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Major article

# Catheter-associated urinary tract infection after cardiovascular surgery: Impact of a multifaceted intervention

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***Background:*** The aims of this study were to assess the impact of a multifaceted intervention on the incidence of catheter-associated urinary tract infection (CAUTI) and on the urinary catheter utilization (UCU) ratio, evaluating adherence to recommendations for the use of indwelling urinary catheters (IUCs).
***Methods:*** This prospective, before-and-after interventional study was conducted in three 6-month phases: preintervention (phase 1), intervention (phase 2), and postintervention (phase 3). We observed IUC insertion technique, maintenance care, and removal/nonremoval practices; provided training on CAUTI prevention measures; evaluated professional knowledge; provided adherence feedback; determined the incidence of CAUTI, and calculating the UCU ratio.
***Results:*** Between phases 1 and 3, CAUTI incidence fell from 11.42 to 4.40 cases/1000 catheter-days ($P = .216$), whereas the UCU ratio remained constant. The risk of CAUTI was 2.6-fold higher in phase 1 than in phase 3. Adherence to hand hygiene (before and after IUC insertion) improved significantly, as did adherence to attaching the IUC to the patient and maintenance care guidelines. The reasons for IUC use (including inappropriate reasons) did not differ significantly. Professional knowledge improved significantly after training.
***Conclusion:*** A multifaceted intervention effectively reduced CAUTI incidence and improved the quality of care.



Urinary tract infection is one of the most common hospital-acquired infections. Approximately 80% of urinary tract infections are catheter-associated urinary tract infections (CAUTIs), which are associated with considerable morbidity, high hospital costs, and longer hospital stays.[1-4] Despite the risk of infections and complications from the use of indwelling urinary catheters (IUCs), few studies have assessed the impact of interventions aimed at reducing the CAUTI rate and the urinary catheter utilization (UCU) ratio, especially in patients undergoing cardiovascular surgery.

The objective of this study was to evaluate the impact of a multifaceted intervention on the CAUTI rate, the UCU ratio, compliance with recommendations for insertion, maintenance care, the need to leave an IUC in place, and the knowledge of nursing staff regarding the recommended IUC protocols.

## METHODS

### *Setting and patients*

This study was conducted at the Hospital São Paulo, operated by the Federal University of São Paulo/Paulista School of Medicine, a teaching hospital with 750 beds and 11 intensive care units (ICUs) for various specialties. The cardiac ICU (CICU) has 6 beds. The study population consisted of adult patients admitted to the CICU following cardiovascular surgery and who had an IUC in place for more than 24 hours. We excluded nonsurgical patients and patients in whom an IUC was not used. We followed the patients until discharge.

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*Study design*

This was a prospective intervention study conducted in 3 phases: preintervention (April 2011 to September 2011), intervention (October 2011 to March 2012), and postintervention (April 2012 to September 2012). We drew comparisons among those 3 phases in terms of the incidence of CAUTI and the rate of IUC use. We identified cases of CAUTI using the diagnostic criteria established in 2012 by the US Centers for Disease Control and Prevention (CDC).[5]

*Intervention*

In the intervention phase of the study, we monitored various protocols related to IUC use. To evaluate adherence to the various protocols over the course of the intervention phase, we conducted visits on different days and at different times throughout the phase.

We first observed IUC insertion in the operating room, verifying the use of hand hygiene before and after the procedure, sterile gloves, a sterile field, sterile lubricant, and antiseptic solution to clean the genital area. We also checked whether the collection bag was connected to the IUC before insertion, and we noted the number of insertions required (the ideal being successful insertion on the first attempt).

In the CICU, we observed the precautions taken for IUC maintenance, such as keeping the collection bag below the bladder but off the floor, checking for clear urine flow, not allowing the collection bag to be more than two-thirds full, protecting the outlet port, and keeping the IUC attached to the patient, as well as noting whether the duration of IUC use was recorded on the appropriate form.

Among the CICU patients selected, we evaluated the need to leave the IUC in place and the patient conditions that justified doing so, categorized as follows: being in the immediate postoperative period; showing hemodynamic instability; requiring mechanical ventilation; developing kidney injury; retaining urine; presenting with urinary blockage; and other. Hemodynamic instability was defined as hypotension or cardiac dysfunction when receiving treatment with adrenaline, noradrenaline, dobutamine, vasopressin, or sodium nitroprusside. Kidney injury was defined as a postoperative serum creatinine level $\geq$2 times that recorded at baseline.

We conducted training sessions in which we used the Institute for Healthcare Improvement's UTI bundle,[6] which outline 4 basic CAUTI prevention measures: avoid unnecessary urinary catheters, insert urinary catheters using aseptic technique, maintain urinary catheters based on recommended guidelines, and review the need for urinary catheterization daily and remove catheters promptly when indicated. Training sessions were held face-to-face. Each session was approximately 40 minutes in duration and was offered at 8 different times throughout the various shifts, so that all relevant personnel could attend. All cardiothoracic surgery residents received a letter, officially delivered by the secretary of the department, listing the CAUTI prevention measures. Informative posters were placed in high-visibility locations.

Using a questionnaire, applied on different days before and after the training period, we evaluated nursing staff in terms of the level of knowledge regarding the recommended IUC protocols. Participation was voluntary and anonymous. We provided feedback related to our observations and evaluations, as well as data related to the incidence of CAUTI, by posting reports on the wall within the nursing station. We also provided a urinary catheterization kit to the CICU.

The study was approved by the Research Ethics Committee of the Federal University of São Paulo. Written informed consent was obtained from the all patients involved or from the relative or guardian responsible for their care.

*Statistical analysis*

All statistical analyses were performed with SPSS version 20.0 (IBM, Armonk, NY). The level of significance was set at 5%. Categorical variables were compared using the $\chi^2$ test or Fisher's exact test. We compared numerical variables using ANOVA or, for variables without normal data distribution, the Kruskal-Wallis test. We used the Cochran-Armitage test to identify trends in the incidence of CAUTI. To assess the simultaneous effects of study phase, patient sex, patient age, and clinical patient variables on the risk of infection, we used a Poisson multiple regression model, analyzed with Stata version 12 (StataCorp, College Station, TX), adjusting for duration of IUC use.

## RESULTS

In the preintervention phase, 110 patients were admitted to the CICU with an IUC in place after cardiovascular surgery. There were 102 such admissions in the intervention phase and 118 in the postintervention phase. In terms of the demographic and clinical characteristics of the patients, there were no statistically significant differences among the 3 study phases (Table 1). The median overall duration of IUC use was 3 days in all 3 study phases ($P = .333$). Although the median duration of IUC use in the CICU dropped from 3 days in the preintervention phase to 2.5 days in the postintervention phase, the difference was not statistically significant ($P = .365$).

Patients were categorized by the type of cardiovascular surgery they had undergone: coronary artery bypass grafting, valve surgery, aortic surgery, multiple procedures performed during the same operation, and other types. For all patients, we analyzed only the first operation. There were no statistically significant differences among the 3 study phases in terms of the types of surgery performed ($P = .852$).

Table 2 details the numbers of CAUTIs, catheter-days, and patient-days by study phase. The incidence of CAUTI was 11.47 cases/1000 catheter-days in the preintervention phase, 7.83 cases/1000 catheter-days in the intervention phase, and 4.40 cases/1000 catheter-days in the postintervention phase, translating to an overall reduction of 61.7% over the course of the study (relative risk [RR], 0.38; 95% confidence interval [CI], 0.04-2.14; $P = .216$). The UCU ratio was 0.62 in the preintervention phase, 0.72 in the intervention phase, and 0.61 in the postintervention phase, with no reduction over the course of the study (RR, 0.98, 95% CI, 0.87-1.12, $P = .881$).

The monthly evolution of CAUTI incidence over the course of the study is depicted in Figure 1. The incidence peaked at 37.5 cases/1000 catheter-days in September 2011, just before the beginning of the intervention phase. As shown in the figure, there were several months in which no CAUTIs were reported. The etiologic agents identified were *Escherichia coli*, *Proteus mirabilis*, *Klebsiella pneumoniae*, and *Enterobacter* spp, each of which was responsible for 2 cases of infection, as well as *Pseudomonas aeruginosa*, *Pseudomonas* spp, *Candida albicans*, *Candida tropicalis*, and *Trichosporon* spp, which were responsible for 1 case each.

To analyze the risk of infection, we used a Poisson regression model in which the dependent variable was the number of infections, the exposure variable was the duration of IUC use in the CICU, and the explanatory variables were study phase, age, sex, Acute Physiology and Chronic Health Evaluation II score, Charlson Index, American Society of Anesthesiologists physical status classification, diabetes mellitus, and arterial hypertension. Only the