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Comparison of the preventive effect of urethral cleaning versus disinfection for catheter-associated urinary tract infections in adults: A network meta-analysis

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ABSTRACT

Background: Catheter-associated urinary tract infections (CAUTIs) are the main cause of infectious complications in patients with indwelling urinary catheters (IDCs). However, the best cleaning methods for the prevention of CAUTIs have not been evaluated clearly in previous studies.
Methods: An electronic database search was performed, from inception to December 2017. Randomized controlled trials and quasi-experimental trials using different methods of urethral cleaning versus disinfection to prevent CAUTIs were considered. The study selection and data collection were performed independently by two reviewers. The risk of bias assessment was performed using the Cochrane risk of bias scale. The primary outcome was the incidence rates of CAUTIs. A network meta-analysis was conducted to compare the effect among the different methods of urethral cleaning versus disinfection to prevent CAUTIs.
Results: Thirty-three studies (6490 patients) with seven different methods of urethral cleaning versus disinfection were eligible for inclusion, and the data were summarized in the network meta-analysis. No evidence of heterogeneity ($P > 0.05$) was observed among the studies. The network meta-analysis showed that there was no difference in the incidence of CAUTIs when comparing the different urethral cleaning methods versus disinfection ($P > 0.05$ for all). However, chlorhexidine ranked first in the results of the Bayesian analysis and is recommended for preventing CAUTIs.
Conclusions: Current evidence suggests that there are no significant differences among different urethral cleaning versus disinfection methods with regard to CAUTI incidence rates.

Introduction

Indwelling urinary catheters (IDCs) are invasive devices that are used widely in the hospital setting. Approximately 20% of hospitalized patients receive an IDC for urination or bladder rinsing, and they are commonly used for nursing after surgery. One of the common complications of IDC use is catheter-associated urinary tract infection (CAUTI), with an incidence rate of 3–7% in the general ward and 17.6% in the intensive care unit. CAUTIs comprise about 40% of hospital-acquired infections (Trautner et al., 2011) and result in a prolonged hospitalization time, increased hospitalization costs, and even an increased risk of death.

The localization of bacteria around the urethra has been recognized as being closely related to CAUTIs, and reducing bacterial colonization may decrease the potential risk of CAUTIs (Ercole et al., 2013). The guidelines of the Infectious Diseases Society of America do not recommend the use of antimicrobial agents to prevent CAUTIs due to the lack of sufficient clear evidence regarding the preventive effects. However, 17–69% of CAUTIs could be prevented if the appropriate urethral disinfection care strategy was used (Rebmann and Greene, 2010). A previous systematic review reported that the incidence rate of CAUTIs could be reduced by washing with water or brine before the insertion of IDCs, but the authors claimed that the results should be treated with caution because of the small sample size and the limitation to English language publications for the studies included (Fasugba et al.,2017). Considering the medical environment and ward conditions in developing countries like China, there remains a big gap when compared to Western developed countries. Furthermore, the findings of clinical trials in China on urethral cleaning and disinfection for the prevention of CAUTIs have not been consistent. This study was performed to provide a basis and

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reference for the prevention of CAUTIs through a network meta-analysis of the relevant literature based on the Bayesian method.

Methods

This network meta-analysis was conducted according to the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) guidelines (Hutton et al., 2015).

Selection criteria

Both randomized controlled trials (RCTs) and quasi-experimental studies (pre- and post-test design, non-RCTs) were considered for this network meta-analysis, irrespective of language and publication status. Hospitalized patients (>18 years) who had IDCs were included. In the experimental group, an antiseptic such as iodine, chlorhexidine, nitrofurazone, etc. was used to clean the meatal, peri-urethral, or perineal areas before IDC insertion or intermittent catheterization, or during routine meatal care. In the control group, the meatal area was cleaned with non-medicated agents such as sterile water, tap water, saline, etc.

The primary outcome of this study was the incidence rates of CAUTI at 7–10 days after IDC placement following the use of different urethral cleaning versus disinfection methods. Studies that evaluated the use of antiseptic agents along with routine nursing for cleaning the meatal, peri-urethral, or perineal areas before IDC insertion or intermittent catheterization, and during routine meatal care, were excluded. Studies reporting duplicate data were also excluded.

Literature search

The systematic literature search was limited to studies reported in the Chinese and English language databases from the date on which the database was established to October 1, 2017. The literature in Chinese was searched using the Chinese Biomedical Literature Service System (SinoMed, http://www.sinomed.ac.cn/), China National Knowledge Infrastructure (CNKI, http://www.cnki.net/), Chinese Science and Technique Journals Database (VIP; http://www.cqvip.com), and Wanfang database (http://www.wanfangdata.com/). Articles published in English were sought in the PubMed, Embase, and Cochrane Library databases.

Search terms in the title, abstract, and keywords included “catheter-associated urinary tract infections”; “indwelling urinary catheters”; “meatal cleaning”; “antiseptic”; and “bundle intervention”. A comprehensive list of terms was used in PubMed (Appendix A). The grey literature; such as surveillance reports; academic dissertations; and conference abstracts; was also examined. Furthermore; a reference list of key reviews was searched for additional studies. Details of the search strategy are provided in Appendix A.

The full texts of potentially relevant studies were obtained and two of the reviewers (YC and ZG) scrutinized these reports independently. Differences in eligibility assessments were resolved by discussion and when necessary a final consensus was reached with the assistance of a third reviewer.

Data extraction

A standardized checklist was used to extract data from the studies that met the inclusion criteria. Data were extracted independently by two reviewers (YC and ZG). The following variables were recorded for each study: author, publication date, study design, sample size, type of intervention, duration of the intervention, and CAUTI rates. The full texts of potentially relevant publications were obtained and re-evaluated by the same investigators. Any discrepancies between the findings of the two reviewers were adjudicated by a third reviewer. Attempts were made to contact (by e-mail) the corresponding authors of articles that did not provide details of the study background to obtain relevant information.

Quality control

The Cochrane risk of bias tool (Higgins and Green, 2011) was adopted to evaluate the risk of bias for each included study with regard to the following items: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting bias, and other biases. The risk of bias assessment was conducted independently by two reviewers (YC and ZG), and disagreements were resolved by discussion with another author. Each item was categorized as presenting a high, unclear, or low risk of bias.

Statistical analysis

A network meta-analysis was performed to assess the risk of CAUTI with the use of different urethral cleaning versus disinfection methods. The network meta-analysis was performed using R 3.4.2 software with the package for “rjags” invoking JAGS 4.3.0 software. JAGS (Just Another Gibbs Sampler) is a program for the statistical analysis of Bayesian hierarchical models by Markov Chain Monte Carlo method. Parameters for the JAGS software were as follows: number of chains = 4; tuning iterations = 20 000; simulation iterations = 50 000; thinning interval = 10; inference samples = 10 000; and variance scaling factor = 2.5. The odds ratio (OR) and 95% confidence interval (CI) were calculated for dichotomous data and forest plots were created using RevMan 5.3.3. Bayesian methods were also used with both fixed-effects and random-effects multiple treatment comparisons (MTC) for indirect comparisons. The probability was plotted to help identify the best method in each treatment arm for each outcome (rankograms) in a histogram. Either a 95% CI that included 1 in the loop analysis or a p-value of <0.05 in the node-splitting analysis was considered to indicate a significant inconsistency.

Results

Literature identified

Of 4060 articles identified in the electronic database search, 2387 remained after the removal of duplicate records in Endnote X8.1. Articles were then excluded based on title and abstract screening for the following reasons: 1326 were not relevant, 376 were review or editorial articles, 224 were research on risk factors, and 75 compared the cost of different treatments for CAUTIs. A further 355 studies were excluded after full-text screening: 148 for reporting bacterial culture-positive results and not CAUTIs, 135 for reporting basic research or animal experiments, and 72 for including participants with pre-existing CAUTIs. Two additional studies were identified through the reference lists and hand searching. Finally, 33 full-text articles were considered eligible.

Evidence network and characteristics of the literature

Seven different interventions were used in the articles included in this study: routine meatal care, tap water, saline, soap and water, chlorhexidine, antibacterial drugs, and iodine. The network relationship among the seven intervention measures is shown in Figure 1. One paper included two studies; hence there were a total of 34 studies (three quasi-experimental studies and 31 RCTs). Of the 34 studies, 13 compared iodine with tap water, six compared