Review Article

Prevention and management catheter-associated urinary tract infection in intensive care unit

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Abstract

Context: Urinary tract infection (UTI) is the most common hospital-acquired infection. Around 80% of UTIs are associated with urinary catheters.

Aims: The aim of this study was to review and to describe epidemiology and approaches for the prevention and management of catheter-associated urinary tract infection (CAUTI) in intensive care unit (ICU) patients.

Settings and Design: A narrative review of studies was undertaken.

Materials and Methods: A review of PubMed, Google Scholar, Medline, and CINAHL databases were conducted to identify peer-reviewed, English language, and studies published between 1999 and 2018. Related papers were reviewed with using standard keywords. The research was conducted on epidemiology and management of CAUTI in the ICU. Of the 186 English publications, 36 were duplicates.

Statistical Analysis Used: Quality assessments, data extractions, and analysis were completed on all included studies.

Results: The prevalence of UTI in the ICU is directly related to the widespread use of urethral catheter (32.2%). Guidelines are available that provide comprehensive recommendations for detecting and preventing healthcare-associated infections for CAUTI.

Conclusions: Further studies are needed due to the importance and high prevalence of these infections. We recommend the opportunity to increase any strategy able to reduce the incidence of infections related to urinary catheterization and its consequences in ICUs.

Keywords: Epidemiology, Intensive care unit, Management, Urinary catheterization, Urinary tract infections

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INTRODUCTION

Urinary tract infection (UTI) is the most common hospital-acquired infection;[1-3] in other words, UTI is the most prevalent infection (32.2%).[4] Contrary to the results of some studies,[5,6] around 80% of UTIs are associated with urinary catheters,[7] and the risk of infection increases in patients who are acutely ill.[8-11]

From the multivariate analysis, five independent risk factors were determined: female sex, length of ICU stay, use of

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antimicrobial therapy, severity score at admission, and duration of catheterization.

However, UTI elevates the risk of pyelonephritis, premature delivery, and fetal mortality among pregnant women and is associated with impaired renal function and end-stage renal disease among pediatric patients.[12]

The most frequent nosocomial infections are in critically ill patients,[13-15] and healthcare-associated infections from indwelling urinary catheters lead to increased patient morbidity[16] and mortality.[17] In addition, the prevalence of UTI increased gradually by the duration of hospitalization.

Some studies of catheter-associated urinary tract infection (CAUTI) epidemiology, surveillance, and prevention have focused on the intensive care unit (ICU) population.[18-20] In the one study a total of 506 CAUTIs, 363 (72%) occurred in non-ICU patients, and 143 (28%) occurred in ICU patients. A total of 363 CAUTIs, 143 (28%) occurred in ICU patients.[11] A study reported the frequency of catheter-associated bacteriuria was 9.6%.[12]

During the 3 years, 4465 patients were admitted 4915 times to an ICU for 48 h or more. A total of 356 ICU-acquired UTIs occurred among 290 (6.5%) patients, yielding an overall incidence density of ICU acquired UTIs of 9.6 per 1000 ICU days. Antibiotic-resistant organisms were identified among 14% isolates.[13]

The most common microorganisms causing nosocomial UTI were *Escherichia coli* (50%) *Staphylococcus* (17.5%), *Klebsiella* (7.5%), fungal infections (5%), and *Enterobacter* (2.5%). There was a significant difference in females between period of urethral catheter (UC) use, period of bedtime, and occurrence of urinary infection ($P = 0.05$). No significant difference was observed between age and nosocomial UTI.[21] A summary of the most relevant studies is presented in the Table 1.

Generally, CAUTI is one of the most common infections in this context that is responsible for high morbidity, increased hospital stay, and associated costs. On the other hand, there are a few extensive and coherent studies on nosocomial infections caused by urinary catheters, epidemiology, risk factors, prevention, control, and management of CAUTI in the ICU.

Consequently, the objective of this study was to review and to describe the epidemiology and approaches for the prevention and management of CAUTI in ICU patients.

MATERIAL AND METHODS

A narrative review of studies was undertaken. A three-step search strategy will be utilized in this review. An initial limited search of PubMed, Medline, and CINAHL will be undertaken, followed by analysis of the text words contained in the title and abstract and of the index terms used to describe the article. A second search using identified keywords and index terms will then be undertaken across all included databases. Index terms will be selected to match the specific database since index terms may vary between databases. Third, the reference lists of reports and articles included for critical appraisal will be searched for additional studies. Studies published in English will be considered for inclusion in this review. This relates to the expertise of the review team.

The search strategy included a MeSH Terms search using "Nosocomial Infections" and "Intensive Care Unit" and hospital-acquired infection and relevant subheadings, with the search restricted to major topic headings only. The following search term strategy was also used: "ICU, Infections, catheter-associated, urinary tract, CAUTI, UTI" AND "approach, incidence, risk factors, prevalence, prevention, management." Searches were limited to include only studies published in the English language, between 1999 and 2018. The second criterion required the inclusion of at least one relevant outcome (either CAUTI rates, urinary catheter use, or need for catheter replacement)

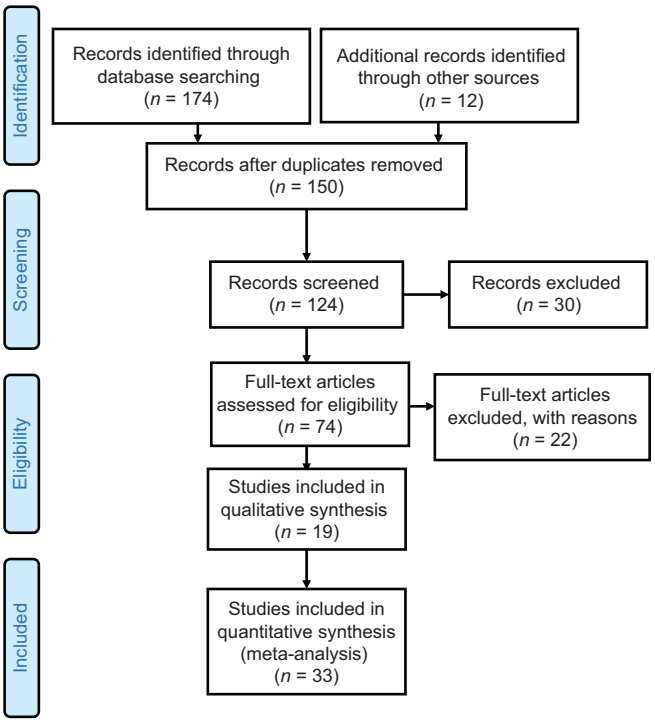

Figure 1: PRISMA 2009 flow diagram

Table 1: Reviewed research articles

Author/years	Design	Materials and Methods	Main findings
Lam TB *et al*., 2014	Systematic Reviews	Reviews of Medline, Clinical Trials. WHO ICTRP and hand searching of journals and conference proceedings	Silver alloy-coated catheters were not associated with a statistically significant reduction in symptomatic CAUTI
Zahraei SM *et al*., 2012	Prospective surveillance study	Nosocomial Infection Surveillance System covers 95 hospitals throughout Iran, each with over 200 beds	UTI was the most prevalent infection (32.2%) and was most often detected in ICUs
Esen S *et al*., 2004	Cross-sectional study	56 ICUs from 22 university or teaching hospitals. Invitation to participate, heads of departments of clinical microbiology, infectious diseases of hospitals	ICU-related infections are common and often associated with resistant microorganisms
Moola S *et al*., 2010	Systematic review	Published and unpublished studies with an initial limited search of Medline and CINAHL databases	Use of a surgical sterile catheterization technique is not required, and that tap water is sufficient for cleaning genitalia
Bagshaw SM *et al*., 2006	Cross-sectional study	Review the occurrence, microbiology, risk factors for acquisition	All patients who develop an ICU-acquired UTI have indwelling urinary catheters
Galiczewski JM *et al*., 2017	Retrospective study, case-control study	Intervention of direct observation was added to the standard insertion procedure	CAUTI rates decreased from 2.24 to 0 per 1000 catheter days
Babamahmoodi F *et al*., 2015	Retrospective study	Incidence, clinical presentation, risk factors, causative agents, and antibiotic resistance pattern of bacteria analyzed	The most common hospital-acquired infections were respiratory infection 49.1%. UTI 16.7%
Lockwood C *et al*., 2004	Systematic review	The databases searched included: CINAHL, Medline, Current Contents, Cochrane Library, Expanded Academic Index, and EMBASE	Higher incidence of bacteriuria associated with Foley catheters compared with intermittent catheterization
Sadegh Zade V *et al*., 2004	Descriptive study	For all research cases, urine culture was performed. Demographic characteristics questionnaire and disease severity evaluation questionnaire	The most common microorganisms causing nosocomial UTI were: *Escherichia coli* (50%)
Vincent J-L *et al*., 2009	Prospective study	Demographic, physiological, bacteriological, therapeutic, and outcome data were collected	The ICU mortality rate of infected patients was more than twice that of noninfected patients (25%)
Meddings J *et al*., 2014	Systematic review	A meta-analysis regarding interventions prompting UC. A narrative review summarises other CAUTI prevention strategies including aseptic insertion, catheter maintenance, antimicrobial UCs, and bladder bundle implementation	Implementation strategies are important because reducing UC use involves changing well-established habits
Talaat M *et al*., 2010	Prospective study	Surveillance of CAUTIs was conducted in 4 ICUs during a 13-month period	Risk factors associated with acquiring CAUTI were female gender and previous catheterization
Rosenthal VD *et al*., 2006	Prospective cohort surveillance	55 ICUs of 46 hospitals. Rates of device-associated infection per 100 patients and per 1000 device days	Mortality rate for patients with device-associated infections ranged from 35.2%
Remschmidt C *et al*., 2018	Cross-sectional study	Enterococcal infections from 857 ICUs and 1119 surgical departments were analyzed	UTIs: 2-11.2%. In Germany, the proportion of vancomycin-resistant enterococci in nosocomial infection due to enterococci is still increasing

ICUs: Intensive care units, CAUTIs: Catheter-associated urinary tract infections, UTIs: Urinary tract infections, UCs: Ureteral catheters, ICTRP: International clinical trials registry platform, CINAHL: Cumulative index to nursing and allied health literature

and a comparison group. Studies of other nosocomial infections (bloodstream, pneumonia, etc.) were excluded [Figure 1]. The related articles' function was used to broaden the search, and all abstracts, studies, and citations scanned were reviewed.

Of the 186 English publications, 36 were duplicates. Quality assessments, data extractions, and analysis were completed on all included studies. In other words, data will be extracted by two reviewers independently. Any discrepancies between the reviewers will be resolved by discussion. The study was approved by the Ethical Committee of Kermanshah University of Medical Sciences (IR.KUMS.REC.1397.977).

RESULTS

Our literature review reveals different statistics of UTIs that account for nosocomial infections in ICU.[1,5,6,12,22] They are associated with increased morbidity and mortality, increased hospital stay[23] and hospital costs,[7] and jeopardizing patient safety. The prevalence of UTI in ICU is directly related to the widespread use of UC.[17] It has been estimated that between 17% and 69% of UTIs associated with the UC can be prevented through an evidence-based prevention program.[24] As the duration of catheterization is the principal determinant of infection with long-term indwelling catheters, it is not clear that any interventions can decrease the prevalence of bacteriuria in this setting.[25] Prevention of CAUTI and its complications is a major goal.

Previously published guidelines are available that provide comprehensive recommendations for detecting and preventing healthcare-associated infections. The intent of this document is to highlight practical recommendations in a concise format designed to assist acute care hospitals in implementing and prioritizing their CAUTI prevention efforts. Refer to the Society for Healthcare Epidemiology of America/Infectious Diseases Society of America "Compendium of Strategies to Prevent Healthcare-Associated Infections" Executive Summary and Introduction and accompanying editorial for additional discussion: 80% UTIs as a result of hospital-acquired infections are attributable to an indwelling UC. In addition, UTI is the most important adverse outcome of urinary catheter use. Morbidity attributable to any single episode of catheterization is limited, but the high frequency of catheter use in hospitalized patients means that the cumulative burden of CAUTI is substantial.[26]

However, there was no significant difference in infection rate using either sterile surgical or nonsterile insertion technique.[27] Several measures have been introduced to reduce CAUTIs.[3] One of these measures is the use of water for cleansing before catheter insertion was recommended. In addition, there was no additional benefit from specific meatal care other than standard daily personal hygiene and removal of debris. Furthermore, infection rates were similar for both latex and silicone catheters, and the use of a complex closed drainage system in the intensive care environment did not confer any additional benefit. Neither the addition of chlorhexidine nor hydrogen peroxide to the drainage bag was found to be effective at reducing UTI rates.[27] Added to the said content, the addition of antibacterial solutions to drainage bags and the routine change of drainage bags had no effect on catheter-associated infection.[8]

Maintaining a closed drainage system and adhering to appropriate catheter care techniques will also limit infection and complications. Catheter flushing or daily perineal care do not prevent infection and may, in fact, increase the risk of infection. In addition, complications of infection may be prevented by giving antibacterials for bacteriuria immediately before any invasive urological procedure and by avoiding catheter blockage, twisting, or trauma.[25] Although asymptomatic nosocomial UTI usually deserves no therapy, it needs to be considered carefully in terms of its environmental impact on the emergence of bacterial resistance.[28]

Generally, the Centers for Disease Control and Prevention recommends, based on strong evidence for its implementation, the use of packages based on evidence and ongoing training of health personnel in the extrinsic risk factors of UTI associated with UC-related nursing care (technique of insertion, maintenance, and drainage system). This will also make it possible to evaluate and compare the quality of our cares with other ICUs, using quality indicators established by the National Surveillance Study of Nosocomial Infections in Medical Services Intensive.[24]

DISCUSSION

These recent publications increase our awareness of the problem of CAUTI but leave significant gaps in our knowledge. Of particular concern is how little recent evidence supports our current management strategies for CAUTI. The results of the review study showed that infection is a major cause of morbidity and mortality in ICUs worldwide.[2,15,22,29-31] CAUTIs include an important part of these infections.[32] However, relatively little information is available about the global epidemiology of such infections.[30] Furthermore, reports from several studies indicate that nosocomial UTIs frequently complicate the course of patients admitted to ICUs.[13,16,28] Nevertheless, since nosocomial UTIs which are important causes of morbidity in ICU patients are difficult to diagnose and treat, more efforts should be used for preventive measures.[23]

The current evidence suggests that the use of a surgical sterile catheterization technique is not required and that tap water is sufficient for cleaning genitalia. Following insertion, daily hygiene around the meatal area is as effective as catheter toilets, and catheters impregnated with silver may reduce the incidence of catheter-associated bacteriuria.[8] However, most of the recommendations arising from this review were based on single studies, often with limited numbers of participants.

Hand washing is the single most important, simplest, and least expensive way for preventing infection's spreading. Nevertheless, in most healthcare institutions, recommended hand washing practices remain low that the reasons include lack of scientific knowledge.[14] However, monitoring and providing feedback on catheter use and CAUTI rates are important in the implementation and continued use of CAUTI preventive strategies. Furthermore, reducing indwelling catheter use addresses the noninfectious complications of urinary catheter use such as catheter-related patient discomfort and immobility.[33]

Device-associated infections in the ICUs of these developing countries pose greater threats to patient safety than in ICUs.[15] Active infection control programs that perform surveillance of infection and implement guidelines for prevention can improve patient safety and must become a priority in every country. One of the members of the healthcare team whose role is critical in control of nosocomial infection is a nurse. For this reason, proper scientific information from a variety of nosocomial infections and their prevention methods are necessary.

Despite infection control policies and procedures, CAUTI rates remain a significant problem in hospitals. Using the identified risk factors, tailored intervention strategies are now being implemented to reduce the rates of CAUTIs in the ICUs.[9] Therefore, the problem of how to manage CAUTI will become even more relevant in the coming years.[34] Hence, the unanswered questions in this field will be an inspiring challenge for the current and future generations of clinical investigators.

CONCLUSIONS

We need new trials to focus on the prevalence of CAUTI to manage the treatment of this infection. There is a relative paucity of research on nosocomial UTI specifically acquired in the ICU, and further studies are needed to better define the epidemiology and management of these infections. We recommend the opportunity to increase any strategy able to reduce the incidence of infections related to urinary catheterization and its consequences in ICUs, as a more rational length and modality of catheterization, in addition to the use of innovative catheters.

Limitations

The limitations of this study include lack of access to full content of some articles and shortage of the required resources in databases.

Conflicts of interest

There are no conflicts of interest.

Authors' contribution

M. Rahimi and H. Babaei: Contribution in designing, writing, revising and approving the final manuscript. Kh. Farhadi: performing the interviews and designing, interpreting the discussion and F. Soleymani: doing data collection and approving the final manuscript as well.

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