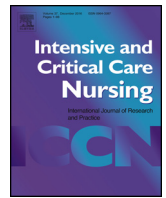




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Original article

Prevention of central venous line associated bloodstream infections in adult intensive care units: A systematic review

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ABSTRACT

Background: In adult Intensive Care Units, the complexity of patient treatment requirements make the use of central venous lines essential. Despite the potential benefits central venous lines can have for patients, there is a high risk of bloodstream infection associated with these catheters.

Aim: Identify and critique the best available evidence regarding interventions to prevent central venous line associated bloodstream infections in adult intensive care unit patients other than anti-microbial catheters.

Methods: A systematic review of studies published from January 2007 to February 2016 was undertaken. A systematic search of seven databases was carried out: MEDLINE; CINAHL Plus; EMBASE; PubMed; Cochrane Library; Scopus and Google Scholar. Studies were critically appraised by three independent reviewers prior to inclusion.

Results: Nineteen studies were included. A range of interventions were found to be used for the prevention or reduction of central venous line associated bloodstream infections. These interventions included dressings, closed infusion systems, aseptic skin preparation, central venous line bundles, quality improvement initiatives, education, an extra staff in the Intensive Care Unit and the participation in the 'On the CUSP: Stop Blood Stream Infections' national programme.

Conclusions: Central venous line associated bloodstream infections can be reduced by a range of interventions including closed infusion systems, aseptic technique during insertion and management of the central venous line, early removal of central venous lines and appropriate site selection.

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Implications for clinical practice

- Interventions other than high cost devices such as antimicrobial-coated catheters offer an alternative or complementary solution to central venous line associated bloodstream infections in adult Intensive Care Units.
- The findings in this study show that low cost interventions such as education, surveillance, checklists, reporting and central venous line bundles and aseptic management of these devices have positive outcomes in reducing central venous line associated bloodstream infections rates.

Introduction

Patients admitted to Intensive Care Units (ICUs) require specialised management of life threatening conditions. The complexity of the treatment and the procedures that patients in ICU may require, make central venous lines essential (College of Intensive Care Medicine of Australia and New Zealand [CICM], 2011). High

volume intravenous fluids, parenteral nutrition, cardiovascular measurements, medication administration and blood infusions all require the use of central venous lines (Walder et al., 2002; World Health Organization, 2014). Despite their potential benefits, the risk of central venous line associated bloodstream infections (CLABSI) is high (Siempos et al., 2009). A CLABSI is a laboratory-confirmed bloodstream infection (BSI) in a patient who had a central venous line within the 48 hours prior to development of the BSI, not related to an infection at another site (Centre of Control and Disease Prevention, 2014; Fagan et al., 2013; Kallen et al., 2010; O'Grady et al., 2011, 2002).

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A 2010 study conducted in the United States of America (USA) identified that about 41,000 patients developed CLABSI (Centre for Disease Control and Prevention, 2011; Virginia Department of Health, 2013). Around 18,000 of those affected were ICU patients, and one in four may die (Centre for Disease Control and Prevention, 2011; Virginia Department of Health, 2013). CLABSI is also associated with increased cost in patient care (Walder et al., 2002), estimated at USD\$33,000 (Stevens et al., 2014).

Consequently, there is increased interest in ways to reduce and prevent CLABSI (Dumont and Nesselrodt, 2012; O'Grady et al., 2011). In 2008, a systematic review was undertaken evaluating strategies other than antimicrobial-coated catheters to reduce risk of CLABSI in the ICU (Ramritu et al., 2008b). In 2011, the Centre for Disease Control and prevention published updated guidelines for the prevention of intravascular catheter associated infections (O'Grady et al., 2011, 2002). Despite these guidelines, and advances in understanding related to infection patterns, pathogen agents, different pathogenesis, epidemiology and new diagnosis and prevention techniques in the last decade (Kim et al., 2011), no update of this systematic review has been undertaken.

The aim of this systematic review was to identify all existing interventions to prevent and/or reduce CLABSI in adults in ICU, other than antimicrobial-coated catheters. Literature published from 2007 was included, as that is when the previous systematic review was undertaken (Ramritu et al., 2008b).

Methods

This systematic review followed the Cochrane Effective Practice and Organisation of Care Review Group (EPOC) recommendations to assess quality in systematic reviews (Chandler et al., 2013). Randomised controlled trials and observational studies which investigated interventions for the prevention or reduction of CLABSI in adult ICU patients were included. The quality of evidence for each included study was determined based on the Grades of Recommendations, Assessment, Development and Evaluating (GRADE) Working Group (Schünemann et al., 2011). Only studies with a high or moderate quality rating were included.

Inclusion criteria

- Studies conducted in ICUs with adult patient populations were included.
- All interventions which sought to prevent and/or reduce CLABSI including the CDC recommended interventions (Centre for Disease Control and Prevention, 2011; Centre of Control and Disease Prevention, 2014; O'Grady et al., 2011, 2002) and the Institute of Healthcare Improvement (IHI) compilation of bundle of interventions designated to work together to reduce CLABSI were included.

Outcome measures

The following outcome measures were examined following the suggestions given by the Cochrane EPOC Review Group (Chandler et al., 2013).

Primary outcomes

- Central venous line associated bloodstream infection rates (per 1000 central venous line days)
- Identification and incidence rate of pathogen agents identified in the colonised central venous lines detected (laboratory test report data)
- Mortality and comorbidity rates related to CLABSI.

- Increased length of hospitalisation (measured in days) caused by the presence of CLABSI.

Secondary outcomes

- Measurement of the time (measured in days) from central venous line insertion to removal.
- Length of stay in ICU, measured from the day of admission to ICU to the day of discharge from ICU.

Exclusion criteria

- Studies published in languages other than English.
- Non-academic studies, conference abstracts, oral presentation or not original research.
- Characteristics of participants not reported, no baseline data, studies with no clear description of the intervention applied.
- Studies with unclear aim, methodology, or data collection, or those with missing data were excluded.
- Studies conducted wholly or in part with paediatric populations where the results were not reported separately.
- Studies where ICUs were included together with another ward (e.g. emergency department, coronary care units) where the results were not reported separately.
- Studies where antimicrobial-coated catheters were used were excluded from this review because several systematic reviews have recently been published on this topic (Antonelli et al., 2012; Liu et al., 2014; Raad, 2012; Ramritu et al., 2008a).

Search strategy

MEDLINE; CINAHL Plus; EMBASE; PubMed; Cochrane Library, Google Scholar and Scopus databases were searched using the following keywords (or abbreviations) and MeSH search terms; 'catheteri*ation-central venous', infection*, prevention*, blood-stream*.

Data collection

The Cochrane Collaboration RevMan software (The Cochrane Collaboration, 2014) was used for data entry and management. The data were extracted following The Cochrane's manual checklist (Higgins and Green, 2011). One researcher screened the titles and abstracts of each study. The three researchers then analysed the full-text of 87 studies meeting the inclusion criteria for full text assessment.

Assessment of methodological quality

Three researchers assessed the quality of each study, to determine inclusion, using the Meta-Analysis of Statistics Assessment and Review Instrument (MAStARI) tool (Joanna Briggs Institute, 2014).

Assessment of risk of bias in included studies

The Cochrane Risk and Bias Assessment (RoBANS) tool and guideline were applied to each of the included studies (Higgins et al., 2011).

Data synthesis

Outcome measures and statistical analysis, such as relative risk (RR), probability (*p*), Pearson Correlation Coefficient, Confidence Interval (CI) and the statistical power of the mean were analysed.

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