Multimodal Supervision Programme to Reduce Catheter Associated Urinary Tract Infections and Its Analysis to Enable Focus on Labour and Cost Effective Infection Control Measures in a Tertiary Care Hospital in India

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ABSTRACT

Background: Catheter Associated Urinary Tract Infections (CAUTI) contribute 30%-40% of all the nosocomial infections and they are associated with substantially increased institutional death rates. A multimodal supervision program which incorporates training of the staff with respect to infection control measures can be effective in reducing the CAUTIs in hospitals.

Aim: To assess the impact of a multimodal UTI supervision program on the CAUTI rates over a year, from January 2009 to December 2009, in a tertiary care hospital in India.

Setting: A 215 bedded tertiary care private hospital.

Materials and Methods: The CAUTI rates were analyzed for the first 6 months (January 2009-June 2009). A UTI supervision program was instituted in the month of July 2009, which included training with respect to the standard protocols for the sample collection and diagnosis, the bundle components of the urinary catheter checklist and hand hygiene practices. The impact was assessed as per the CAUTI rates in the subsequent months.

Results: The average CAUTI rate was reduced by 47.1% (from 10.6 to 5.6) after the introduction of the supervision program.

This study presented the mean age of the patients with CAUTIs as 54.5 years and it showed an approximately equal contribution of both the sexes (52.94% in males and 47.05% in females). The impact analysis of the supervision program showed a reduction of 8.7% (from 23 days to 21 days) during the average duration of the catheterization. The adherence to the components of the urinary catheter check list was increased by 44.4% (p=0.069) and the hand hygiene compliance was increased by 56.4% (p=0.004) respectively after the interventions. Components like bladder irrigation and practising perineal cleaning were found to show no effect on the CAUTI rates.

Conclusion: The most common labour and cost effective infection control measures as revealed by the supervision programme were adherence to the urinary catheter checklist components (indication for catheter insertion and change, asepsis maintenance during and after the catheter insertion and avoiding urine reflux) and hand hygiene practices, whereas bladder irrigation and practising perineal cleaning thrice a day were unnecessary measures.

INTRODUCTION

Catheter Associated Urinary Tract Infections (CAUTIs) are the most common nosocomial infections in hospitals and nursing homes, which constitute 30%-40% of all the hospital acquired infections [1]. They have been associated with increased morbidity, mortality, hospital costs, and length of the hospital stay [2]. The prevalence of CAUTIs in the catheterized patients in acute care settings (catheter used for <7 days) is 3%-7%, in patients who require a urinary catheter for >7 days, it is up to 25% and it approaches 100% after 30 days [3,4]. About 17% of the healthcare associated bacteraemias are from urinary sources, with an associated mortality of approximately 10% [5].

Virtually, all the healthcare-associated Urinary-Tract Infections (UTIs) are caused by the instrumentation of the urinary tract (insertion of catheters). The risk factors which are associated with CAUTIs include female sex, older age, prolonged catheterization, impaired immunity, diabetes, renal dysfunction, severity of illness, insertion of the catheter outside of the operating room, inadequate professional training of the person who inserts the catheter, incontinence and the inpatients in the orthopaedic and the neurology departments [2].

The sources of the *microorganisms* which cause CAUTIs can be endogenous, i.e., via meatal, rectal or vaginal colonization or exogenous, i.e., via the contaminated hands of the healthcare personnel or via contaminated equipment. Microbial pathogens can enter the urinary tract either by the extra-luminal route [6], along the outside of the catheter, or by the intra-luminal route along the internal lumen of the catheter from the contaminated collection bag or from the catheter drainage tube junction. As the duration of the catheterization increases, there is the formation of a biofilm which renders the bacteria resistant to antimicrobials and difficult to treat [7]. CAUTIs comprise perhaps the largest institutional reservoir of nosocomial pathogens [8-10], the most important of which are multidrug-resistant Enterobacteriacae, other than *Escherichia coli,* such as *Klebsiella, Enterobacter, Proteus,* and *Citrobacter; Pseudomonas aeruginosa; A. baummannii; Enterococci* and *Staphylococci* and *Candida spp* [11].

Urinary-Tract Infections (UTIs) are defined by using Symptomatic urinary-Tract Infection (SUTI) criteria or asymptomatic bacteraemic UTI (ABUTI) criteria. UTIs that are catheter-associated (i.e., in which the patients have an indwelling urinary catheter at the time of or within 48 hours before the onset of the event) are reported by using diagnostic criteria as per the CDC guidelines [12].

Supervision programs which involve bundled infection control practices in hospitals do bring the rates of CAUTIs down. About 17%-69% of the CAUTIs may be prevented by taking the recommended infection control measures [13]. Certain issues however remain unresolved. Are the infection control practices labour and cost effective? Is a uniform protocol for the sample collection and the diagnosis of CAUTIs followed by all the clinicians? Which infection control practices result in the maximum reduction of the CAUTIs? To answer all these questions, this study was undertaken.

METHODS

The entire study was a before-after study with historical controls, which covered a period of one year from January 2009 to December 2009, in an Indian tertiary care 215 bedded super-speciality hospital setting. In the first 6 months, the data which pertained to the inpatients (in the ICU and the wards) with a urinary catheter was analyzed to see the number of CAUTIs. The urine sample collection protocols were critically examined to detect the deviations from standard guidelines [2] and to institute corrective measures if required. In the microbiology lab, the organisms which were isolated from the urine specimens were subjected to standard identification [14] and sensitivity testing by using VITEK 2 Compact Biomerieux and the results were recorded in the WHONET 5.4 programme. The CAUTIs rates per month were calculated as the number of urinary infections divided by the total number of catheter days. The diagnosis of the urinary tract infections and asymptomatic bacteriuria was done according to the standard definitions for urinary tract infections which was given in the National Healthcare Safety Network (NHSN) guidelines [12]. In the first 6 months, any deviations in the methodology of the UTI diagnosis according to the guidelines were recorded and these were subsequently corrected after the institution of the supervision programme in the month of July. Each CAUTI case was analyzed for the indication for the catheterization, duration of the catheterization, age, sex, and other risk factors.

In the month of July 2009, the UTI supervision program was instituted. Under this program, in the first week, the key areas which required improvement were identified. In the second week, the bundle of prevention measures was implemented by means of a urinary catheter checklist [Table/Fig-1] by giving relevant training. Training was also imparted on the standard definitions and the guidelines, as was outlined by the HICPAC [2]. During the third and the fourth weeks, auditing was conducted by the infection control department to determine the compliance to the urinary catheter checklist and the hand hygiene practices.

The urinary catheter checklist adherence by the staff was monitored for all the catheterized patients all over the hospital and the rates were calculated as:

$$\text{Checklist adherence rate} = \frac{\text{Number of staff adhering to the checklist X 100}}{\text{Total number of staff audited}}$$

Non-compliance with two components in the checklist, namely bladder irrigation and practising perineal cleaning thrice a day, was still taken as full compliance, but the non-compliance was noted.

A special emphasis was placed on the hand hygiene and the hand hygiene compliance rate was calculated as

$$\text{Compliance rate} = \frac{\text{Number of times the hand hygiene performed X 100}}{\text{Total Number of times hand hygiene should be done}}$$

At the end of the supervision program, an assessment was made of the impact of the intervention on the CAUTI rates (comparison of the pre-intervention rates [baseline] with the post-intervention rates).

RESULTS

A total of 34 CAUTI cases were documented in the entire year (Jan 2009- Dec 2009). The average CAUTI rate for the year was 7.93.

Among the 34, 20 infections (58.8%) occurred in the first 6 months. The introduction of the supervision program was done in July and the following 6 months showed 14 infections (41.2%). The average CAUTI rate [Table/Fig-1] in the first 6 months was 10.6 and it reduced to 5.6 (47.1% decrease) in the next 6 months.

The age and gender distribution of the CAUTIs for the different age groups (<5 years to >65 years) showed a higher number of infections in the age groups of 50-65 and >65 years (11 infections each out of 34 infections).The gender distribution showed an almost equal number of infections in both the sexes [18 (52.94%) in males and 16 (47.05%) in females]. The average duration of the catheterization was 17.1 days for all the catheterized patients for the entire year. However, in the first 6 months, the average duration of the catheterization was 23 days and after the supervision program, it reduced to 21 days (8.67% reduction).

The total number of *microorganisms* which was isolated from the 34 infections was 37, as more than one organism was isolated from some samples and their sensitivity pattern was recorded [Table/Fig-2]. The predominant organisms were *Candida* spp (29.7%), *E.coli* (18.9%), *Klebsiella pneumoniae* (18.9%) and others [*Providencia* rettgerii (13.5%), *Enterococcus spp* (5.4%), *Pseudomonas aeruginosa* (5.4%), *Proteus mirabilis* (2.7%), *Myroides* spp (2.7%) and *Acinetobacter baumannii* (2.7%)].

The average urinary catheter checklist adherence rate was 45% before the supervision program and it was 65% after the program, which showed an increase of 44.4% (p=0.069) [Table/Fig-3]. The average rates of the hand hygiene compliance [Table/Fig-3] before and after the supervision program were 33% and 51% respectively, thus indicating an increase of 56.4% (p=0.0004).

A detailed study of the sample collection protocols in the first 6 months revealed a flaw in the sample collection in 5 out of the 20 cases (25%), where a possibly contaminated sample was used for the analysis. The staff were made aware of the standard guidelines for the sample collection. In 4 out of 20 cases (20%), in the first 6 months, there was an inappropriate diagnosis of the UTIs. Overall, 9 out of 20 (45%) cases, in the first 6 months, were not true CAUTIs.

DISCUSSION

There were 34 patients who acquired the catheter associated urinary tract infections as per the study which was conducted for a period of one year. The CAUTI rates varied over the year between 2.3 to 25.3 urinary tract infections per 1000 catheter days. The average CAUTI rate per month for the entire year was 7.93, though the first 6 months showed a rate of 10.6 and the next 6 months

Month (2009)	Number of UTI	Total catheter days	Rates of UTI/1000 catheter days
January	1	197	5.07
February	2	243	8.23
March	1	290	3.44
April	1	281	4.7
May	8	473	16.9
June	7	276	25.3
July	3	507	5.9
August	1	433	2.3
September	3	403	7.4
October	2	442	4.5
November	3	381	7.9
December	2	360	5.6
TOTAL	34	4286	7.93

[Table/Fig-1]: Urinary Tract Infection Rates for Year 2009

Organisms Isolated	Number of isolates	Antibiotics Susceptibility
Candida	11	NA*
Klebsiella pneumoniae	7	ESBL† (5)- Polymixin B, Colistin, Tigecycline, Carbapenems Cefoparazone-Sulbactam
		Non-ESBL(2)- Cefipime, Ciprofloxacin, Cefuroxime, Tigecycline, Colistin, Polymixin B
Providencia rettgeri	5	Colistin, Polymixin B & Piperacillin-Tazobactam
E. Coli	7	ESBL (3)- Colistin, Imepenem, Meropenem, Tigecycline, Polymixin B, Nitrofuratoin, Piperacillin-Tazobactam
		Non-ESBL(4)- Cefipime, Cefuroxime, Amikacin, Imepenem etc
Acinetobacter† baumannii	1	Colistin, Polymixin B
Enterococcus spp (VRE)‡	2	Teicoplanin, Chloramphenicol, Linezolid, Rifampicin
Pseudomonas†	2	Polymixin B, Colistin, Nitrofurantoin
Proteus	1	Amikacin, Cefipime, Cefuroxime, Ceftazidime, Nitrofurantoin
Myroides	1	Multi drug resistant

[Table/Fig-2]: Antibiotic susceptibility patterns of Organisms Isolated from Positive Urine Cultures

* Candida is not processed for sensitivity in urine specimens.
† Carbapenem Resistant strains.
‡ Vancomycin Resistant Enterococci showing resistance to high level Gentamicin.

Month (2009)	Average Urinary catheter Checklist Adherence Rate	Average Hand Hygiene Compliance Rate	CAUTI
Pre-Intervention			
January	55	20	1
February	45	25	2
March	55	30	1
April	60	37	1
May	25	40	8
June	30	46	7
Post Intervention			
July	50	40	3
August	65	45	1
September	60	50	3
October	70	45	2
November	65	60	3
December	80	70	2

[Table/Fig-3]: Comparison of Average rates of Urinary Catheter Checklist Adherence & Hand Hygiene Compliance for the year 2009

control policies and the protocols which were being followed in the developed countries.

As was observed in the present study, the mean age of the patients who developed CAUTIs was 54.5 years. A surveillance report which was made by Maha Talaat et al., showed that patients above 40 years of age had a significantly higher risk of acquiring CAUTIs [20]. Chao et al., [21] and Hussain et al., [22] indicated that females and elderly and debilitated patients were at a higher risk of acquiring infections. However, in the present study, equal number of males and females [18 (52.94%) males and 16(47.05%) females] were found to develop CAUTIs. This was probably because of the risk factors which contributed equally in both the sexes in the older age group.

For the patients who developed CAUTIs in the first 6 months, the average duration of the catheterization was 23 days and after the supervision program, it reduced to 21 days. These results were similar to those of a study which was done by T Tsuchida et al., [23] in Japan, where the mean duration of the catheterization was 25 days. Other studies have reported the average duration of the catheterization to be 16.4 days [24]. A study which was done by Garibaldi et al., [25] showed that the risk of developing bacteriuria increased by 5% for each additional day when the catheter was *in situ* and that after the tenth day, 50% of the patients had acquired bacteriuria.

The present study showed that the organism which was most commonly isolated from the CAUTIs was *Candida spp,* which showed 29.7% prevalence, which was in accordance to that in the prospective studies from the ICUs of Cairo University and Alexandria University Hospital, with 50% and 51% prevalence of *Candida* spp. in the CAUTIs [26]. *Candida* was followed by *E.coli* and *K. pneumoniae,* which showed an equal prevalence of 18.9%. Among these isolates, there were 42.8% ESBLs in *E. coli* (3 ESBLs out of 7 *E.coli*) and 71.4% ESBLs in *K. pneumoniae* (5 ESBLs out of 7 *K. pneumoniae*). Other isolates included *P. rettgerii* (13.5%), *Enterococcus* spp (5.4%), *P. aeruginosa* (5.4%), *P. mirabilis* (2.7%), *Myroides* spp (2.7%) and *A. baumannii* (2.7%). In a similar study, Jha et al., [27] found that most of the common organisms which were responsible for CAUTIs were *E. coli* (49%), *Staphylococcus aureus* (23%), *Proteus* spp. (3.6%), *Klebsiella* (9.71%), *P. aeruginosa* (0.8%), and *Citrobacter* (2.8%).

showed a rate of 5.6. This was because of the introduction of the UTI supervision program in the middle of the year, which brought the rates down by 47.1%. Multifaceted infection control/quality improvement programs do reduce the risk of the CAUTIs [15,16].

The results which were obtained by Madani N et al., [17] in Morocco corresponded to the results of our study, where the average CAUTI rate was 11.7 per 1000 catheter days. In contrast, findings from New York [18] indicated the average CAUTI rate to be 3.61. The studies which were carried out by WHO [19] also indicated that the developed countries showed a lower rate of UTIs (< 5 CAUTIs per 1000 catheter days) as compared to that in the developing countries (5-15 CAUTIs per 1000 catheter days). This may be because of the high standards of the infection

Checklists have tremendous potential for improving the safety and the quality of the infection control guidelines and for reducing the chances of omissions [28]. Therefore, the urinary catheter checklist adherence was an important focus of the supervision program. The average rate of the urinary catheter checklist adherence of the healthcare staff increased by 44.4% after the supervision program. Similarly, the hand hygiene compliance of the staff was also monitored by regular audits and it was found to increase by 56.4%. This steady increase in the rates of hand hygiene compliance in the entire year may have been a result of the continuous implementation of the hand hygiene policies. Similar hand hygiene compliance rates have been reported by INICC (International Nosocomial Infection Control Consortium) in Peru, which were found to range from 20% to 70% [29].

Since, 9 out of 20 (45%) were not true infections, more emphasis should be placed on the standardized guidelines of the sample collection and diagnosis, as was done in the UTI supervision programme. The UTI supervision program which was initiated in July 2009 was successful in bringing down the CAUTI rates in August itself and also thereafter. In spite of all these efforts, the rates rose in September and November to 7.4 and 7.9 respectively. The reason for this may be the patient related factors, as all the patients belonged to the high risk category. Similar results were obtained by Tom J Blodgett et al., [30] in 2009, upon the introduction of the intervention, which resulted in a failure in reducing the CAUTI rates, for which the author proposed methodological flaws as the possible reason for these rates. Another issue of concern which was addressed in the supervision program was the need for catheterization. A study on this aspect indicated that before the introduction of the supervision program, the insertion of a catheter was justified in 14 out of 20 (70%) cases and that after the program, it was justified in 10 out of 14 (71.4%) cases. This clearly showed that even after the supervision program, there was no decrease in the number of patients who had an indwelling catheter and therefore, changing the mindsets of the clinicians was a slow process, which would require further training. From within the bundle, it was observed that bladder irrigation and practising perineal cleaning thrice a day had no observable effects on the development of the infections. However, training of the staff, urinary catheter checklist adherence, hand hygiene compliance and avoiding the urine reflux were important measures which had to be taken. Evidences from earlier studies suggested there was no benefit of the bladder irrigation in patients who had indwelling or intermittent catheters [31,32]. Similarly, maintaining routine hygiene in the catheterized patients (e.g., cleansing of the meatal surface during daily bathing) is recommended instead of repeated antiseptic meatal cleaning regimens during the maintenance of the catheter, to prevent CAUTIs [2,33,34].

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