Comparison of Noble Metal Alloy Coated Urinary Catheters with Non Coated Catheters in Reducing Catheter-Associated Urinary Tract Infections

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ABSTRACT

OBJECTIVE: To assess the effectiveness of Noble metal alloy catheter in reduction of catheter acquired urinary tract infections in comparison to the standard catheters commonly used in our setups.

STUDY DESIGN: Prospective comparative study.

PLACE AND DURATION: Intensive Care Unit Bahawal Victoria Hospital, Bahawalpur from 1st October 2016 to 30th May 2017

METHODOLOGY: Through non-probability consecutive sampling technique 56 patients were included and randomly divided into two equal groups. One group was designated as latex noble alloy catheter and second group as siliconized latex Foley catheter. The outcome was to assess catheter acquired urinary tract infection, Catheter associated asymptomatic bacteriuria, symptomatic bacteremic urinary tract infection, asymptomatic bacteremic urinary tract infection, oliguria and polyuria.

RESULTS: Catheter acquired urinary tract infection was observed as 28.6% in standard catheter group and 7.1% Noble metal alloy group, similarly catheter acquired asymptomatic bacteria was observed 10.7% and 7.1%, respectively. Catheter acquired urinary tract infection and catheter acquired asymptomatic bacteriuria were 39.3% and 14.3%, respectively, asymptomatic bacteremia urinary tract infection 14.3% and 0%, symptomatic bacteremia urinary tract infection 17.9% and 0%, symptomatic bacteremia urinary tract infections and a symptomatic bacteremia urinary tract infections 21.4% and 0% Other bacteremia not associated with urinary tract infections 32.1% and 14.3%, polyuria 46.4% and 21.4% and oliguria 25% and 28.6% for the group A and B respectively.

CONCLUSION: Noble metal alloy coated catheters are effective in use to reduce catheter acquired urinary tract infections.


HOW TO CITE THIS:

INTRODUCTION

Urinary tract infection is commonest of the hospital acquired infection all over the world, accounting for up to 40% of all the healthcare setup associated infections¹. Out of all the urinary tract infections, 80% are caused by the use of indwelling catheters². Indwelling catheters are used for the purpose of observing the urine output of the patients admitted in ICUs. Almost fifteen to twenty percent of the patients present in the ICU require catheterization and most of the keep their catheter for two to four days. Incidence rate of urinary tract infections caused by catheters (catheter acquired urinary tract infections or CAUTIs) is approx. 1 million per year in United States of America, while expenses are estimated to be 400 million dollars per year that are spent to treat these urinary tract infections³. Catheter acquired urinary tract infections are mainly caused by commensal perineal flora⁴ but, other infectious agents can also cause these infections like bacteria from hands of the healthcare providers. Escherichia coli, Enterococci, Klebsiella, Pseudomonas aeruginosa or Enterobacter is the most common causal agents⁵. Pain and discomfort are not the only complications caused by the catheter acquired urinary tract infections but, it also increases the hospital stay from 1 to 4 days and also results in increased uptake of antibiotics ultimately developing the more resistant strains of microbes⁶. Pyelonephritis, cystitis and bacteremia are other consequences of catheter acquired urinary tract infections. Bacteremia can proceed to cause septicemia and thus septic shock which is highly fatal. Therefore, an early intervention to catheter acquired urinary tract infections must be made to prevent these horrendous turn of events. Possible interventions are proper hand hygiene of the staff handling the patient, careful, proper and safe drainage system use and avoidance of catheter insertion unless indicated¹. Multiple methods are being introduced, which involve use of much more compatible and effectively antimicrobial catheters, so that rate of catheter acquired urinary tract infections can be reduced.

Up till now, various materials with antimicrobial and antiseptic
properties have been introduced which are used for coating the catheters. Among these, Noble metal alloy, nitrofurazone, hydrogel, chlorhexidine, silver metal alloy and polymeric coatings are the ones with varying grade of positive results. Hydrogel and Noble metal alloy layer has been documented as the most successful coating to reduce catheter acquired urinary tract infections. Noble metal alloy and hydrogel layer coated catheters are in common practice in ICU setups of US and many studies have also proved their cost effectiveness, safety and efficacy. But results of these studies vary significantly, which shows that the efficacy mostly depends upon the catheterization time period, hospital, region, patient group properties and how we define catheter acquired urinary tract infections.

Rationale of our study to investigate the efficacy of Noble metal alloy catheter to control catheter associated urinary tract infection, this study will fulfill the gap of research on this topic as no local study available before. We conducted this study with an objective to assess the effectiveness of Noble metal alloy catheter in reduction of catheter acquired urinary tract infections in comparison to the standard catheters commonly used in our setups.

METHODOLOGY

This prospective comparative study was done at Intensive Care Unit of Bahawal Victoria Hospital, Bahawalpur from 1st October 2016 to 30th May 2017. Ethical approval for the study was taken from Hospital Ethics Committee and informed consent was taken from patients or their guardian. Non-probability consecutive sampling technique was for sampling. Sample size was calculated from the reference study by Aljohi et al. Patients with age greater than 18 years, with no urinary tract infection, in need of an indwelling catheter for 3 days or more and using closed drainage system are included in the study. Similarly, patients less than 18 years old, using open drainage system, with their urinary tract already infected or congenitally/obstetrically abnormal and those who were being catherized for less than 3 days were excluded. As per inclusion and exclusion criterion 56 patients were included in the study. Patients randomly divided into two equal groups. One group was designated as latex noble alloy catheter and second group as siliconized latex Foley catheter. Latex catheter coated with Noble metal alloy and hydrogel is also known as BIP Foley Catheter.

Data about age, gender and date of catheterization was gathered and then documented. Sterilized apparatus and aseptic technique was used to keep the rate of catheter acquired urinary tract infections. It was made sure that personnel handling the procedure undergone proper hand hygiene and kept closed drainage system intact and secured the catheters. Data was collected before catheterization i.e. baseline and then at the end of the procedure at the day 3 after catheterization. The author of the study examined the patients for suprapubic tenderness, body temperature, costovertebral tenderness or pain and other urinary tract infection related signs and symptoms, polyuria and oliguria. Blood and urine cultures were examined for white blood cells. Standard microbiological procedure was adapted for all the blood and urine analysis tests in laboratory.

If a patient as catherized within 48 hours before specimen collection, if patient had positive urine culture of ≥10^5 cfu/ml or ≥10^6 cfu/ml with one or two microbes, if patient had one of following symptoms; dysuria, fever or suprapubic pain and if urine culture was positive ≥10^5 and <10^6 cfu/ml, then one of these finding will define that patients is suffering from catheter acquired urinary tract infection. Similarly catheter acquired asymptomatic bacteremia will be defined if patient was catherized before or during the 48 hours before the specimen was taken, if urine culture of ≥10^5 cfu/ml or ≥10^6 cfu/ml is positive with one or two microbes maximum, urine culture was positive of ≥10^5 and <10^6 cfu/ml, even if only one of these evidences would be required. In case of no infection developed efficacy was considered as present.

In case of asymptomatic urinary tract infection, patients must be symptomatically free of catheter acquired urinary tract infection, patients urine culture contains maximum two microbes with one having bacteria of ≥10^5 cfu/ml and blood culture must also be positive for the same organism, of which urine culture was found positive. A patient found positive for catheter acquired urinary tract infection and also has a positive blood culture with the same bacteria for which urine culture was positive will be declared as symptomatic bacteremic urinary tract infection.

Data analysis: Data analysis was done by using SPSS version 24. Mean and standard deviation was calculated for numerical variables like age and frequency percentage were calculated for categorical variables like CAUTI, CA-ASB, Polyuria and Oliguria. Student t-test and chi square test were applied to see association between groups. P value ≤ 0.05 was considered as significance.

RESULTS

A total number of 56 patients were included and divided into two equal groups n=28 in each i.e. standard catheter (Group A) and noble metal alloy catheter (Group B). The mean age of the patients of group A was 55.71±4.54 years (t= 4.471, p=0.000). There were 60.7% (n=17) males and 39.3% (n=11) females. While, the mean age of the patients of group B was 50.02±4.96 years. There were 57.1% (n=16) males and 42.9% (n=12) females.

CAUTI was observed as 28.6% (n=8) and 7.1% (n=2), CA-ASB 10.7% (n=3) and 7.1% (n=2), CAUTI+CA-ASB 39.3% (n=11) and 14.3% (n=4), ABUTI 14.3% (n=4) and 0% (n=0), SBUTI 17.9% (n=5) and 0% (n=0), SBUTI+ABUTI 21.4% (n=6) and 0% (n=0), Other bacteremia not associated with UTI 32.1% (n=9) and 14.3% (n=4), polyuria 46.4% (n=13) and 21.4% (n=6) and oliguria 25% (n=7) and 28.6% (n=8) for the group A and B respectively (Table-I).

Association was found between age (p=0.000), CAUTI (p=0.036), CAUTI+CA-ASB (p=0.035), ABUTI (p=0.038), SBUTI (p=0.019), SBUTI+ABUTI (p=0.010), polyuria (p=0.048) in groups, while there was no association was between gender
(p=0.786), CA-ASB (p=1.0), other bacteremia not associated with UTI (p=0.114), oliguria (p=0.763), after applying the chi-square and independent samples t test (Table-I).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Standard Catheter Group A</th>
<th>Noble Metal Alloy Catheter (Group B)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAUTI</td>
<td>8 (28.6%)</td>
<td>2 (7.1%)</td>
<td>0.036</td>
</tr>
<tr>
<td>CA-ASB</td>
<td>3 (10.7%)</td>
<td>2 (7.1%)</td>
<td>1.0</td>
</tr>
<tr>
<td>CAUTI+CA-ASB</td>
<td>11 (39.3%)</td>
<td>4 (14.3%)</td>
<td>0.035</td>
</tr>
<tr>
<td>ABUTI</td>
<td>4 (14.3%)</td>
<td>0 (0%)</td>
<td>0.038</td>
</tr>
<tr>
<td>SBUTI</td>
<td>1% (17.9%)</td>
<td>0 (0%)</td>
<td>0.019</td>
</tr>
<tr>
<td>SBUTI+ABUTI</td>
<td>6 (21.4%)</td>
<td>0 (0%)</td>
<td>0.010</td>
</tr>
<tr>
<td>Other bacteremia not associated with UTI</td>
<td>9 (32.1%)</td>
<td>4 (14.3%)</td>
<td>0.114</td>
</tr>
<tr>
<td>Polyuria</td>
<td>13 (46.4%)</td>
<td>6 (21.4%)</td>
<td>0.048</td>
</tr>
<tr>
<td>Oliguria</td>
<td>7 (25%)</td>
<td>8 (28.6%)</td>
<td>0.763</td>
</tr>
</tbody>
</table>

*CAUTI catheter acquired urinary tract infection  *CA-ASB catheter associated asymptomatic bacteriuria  *ABUTI asymptomatic bacteremic urinary tract infection, *SBUTI asymptomatic bacteremic urinary tract infection.

**DISCUSSION**

Very thin Noble metal alloy of palladium, gold and silver which attached to catheter surface quite firmly constitutes the Noble metal coating. In recent years, several studies have been performed to assess the efficacy of Noble metal alloy catheter through different study designs, cohort, clinical trials and surveillance. The results have been found in favor of its use as results prove that this coating is non-toxic. Other words all these studies suggest that this coating not only reduces the rated catheter induced urinary tract infections but also has next to none adverse effects.

In a previous study conducted by Aljohi AA et al it was reported that incidence of CAUTI in standard catheter group was 40% and in Nobel metal alloy group it was 6.7%. In our study CAUTI was 28.6% vs 7.1% in standard and Nobel metal alloy catheter group respectively. Results of this can be compared with our study. Risk reduction of CAUTI was 83% in that study.

Lederer et al. performed a cohort study which was multi-center and involved 853 patients. According to that study there was significant 58% reduction in the rate of catheter acquired urinary tract infections (according to CDC definition of catheter acquired urinary tract infections) with the use of Noble metal alloy coated catheter. Similar results were found in another study with large number of patients and this study also provided the conclusion that use of Noble metal alloy is overall cheaper as it reduces hospital stay by reducing rate of catheter acquired urinary tract infections.

In our study CA-ASB was found in 10.7 in standard group and 7.1% in Nobel metal alloy group in a previous study it was reported that CA-ASB was found in 3.3% of cases in standard group and 1.5% in Nobel metal alloy. These findings are also comparable with our results. Overall observation of other studies and literature concluded that infection rate is shorter in metal alloy group.

In our study ABUTI is 14.3% and 0%, SBUTI 17.9% and 0%, SBUTI+ABUTI 21.4% and 0%. In another study ABUTI was found only in one case and SBUTI was found in two cases which is a low ratio as compared to our study. Similarly in another study it was observed that there was no difference CAUTI in both groups. Polyuria and Oliguria are also our main outcome variables we found polyuria 46.4% vs 21.4% and oliguria 25% vs 28.6% for the group A and B respectively. In our reference study in standard catheter group polyuria was observed in 35.3% of patients and Noble metal alloy group it was 12.5%, similarly oliguria was 29.4 % vs 25%.These results are also comparable with our results.

Nonetheless most of the previous studies performed about the efficacy of Noble metal alloy coating and its efficacy in reducing catheter acquired urinary tract infections are not randomized and in most of the studies the definition of catheter acquired urinary tract infections is somewhat different than the one used in our study as before 2009 bacteriuria was put in the category of catheter acquired urinary tract infections.

Furthermore previous studies were performed on significantly larger samples of patients making it difficult of identify the group of the patients benefiting the most from the use of Noble metal coated catheter. So recently study has been performed to identify the patients group not getting its benefits and they found that patients who had lower risk of undergoing surgery and those who were catherized for short duration of time did not benefit from the use of Noble metal coated catheter. But there are multiple other studies which show that Noble metal alloy coated catheter is actually beneficial for reducing catheter associated bacteriuria when used for shorter duration of time i.e. 1 to 3 days.

**CONCLUSION**

The Noble metal alloy coated catheter are effective in use to reduce catheter acquired urinary tract infections. Further studies are required to find out its cost effectiveness and its efficacy in different group of patients.
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Contribution of Authors:
Haseeb A: Conceived idea, Designed methodology, Data analysis and Manuscript writing
Hafiz MAA: Manuscript writing, Data compilation and analysis
Maha K: Final critical review of manuscript
Aymen N: Data collection and compilation, Literature review

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REFERENCES