Catheter-associated urinary tract infection: why do not we control this adverse event?

ABSTRACT

Objective: To identify factors related to the occurrence of urinary tract infection associated with urinary catheter use. Method: A longitudinal, retrospective cohort study carried out by analyzing the electronic medical records of patients admitted to an intensive care unit of a high-complexity hospital from July 2016 to June 2017. Demographic and clinical data were analyzed by descriptive and analytical analysis. Results: The incidence density of urinary tract infection related to urinary catheter use was 4.8 per 1000 catheters/day, the majority (80.6%) with no indication for catheter use, and there was no prescription for insertion and/or maintenance in 86.7%. The mean time between catheter insertion and infection diagnosis was 11.3 ± 6.3 days (6 to 28 days). Statistically significant factors (p < 0.001) related to urinary infection linked to catheter use were hospitalization time in the unit (16.7 ± 9 days), catheter permanence time (12.7 ± 6.9 days), and the use of antimicrobials in the intensive care unit (8.6 ± 6.3 days). Conclusion: The association of indication absence and the record of the need for maintenance possibly potentiated the occurrence of urinary tract infection associated to catheter use.

DESCRIPTORS

Urinary Catheters; Catheter-Related Infections; Patient Safety; Infection Control.
INTRODUCTION

Urinary tract infection (UTI) is one of the most prevalent health care-related infections, accounting for approximately 30% of intensive care unit (ICU) reports because of its relationship to urinary catheterization, but has great preventive potential.[1-3]

Approximately 80% of healthcare-related UTIs are associated with urinary catheter (UC) use. The risk of developing a catheter-associated UTI (CAUTI) increases with the duration of catheterization, and may reach 5% with each day of use. Thus, it is estimated that this risk rises to 100% after 28 days of catheterization, culminating in approximately 4% of patients with evolution from secondary sepsis to infection and an estimated mortality rate of up to 30%.[3-6]

Several strategies to prevent the occurrence of CAUTI have been considered, all of which point to a fundamental principle: restricted indication, performed according to guideline recommendations, insertion with aseptic technique, care in maintenance and rigor regarding the permanence time of the UC.[2,5-8] Despite these recommendations, UC use is still considered variable with little or no control, thereby affecting high CAUTI rates, presenting important morbidity and mortality, increased hospitalization time and hospital costs.[1,5-6]

Subjectivity in the indication and keeping it longer than necessary have been described in clinical practice and strongly contribute to the occurrence of CAUTI, which can be considered avoidable adverse events. Thus, it is necessary to identify the gaps in this practice to improve the practice regarding use of urinary catheters and their occurrence in order to carry out timely interventions and modified habits of professionals and expectations about the need for a urinary catheter. It is also necessary to reinforce the importance of multidisciplinary communication in a continuous and consistent manner. Catheter indication should be an activity of the attending physician, but must be known by all care staff. Its maintenance involves participation by a multidisciplinary team to collaborate with the medical team to evaluate the necessity of their permanence, thus guaranteeing the safety of the patient, the team and the institution.[6]

In view of the aforementioned, this study aimed to identify the factors related to the occurrence of CAUTI.

METHOD

STUDY DESIGN

An epidemiological, longitudinal, retrospective cohort study.

STUDY SCENARIO

The study was carried out in an ICU for adult patients of a high-complexity philanthropic hospital with 321 beds, and 80% of the services performed by the Unified Health System (SUS – Sistema Único de Saúde) in the state of Minas Gerais. The ICU is composed of 10 beds, with a monthly average of 36 admissions and an average stay time of 8.6 days. Approximately 95% of patients admitted to the unit used UC.

SELECTION CRITERIA

Patients with UC for more than 24 hours, older than 18 years and had no diagnosis of UTI upon admission were included.

DATA COLLECTION

Data collection was by convenience sampling from July to September 2017 and was carried out by the researcher (who has extensive experience in the diagnostic criteria of CAUTI) through a retrospective analysis of the electronic medical record. The medical and statistical file of the hospital was requested to access all medical records of patients admitted to the ICU from July 2016 to June 2017, and included patients with UC for more than 24 hours, older than 18 years old, and who did not have a UTI diagnosis at admission.

A semi-structured instrument was used to evaluate demographic data such as gender and age, as well as clinical data such as treatment specialization upon admission, indication of UC use, permanence length of UC, CAUTI diagnosis, use of antimicrobials during hospitalization in the unit, isolated microorganisms in the urinalysis and sensitivity profile, hospitalization time in the unit and in the hospital, and the outcome (discharge, transfer or death).

The criteria implemented to define CAUTI was from the National Healthcare Safety Network (NHSN), which consists in[9], patients undergoing catheterization for more than 48 hours or after catheter removal within 48 hours, fever (≥38 °C) and positive urinalysis with no more than two species of microorganisms with growth ≥10^5 colony forming units per ml of urine (CFU/ ml).

Adequate indications for UC insertion were those described by the Centers for Disease Control and Prevention (CDC), according to which patients with acute urinary retention or bladder obstruction should undergo the procedure; in surgeries in which diuresis control is necessary; in the postoperative period of urological surgeries up to 24 to 48 hours and long-term surgeries; submitted to urological surgeries or involving structures contiguous to the genitourinary tract; incontinent with sacral or perineal ulcers; terminal patients, to provide comfort; and those with a long period of bed rest due to trauma to the spine, waist or pelvis.[9] The registered indications (description of the catheterization reason in the patient’s chart) or presumed (when it is possible to evaluate the reason for catheterization by clinical data and the patient’s diagnosis even without registration).

For the evaluation of microorganisms isolated in urinalysis, only those that were epidemiologically important were considered according to the Clinical and Laboratory Standards Institute (CLSI).[10]

The calculation of the CAUTI incidence density was performed by the following formula, according to the NHSN[10]:

\[
\text{Incidence Density} = \frac{\text{Number of CAUTI cases}}{\sum \text{Patient-days}} 
\]
CAUTI incidence density =
\[
\frac{\text{Total number of CAUTI in the surveillance period}}{\text{Number of patients with UC-day in the surveillance period}} \times 1000
\]

DATA ANALYSIS AND PROCESSING

Descriptive analysis of the data, Pearson’s chi-square test or Fisher’s exact test and Mann-Whitney test were performed in the Statistical Package for Social Sciences (SPSS), version 23.0.

ETHICAL ASPECTS

The research complied with all the recommendations of Resolution no. 466/2012 of the National Health Council and was approved by the Research Ethics Committee of the Federal University of Minas Gerais under opinion 2.069.140/2017. A clear and Informed Consent Form was not necessary as it was a survey of secondary data and because the access was in electronic medical records (without direct contact with the patient).

RESULTS

There were 432 patients admitted to the ICU during follow-up; of these, 402 (93.3%) used UC for more than 24 hours, thereby constituting the study sample. The mean age of the patients was 50.6 years (median 50), with a standard deviation of ± 18.8, and 56.7% were male. The mean hospitalization time of patients in the hospital and ICU was 30 and 8.6 days, respectively.

The majority of patients admitted to the ICU came from the emergency room (43.8%) for surgical (56.2%) and/or clinical (43.8%) specializations. The surgical specialization with the greatest number of hospitalizations was neurological surgery (52.2%), and general clinical (52.2%). Moreover, 87.3% of the patients used antimicrobials during ICU stay to treat infections not associated with the objective of this study for an average of 5.3 days. Regarding the evolution, 60.2% were transferred to semi-intensive units or infirmaries, 35.8% evolved to death, and 4% were discharged from hospital. Table 1 shows the characteristics related to the use of UC in the ICU.

No registry of catheter replacement or reintegration into ICU admission was observed, even if inserted in another location outside the hospital units.

The site which presented the highest non-conformity index regarding the appropriate indication for UC insertion was the infirmary (94.3%). All the indications considered adequate for UC use in patients admitted to the ICU were presumed, and most were not prescribed. Only four (7.7%) of the prescribed catheters were presumably adequate.

The number of patients with catheter/day in the surveillance period was 3,080, the CAUTI incidence density was 4.87 per 1,000 UC/day, and 80.0% of the patients who developed infection had no indication for UC use, while 86.7% had no prescription for insertion and/or maintenance.

<table>
<thead>
<tr>
<th>Variables</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location of catheter insertion (n=402)</td>
<td></td>
</tr>
<tr>
<td>Surgical ward</td>
<td>170 (42.3)</td>
</tr>
<tr>
<td>Emergency ward</td>
<td>70 (17.4)</td>
</tr>
<tr>
<td>Intensive care unit</td>
<td>30 (7.5)</td>
</tr>
<tr>
<td>Infirmary</td>
<td>70 (17.4)</td>
</tr>
<tr>
<td>Other locations outside hospital units</td>
<td>62 (15.4)</td>
</tr>
<tr>
<td>Professional who inserted the catheter (n=402)</td>
<td></td>
</tr>
<tr>
<td>Nursing technician</td>
<td>283 (70.4)</td>
</tr>
<tr>
<td>Nurse</td>
<td>34 (8.5)</td>
</tr>
<tr>
<td>Doctor</td>
<td>15 (3.7)</td>
</tr>
<tr>
<td>No record</td>
<td>70 (17.4)</td>
</tr>
<tr>
<td>Prescription of catheter insertion (n=402)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>52 (12.9)</td>
</tr>
<tr>
<td>No</td>
<td>350 (87.1)</td>
</tr>
<tr>
<td>Indication for use of the catheter (n=402)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>78 (19.4)</td>
</tr>
<tr>
<td>No</td>
<td>324 (80.6)</td>
</tr>
<tr>
<td>Type of indication suitable for catheter use (n=78)</td>
<td></td>
</tr>
<tr>
<td>Presumed</td>
<td>78 (100)</td>
</tr>
<tr>
<td>Recorded</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Description of the presumed indication for insertion of the catheter (n=78)</td>
<td></td>
</tr>
<tr>
<td>Patient underwent urological surgery</td>
<td>31 (39.7)</td>
</tr>
<tr>
<td>Patient immobilized due to trauma</td>
<td>19 (24.4)</td>
</tr>
<tr>
<td>Terminal patient to provide comfort</td>
<td>12 (15.4)</td>
</tr>
<tr>
<td>Incontinent patients with sacral or perineal ulcers</td>
<td>6 (7.7)</td>
</tr>
<tr>
<td>Patient with inability to spontaneously urinate</td>
<td>5 (6.4)</td>
</tr>
<tr>
<td>Long-term surgery</td>
<td>5 (6.4)</td>
</tr>
<tr>
<td>Urinalysis performed (n=402)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>141 (35.1)</td>
</tr>
<tr>
<td>No</td>
<td>261 (64.9)</td>
</tr>
<tr>
<td>Result of the urinalysis (n=141)</td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>25 (17.7)</td>
</tr>
<tr>
<td>Negative</td>
<td>116 (82.3)</td>
</tr>
<tr>
<td>Microorganism identified in urinalysis of the catheter (n=25)</td>
<td></td>
</tr>
<tr>
<td>Klebsiella pneumoniae</td>
<td>10 (40.0)</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>4 (16.0)</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>3 (12.0)</td>
</tr>
<tr>
<td>Acinetobacter baumannii</td>
<td>2 (8.0)</td>
</tr>
<tr>
<td>Enterococcus SP</td>
<td>1 (4.0)</td>
</tr>
<tr>
<td>Others</td>
<td>5 (20.0)</td>
</tr>
<tr>
<td>Multiresistant microrganisms (n=25)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>9 (36.0)</td>
</tr>
<tr>
<td>No</td>
<td>16 (64.0)</td>
</tr>
<tr>
<td>Diagnosis of catheter-associated urinary tract infection (n=402)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>15 (3.7)</td>
</tr>
<tr>
<td>No</td>
<td>387 (96.3)</td>
</tr>
</tbody>
</table>
Of the 141 patients who performed urinalysis, 70.9% had previously used antibiotics for at least 24 hours in the ICU. Regarding the CAUTI etiological agent, *Klebsiella pneumoniae* (46.7%), *Escherichia coli* (20.0%), *Pseudomonas aeruginosa* (13.3%), *Acinetobacter baumannii* (13.3%) and *Enterococcus sp* (6.7%) were identified. All multiresistant microorganisms identified in urinalysis were associated with CAUTI, namely: *K. pneumoniae* (44.5%), *E. coli* (22.2%), *P. aeruginosa* (11.1%), *A. baumannii* (11.1%) and *Enterococcus sp* (11.1%). Table 2 shows the comparison of the patients regarding the CAUTI diagnosis according to sociodemographic and clinical factors.

Table 2 – Comparison of sociodemographic and clinical factors of patients admitted to the intensive care unit with and without urinary tract infection diagnosis – Montes Claros, MG, Brazil, from June 2016 to July 2017.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Catheter-associated Urinary Tract Infection</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes n (%)</td>
<td>No n (%)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>7 (4.0)</td>
<td>167 (96.0)</td>
</tr>
<tr>
<td>Male</td>
<td>8 (3.5)</td>
<td>220 (96.5)</td>
</tr>
<tr>
<td>Age range, years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;60</td>
<td>9 (3.3)</td>
<td>263 (96.7)</td>
</tr>
<tr>
<td>≥60</td>
<td>6 (4.6)</td>
<td>124 (95.4)</td>
</tr>
<tr>
<td>Location of catheter insertion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical ward</td>
<td>9 (5.3)</td>
<td>161 (94.7)</td>
</tr>
<tr>
<td>Emergency ward</td>
<td>4 (5.7)</td>
<td>66 (94.3)</td>
</tr>
<tr>
<td>Intensive care unit</td>
<td>0 (0)</td>
<td>30 (100)</td>
</tr>
<tr>
<td>Infirmary</td>
<td>2 (2.9)</td>
<td>68 (97.1)</td>
</tr>
<tr>
<td>Other locations outside hospital units</td>
<td>0 (0)</td>
<td>62 (100)</td>
</tr>
<tr>
<td>Length of stay in the intensive care unit, days</td>
<td>Mean ± standard deviation 16.7±9.0</td>
<td>7.7±8.5</td>
</tr>
<tr>
<td>Hospitalization time, days</td>
<td>Mean ± standard deviation 75.8±68.6</td>
<td>28.2±30.6</td>
</tr>
<tr>
<td>Catheter permanence time, days</td>
<td>Mean ± standard deviation 12.7±6.9</td>
<td>6.9±7.3</td>
</tr>
<tr>
<td>Indication for use of the catheter</td>
<td>Yes</td>
<td>3 (3.8)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>12 (3.7)</td>
</tr>
<tr>
<td>Use of antimicrobials in the intensive care unit</td>
<td>Yes</td>
<td>14 (4.0)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>1 (2.0)</td>
</tr>
<tr>
<td>Days of antimicrobial use in the intensive care unit</td>
<td>Mean ± standard deviation 8.6±6.3</td>
<td>5.2±6.1</td>
</tr>
<tr>
<td>Death</td>
<td>Yes</td>
<td>2 (1.4)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>13 (5.0)</td>
</tr>
</tbody>
</table>

*C*Chi-squared test; †*Fisher’s* exact test; ‡*Mann-Whitney* test. Note: (n=402).

The UC duration was significantly associated with CAUTI. Figure 1 shows this relationship.

**DISCUSSION**

Urinary catheter use was considered inappropriate in 80.6% in relation to the indication and the evaluation of the necessity of its permanence. The CAUTI incidence density in the present study is within the range registered by the National Health Surveillance Agency (*Agência Nacional de Vigilância Sanitária*), which refers to indices of 3.1 to 7.4/1000 catheters/day. It should be considered that this rate may be underestimated even according to the intervals defined by ANVISA. This possibility is based on the fact that the criterion for defining CAUTI used in this study considers a positive urinalysis, a procedure registered in 35.1% of patients with UC, as well as clinical signs. Another interesting fact is that even though urinalysis was performed, a large part (70.9%) of these patients used antibiotics prior to urinalysis, which certainly hinders the growth of microorganisms and provides false-negative results.

Although the CAUTI rate in the present study is comparable to the national data, it is higher when compared to records of international organizations. In a multicenter ICU study from 50 countries, The International Nosocomial Infection Control Consortium (INICC) recorded CAUTI incidence density of 3.9 per 1,000 catheters/day, and this rate was even lower (1.7 per 1,000 catheters/day) in ICUs of American hospitals in the CDC-NHSN report. The difference found between these two reports is associated to the possibility of its variation being...
related to the socioeconomic level of the country and to the
discovery in infection control and patient safety, which can
strongly influence the CAUTI indicators\(^{11-12}\).

Regarding the sociodemographic and clinical factors of
the patient which may increase the risk of CAUTI, advanced
age and female gender are considered groups with higher
predisposition\(^{2,13}\). However, the CAUTI rates in this study
were associated with clinical factors such as the UC perma-
nence time and the patient’s time in the ICU.

Most UCs were inserted by nursing technicians and
without prescription and/or indication; when there was the
indication, all were presumed by the researcher. Although
the data point to the contrary of what is disseminated as a
need for accurate and restricted indication of UC use, sev-
eral studies corroborate this scenario in which catheters are
often inserted without proper indication, and once inserted
they are not reevaluated in time for them to be removed\(^{4-6}\).
It should also be pointed out that the adequate indication
for UC should be considered as the first step in CAUTI
prevention, and that the risk of this adverse event (mostly
avoidable) already shows greater probability of occurrence
when this barrier is exceeded\(^{2,5-7}\).

After adequate indication, or lack of it, relevant CAUTI
prevention and control mechanisms should still be observed
daily, thereby highlighting the next aspect which refers to
the UC duration. It should be evaluated in accordance with
international recommendations, so that it remains in place
for as short of a time as possible.

The majority of insertions performed in surgical patients
did not have adequate indications (72.9%), and the UC
duration (mean of 5.7 days) was higher than indicated by
the guidelines, which recommend the use of this device in
specific surgeries and their removal as soon as possible post-
operatively, preferably within 24 hours, unless there are other
appropriate indications for their permanence\(^{2,7-12}\).

It is also important to evaluate the insertion conditions
of the UC, especially in emergencies such as in the surgical
ward, the emergency room and pre-hospital care. Although
UC replacement at fixed intervals is not recommended, and
the unit investigated does not have a UC exchange protocol
inserted in emergency situations, the guidelines recommend
this practice when there are failures in aseptic technique,
disconnection or leakage, obstruction or if the system drain-
age system is compromised\(^{2,7,15}\).

In this sense, it is also important to highlight the actions
necessary to reduce inappropriate use in terms of UC dura-
tion, how to recognize and notify its presence in the patient,
to discuss the need for their maintenance with the medi-
cal staff daily and ensure prescription for its removal. Such
actions have not been observed in clinical practice, and the
result is maintaining high CAUTI rates caused by failures
in multiprofessional care actions and ineffective commu-
nication resulting from the poor quality of the records.
Studies point out that the catheter presence in the patient
is unknown, inadequate practices, unsafe maintenance, lack
of control and attention to the need for their permanence
by the multiprofessional team as factors which drive the
occurrence of CAUTI\(^{4-6}\).

Thus, nursing performance should play an important role
in daily evaluation of UC permanence. The implementa-
tion of a nurse-oriented protocol effectively reduces CAUTI
prevalence, and it is essential that these professionals feel
empowered to (re)evaluate and discuss the need to maintain
the UC, aiming at reducing their usage time\(^{14}\). The quality
of CAUTI care and prevention programs is directly related
to the adequate number of professionals to exercise care in
order to promote safe care\(^{6,15}\). In the studied unit, the num-
ber of nursing professionals complied with the resolution of
the Federal Nursing Council (COFEN – Conselho Federal
de Enfermagem) for care provided to intensive care patients,
not constituting a barrier in this process.

It is also worth noting that the insertion of the UC, defined
by the normative opinion of COFEN, “is an activity
that requires trained and qualified professionals because it
is an invasive procedure which involves risks to the patient.”
Also, “it requires care of greater technical complexity and
scientific knowledge, and for these reasons UC insertion is
exclusively performed by the nurse in the scope of the nurs-
ing team”, which reinforces its participation in the evaluation
from its indication to the daily maintenance, as well as in the
adopted practices in their handling\(^{6,16}\).

Guidelines for CAUTI prevention emphasize that the
most effective and economic measures are to limit the use
of urinary catheters to patients with clear indication and to
remove them as soon as they are no longer needed\(^{2,7-8}\).
The median time between UC insertion and CAUTI occur-
rence in this study was 8 days. Approximately 50.0% of the
catheterized patients acquire infections after a short period
of time (within 7 days), and the infection is practically inevi-
table after 28 days\(^{16}\).

After UC insertion, the bacteria that colonize the ure-
thal meatus adhere to the internal and/or external surface
of the catheter and can initiate biofilm formation, considered
the most important factor for CAUTI. Thus, in addition to
catheter removal, there is no evidence of effective methods
for prevention or control of biofilm formation\(^{17-19}\).

The main microorganisms which caused CAUTI in this
investigation were the Gram-negative microorganisms such as
K. pneumoniae and E. coli, identified as the most common
etiological agents. The high prevalence of these bacteria is
due to their motility, facilitating their ascension via intra-
or extraluminal of the UC\(^{1,13}\). In addition to E. coli, other
microorganisms are strongly associated with CAUTI, such
as Enterococcus spp, P. aeruginosa, Proteus mirabilis, K. pneu-
moniae and Enterobacter sp.\(^{10}\).

An important factor which aggravates the etiology of
CAUTI is bacterial resistance. In this study, allmultiresis-
tant microorganisms identified in urinalysis were associated
with CAUTI. Intensive care unit patients are at high risk for
CAUTI caused by resistant bacteria, as many have changes
in their immune system and receive broad spectrum antimicro-
biotics, in addition to UC being an important reservoir of
multiresistant microorganisms, causing serious infections, pro-
longed hospitalizations, high costs and higher mortality\(^{4,17}\).

Multiple-measure strategies have been pointed out as being
possible to reduce the occurrence of CAUTIs when adopted

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simultaneously. However, their implementation requires changes which usually involve education, leadership commitment, and implementation of guidelines for indication and appropriate UC use\(^{(21-25)}\). Guaranteeing that all health care team members are aware of the patient has a UC is an important strategy for reducing CAUTI and ensuring quality in maintenance care and a daily assessment of their permanence\(^{(20-25)}\).

Regarding the evaluation of the records adopted in this study (the electronic records analysis), it is known that there may be an absence of information due to the lack of records by the professionals and the quality of the records, as well as physical records which also present these limitations.

**CONCLUSION**

The factors which were significantly associated to CAUTI were the length of hospital stay in the ICU and in the hospital, UC permanence time, and days of antimicrobial use in the ICU. The urinary catheter use was associated with high rates of urinary tract infections, but without indications and records justifying its use. All appropriate indications for UC use were presumed, which is an important indicator of failure in the work process not being systematized in terms of documentation, therefore posing a potential risk to patient safety.

**REFERENCES**


