



Prevention of central venous catheter infections: A survey of paediatric ICU nurses' knowledge and practice

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SUMMARY

Background: Central venous catheters are important in the management of paediatric intensive care unit patients, but can have serious complications which worsen the patients' health, prolong hospital stays and increase the cost of care. Evidence-based recommendations for preventing catheter-related bloodstream infections are available, but it is unknown how widely these are known or practiced in the paediatric intensive care environment.

Objectives: To assess nursing knowledge of evidence based guidelines to prevent catheter-related bloodstream infections; the extent to which Australia and New Zealand paediatric intensive cares have adopted prevention practices; and to identify the factors that encouraged their adoption and improve nursing knowledge.

Design: Cross-sectional surveys using convenience sampling.

Settings: Tertiary level paediatric intensive care units in Australia and New Zealand.

Participants: Paediatric intensive care nursing staff and nurse managers.

Methods: Between 2010 and 2011, the 'Paediatric Intensive Care Nurses' Knowledge of Evidence-Based Catheter-Related Bloodstream Infection Prevention Questionnaire' was distributed to paediatric intensive care nursing staff and the 'Catheter-Related Bloodstream Infection Prevention Practices Survey' was distributed to nurse managers to measure knowledge, practices and culture.

Results: The questionnaires were completed by 253 paediatric intensive care nurses (response rate: 34%). The mean total knowledge score was 5.5 (SD = 1.4) out of a possible ten, with significant variation of total scores between paediatric intensive care sites ($p = 0.01$). Other demographic characteristics were not significantly associated with variation in total knowledge scores.

All nursing managers from Australian and New Zealand paediatric intensive care units participated in the survey ($n = 8$; response rate: 100%). Wide practice variation was reported, with inconsistent adherence to recommendations. Safety culture was not significantly associated with mean knowledge scores per site.

Conclusions: This study has identified that there is variation in the infection prevention approach and nurses' knowledge about catheter-related bloodstream infection prevention. The presence of an improved safety culture, years of paediatric intensive care experience and higher qualifications did not influence the nurses' uptake of recommendations, therefore further factors need to be explored in order to improve understanding and implementation of best practice.

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Introduction

Central venous catheters (CVCs) are an essential part of the management of critically ill patients, serving both as reliable vascular access and the site of venous pressure monitoring. The use of CVCs however, can

lead to complications that result in considerable morbidity, mortality and healthcare costs.

The most serious complication of CVCs is catheter-related bloodstream infections (CR-BSI), and international healthcare agencies including the World Health Organization (2012), the Institute for Healthcare Improvement (2011) and the US Centers for Disease Control and Prevention (CDC) have targeted it as a significant patient safety issue. Recent critical care studies report an incidence of between 1 to 5.5 per 1000 catheter-days (Jeffries et al., 2009; Pronovost et al., 2006b; Schwebel et al., 2012). Children are particularly vulnerable, with CR-BSIs the most commonly reported nosocomial infection

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reported in paediatric ICU (Reyes et al., 2012; Richards et al., 1999). The attributable cost of CR-BSI varies between \$3124 and \$60,536USD per event (Raad et al., 2007; Schwebel et al., 2012) and is associated with an attributable mortality of 0% to 11.5% (Timsit et al., 2011).

CR-BSI are a preventable cause of patient harm for the critically ill (Miller et al., 2011). Landmark work by Pronovost et al. (2006a) in their 'Keystone' project demonstrated that rates of CR-BSI can decrease to zero with the focussed attention on consistent adherence to the use of evidence-based guidelines and interventions (Berenholtz et al., 2004; Han et al., 2010). Nurses are responsible for the daily management of CVCs and are the driving force when applying these evidence-based guidelines.

Background

Several studies have reported the effectiveness of interventions to reduce CR-BSI rates, including maximal sterile precautions by inserters (Carrer et al., 2005; Mermel et al., 1991; Raad et al., 1994), skin antiseptics prior to insertion (Humar et al., 2000; Maki et al., 1991; Mimoz et al., 1996), the use of securement devices (Yamamoto et al., 2002), and early catheter removal (Berenholtz et al., 2004; Pronovost et al., 2006b). In 1981 and in subsequent updates, the CDC collated evidence relating to the prevention of intravascular catheter-related infection and produced a comprehensive set of guidelines for the management of these patients (O'Grady et al., 2011; O'Grady et al., 2002).

In order to provide quality CVC care, it is essential that individual nurses have an understanding of evidence-based recommendations. Previous research (Labeau et al., 2009; Labeau et al., 2008) assessed adult ICU nurses' knowledge of CR-BSI prevention guidelines via validated tests. Specifically, Labeau et al. (2008) developed and validated a questionnaire for evaluating critical care nurses' knowledge of evidence based guidelines for preventing CVC infections in 762 Flemish nurses. They found, and subsequently validated in a further study of 3405 European intensive care nurses (Labeau et al., 2009), a lack of knowledge and deficiencies in training for the prevention of CR-BSI, differences in what is regarded as best practice and a lack of consistent policies (Labeau et al., 2009; Labeau et al., 2008). However, the clinical difference from the adult ICU environment means that these results may not be universally generalised to paediatric settings.

Nurses' knowledge of evidence-based CVC care needs to be supported by the policies, procedures and practices of their own ICU. Despite the publication of evidence based recommendations, changes in practice often lag behind guideline dissemination (Morrison et al., 2006). Rickard et al. (2004) surveyed 14 ICUs in Australia to determine whether clinical practice reflected the CDC guidelines and found significant discrepancies. Other recent surveys in adult critical care settings (Bianco et al., 2013; Jeffries et al., 2009; Koutzavekiaris et al., 2011) have established that substantial variation exists in CR-BSI prevention activities. In paediatrics, studies examining practice and policy surrounding related activities, e.g. hand-washing when caring for CVCs, have found a similar variability (Brennan et al., 2004; Morrison et al., 2006; Warren et al., 2006).

Previous studies have explored the factors that encourage the adoption of evidence-based practice. Krein et al. (2007), within their survey of 516 non-federally funded US adult ICUs, found an association between the use of CR-BSI prevention practices and a higher safety culture score and/or participation in an infection control collaboration. Other factors which have been suggested by literature to support evidence-based practice include the number of ICU beds, level of facility support for evidence-based practice, and metropolitan location (Jeffries et al., 2009; Morrison et al., 2006).

The inconsistent application of evidence-based practice has a significant impact on the frequency of CR-BSI in these vulnerable patients. In addition to the guidelines developed by the CDC, multiple resources are available to educate bedside nurses on CR-BSI prevention best-practice, however within adult ICU, practices and nursing understanding of best

practice vary. There has been no similar study of both nursing knowledge and practice of evidence-based CR-BSI prevention in a paediatric ICU cohort. In order to ascertain whether variability in practice and nursing knowledge is similarly evident in paediatric ICU, a cross-sectional study was undertaken throughout Australia and New Zealand.

Methods

Aims

The aims of the study were to:

- Assess the knowledge of evidence-based strategies to prevent CR-BSI in paediatric intensive care nurses throughout Australia and New Zealand and to identify characteristics that improve this knowledge.
- Determine the extent to which Australia and New Zealand tertiary paediatric ICUs have adopted CR-BSI prevention practices and to identify the factors that encouraged their adoption.

Design

A cross-sectional, descriptive study using a questionnaire and survey was undertaken between 2010 and 2011 via convenience sampling.

Participants

Nursing researchers and managers from all eight tertiary level paediatric ICUs in Australia and New Zealand were invited by phone and follow-up email to participate in the study. Through these representatives, a link to the 'Paediatric ICU Nurses' Knowledge of Evidence-Based CR-BSI Prevention Questionnaire' was distributed to all paediatric ICU nurses ($n = 755$) via email, which led to an on-line survey tool. The nursing researchers and managers were not provided with a copy of the correct answers, and were eligible to participate. Secondly, the 'CR-BSI Practices Survey' was distributed to each units' nurse manager via email. Participation was voluntary and responses were collected anonymously.

Data Collection

Paediatric ICU Nurses' Knowledge of Evidence-Based CR-BSI Prevention Questionnaire

The 'Paediatric ICU Nurses' Knowledge of Evidence-Based CR-BSI Prevention Questionnaire' was developed using a previously validated adult critical care ten-item questionnaire (Labeau et al., 2009; Labeau et al., 2008). Three items from the original validated questionnaire were included and the remainder were modified to ensure its relevance to paediatrics. The paediatric modifications were based on the recommendations provided by the CDC (O'Grady et al., 2002). Each item was formatted primarily as a multiple-choice question with four response alternatives or options (the correct answer and three distractors) (Labeau et al., 2008). The three distractors consisted of strategies whose preventative or therapeutic value has not been established in evidence-based studies. Some questions ($n = 2$) required short answers, in order to assess memory recall for simple procedures.

The questionnaire was composed of ten questions; each correct answer given one point, a wrong answer not affecting the score negatively. For questions requiring short answers, a point was only awarded if all answers were provided and only one point was awarded per question in comparison to each answer. A maximum score thus consisted of a score of ten, a minimum score of zero points. The questionnaire also included questions on demographic characteristics of the respondents: gender; main work activity; nursing level; highest educational attainment; and years of paediatric ICU and critical care experience.

The Paediatric ICU Nurses' Knowledge of Evidence-Based CR-BSI Prevention Questionnaire was piloted for face and content validity via

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