake were removed from the final model

Table 4 - Distribution of total discharged patients and critically ill patients* according to the presence of nosocomial and urinary tract infections, Al-Hada, Kingdom of Saudi Arabia (1998-2002).

Year	Discharged patients		Patients with nosocomial infection		Patients with nosocomial UTI		Nosocomial UTI/total nosocomial infection rate	
	Total n	Critically ill	Total n (%)	Critically ill n (%)	Total n (%)	Critically ill n (%)	Total	Critically ill
1998	**10967**	691	**285 (2.6)**	82 (11.9)	**86 (0.8)**	31 (4.5)	**30.18**	37.80
1999	**14391**	901	**298 (2.1)**	106 (11.8)	**98 (0.7)**	39 (4.3)	**32.89**	36.79
2000	**10672**	686	**373 (3.5)**	81 (11.8)	**108 (1)**	29 (4.2)	**28.95**	35.80
2001	**9114**	572	**274 (3)**	69 (12.1)	**88 (1)**	21 (3.7)	**32.12**	30.43
2002	**9782**	620	**224 (2.9)**	78 (12.6)	**77 (0.8)**	26 (4.2)	**34.38**	33.33

*Those admitted at MICU, SICU, NICU or burn ICU
UTI - urinary tract infection

nosocomial UTI rates were calculated during the period (1998-2002) by dividing the total number of nosocomial infections (crude and UTI) pooled throughout all months by the total number of hospital patients' discharges (x 100). Critically ill patients (those admitted at medical intensive care unit (ICU) "MICU", surgical ICU, nursery ICU or burn ICU, were treated as a separate group. Overall and UTI infection rates were calculated for this particular group.

Statistical analysis. This was carried out with statistical package for social sciences; version 10.0. A linear trend was applied to search for evidence of change in the incidence rate of overall nosocomial and UT infections over time. Age, sex, duration of stay in hospitals, unit of admission, number of urinary catheters, urinary catheter duration, diabetes mellitus, underlying debilitating diseases and history of immunosuppressive drug were treated as categorical variables. The crude measure of

association between single putative risk factors and NUTIs was expressed as the odds ratio (OR) with 95% confidence interval (95% CI). Multiple associations were evaluated in multiple logistic regression models based on the backward stepwise selection. This process allowed the estimation of the strength of the association between each independent variable and the dependent variable taking into account the potential confounding effects of the other independent variables. The covariates were removed from the model if the likelihood estimates had a probability >0.10. Each category of the predictor variables was contrasted with the initial category (reference category). An adjusted odds ratio with 95% CI that did not include 1.0 was considered significant. The significance level of *P* value was set at 0.05.

Results. A total of 206 discharged patients with nosocomial UTI and 618 controls without nosocomial UTI were recruited. Their baseline characteristics (age and sex) are reported in **Table 1**. The age of cases ranged from 2 days to 95 years (46.8 ± 29.3 years; median= 50.0 years), while for controls it ranged from 2 days to 87 years (38.7 ± 29.4 years; median= 45.0 years). The difference between both groups was statistically significant (*P*=0.001). Females represent 49.5% and 46.6% of cases and controls with no significant difference (*p*=0.38). The results of univariate analysis and logistic regression analysis of studied risk factors for nosocomial UTIs are summarized in **Tables 2 & 3**. Nosocomial UTIs was significantly associated with stay in hospitals for more than three weeks as opposed to less than one week (OR=2.18, CI: 1.24-3.29). Regarding unit of admission, patients admitted to either ICU or burn unit were more liable to develop NUTI than those admitted to medical units (OR=2.73, CI: 1.68-4.01 and OR=3.05, CI: 1.74-4.13). Number and duration of urinary catheters were associated with the outcome of interest. Patients with twice urinary catheters (OR=2.18, CI: 1.22-5.14) and those with more than twice urinary catheters (OR=4.56, CI: 2.04-6.28) had an increased risk of NUTI as compared to patients with no history of urinary catheters. Patients with more than 3 days duration of urinary catheter had a 3 fold risk as opposed to those with less or equal to 3 days duration (OR=3.01, CI: 1.87-6.21). Diabetes mellitus was strongly and positively related to nosocomial UTI (OR=6.27, CI: 2.22-9.52). The presence of underlying debilitating disease was also significantly associated with an increased NUTI risk (OR=3.11, CI: 1.29-8.18). Patient's age, sex as well as history of immunosuppressive drugs were not independently associated with the outcome of interest.

The study findings revealed that the incidence rate of overall nosocomial infection along the study period (1998-2002) ranged from 2.07 to 3.50 with a mean of 2.82, while the incidence rate of UTI nosocomial infection ranged from 0.68 to 1.01 with a mean of 0.85 per 100 discharged patients. Urinary tract infection represents approximately 31.7% of overall nosocomial infection throughout the study period. Regarding critically ill patients, as a separate group, the mean overall nosocomial infection and NUTI rates were 12.04 and 3.45 per 100 patients throughout the study period. Urinary tract infection represent around one third of overall nosocomial infections (34.8%) as shown in **Table 4**.

Discussion. Hospital-acquired UTIs represent a significant impairment in the quality of health care. Three major forces are involved in nosocomial infections.[15] The first is antimicrobial use in hospitals and long-term care facilities. The increased concern regarding gram-negative bacilli infections in the 1970s to 1980s led to increased use of cephalosporin antibiotics. As gram-negative bacilli became resistant to earlier generations of cephalosporin antibiotics, new generations were developed. Widespread use of cephalosporin antibiotics is often cited as a cause of the emerging of enterococci as nosocomial pathogens. Approximately the same time, MRSA (Methicillin-resistant staphylococcus aureus} , perhaps also in response to extensive use of cephalosporin antibiotics, became a major nosocomial threat. Widespread empiric use of vancomycin, as a response to concerns regarding MRSA and for treatment of catheter-associated infections by resistant coagulase-negative streptococci, is the major initial selective pressure for VRE (vancomycin-resistant enterococci). Use of antimicrobial drugs in long-term care facilities and transfer of patients between these facilities and hospitals have created a large reservoir of resistant strains in nursing homes. Second, many hospital personnel fail to follow basic infection control, such as hand washing between patient contacts. In ICUs, asepsis is often overlooked in the rush of crisis care.[16] Third, patients in hospitals are increasingly immunocompromised. The shift of surgical care to outpatient centers leaves the sickest patients in hospitals, which are becoming more like large ICUs.[17] Although most patients with NUTI will have asymptomatic bacteruria or mild infection that tends to be self-limiting when the drainage device is removed, some patients will have severe infections, pyelonephritis, septicemia and death.[18] The risk of acquiring a UTI depends on the method and duration of catheterization, the quality of catheter care, and host susceptibility.[19] Urinary tract infections were identified in approximately 30% of

patients with urinary catheters within 2 weeks and virtually 100% at 6 weeks.[20] Another study reported infection rates ranging from 1-5% after a single brief catheterization to virtually 100% for patients with indwelling urethral catheters draining into an open system for longer than 4 days.[21] The current study revealed that the number of catheter insertions and the duration of catheterization play a significant role in determining the occurrence of NUTI. The highest rates of UTI nosocomial infections were observed in intensive care units, which are also the units in which the most severely ill patients are treated and in which the highest mortality rates are observed. Similar findings were found in other studies.[22-23] Our finding supports the results of other recent reports that found that there was a greater risk for NUTI with increased duration of catheterization.[24-26] Tasseau et al[27] found that the risk of NUTI rose from 19% for 5 days long catheterization to 50% for 14 days long catheterization. Females were not at a higher risk for NUTI in our study in contract to what had been reported by other several controlled studies that demonstrated a higher risk for NUTI in females.[26,28-30] Also, gender was found to have insignificant effect in another prospective study.[27,31] Similarly, age was not proved in our study to have a significant effect. The same finding was mentioned in a previous report,[29,31] in contrast to that reported in Platt et al[26] multivariate study of 1474 catheterizations. Length of hospital stay was a strong predictor of the outcome. The same finding was mentioned in a recent report.[30] Diabetes mellitus was a strong risk factor for hospital acquiring urinary tact infection. In a study conducted by de Aguiar el al,[32] UTI was the most frequent cause of infection in diabetic admissions. A changed bacterial adhesion to the uroepithelium,[33] granulocyte dysfunction[34] and impaired antioxidant systems involved in bacterial activity[35] are all involved in the pathogenesis of UTI in diabetics.

In our study, UTIs comprise approximately one third of nosocomial infection that is slightly lower to have been reported by others.[5-6] The overall and urinary tract nosocomial infection rates have remained remarkably stable throughout the study period. Studies over the last decades suggest that the attack rate of NUTI was not as high as previously reported or was even decreasing,[36,37] perhaps due to a controlled catheter policy (shorter duration of catheter use, more attention to catheter hygiene, increase antibiotic use).

In conclusion, UTIs comprise approximately one third of nosocomial infections. The results, thus, indicated that to reduce the incidence of UTI nosocomial infection, it is important to take factors that can be managed into consideration. Therefore, the involved persons should pay more attention and set practical and effective guidelines for the hospital.

Acknowledgment. The authors would like to extend their thanks and appreciation of help to the Program Director, Al-Hada and Taif Armed Forces Hospital, Kingdom of Saudi Arabia. Also, we would also like to thank Mr. Harold Trupos for the revision of the English text.

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