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Review

Effectiveness of non-pharmacological interventions for the prevention of bloodstream infections in infants admitted to a neonatal intensive care unit: A systematic review

Onno Helder [a,1,*], Agnes van den Hoogen [b,1], Coby de Boer [a], Johannes van Goudoever [c,d], Malgosia Verboon-Maciolek [b], René Kornelisse [a]

[a] Department of Pediatrics, Division of Neonatology, Erasmus MC – Sophia Children's Hospital, Erasmus University Medical Center, Rotterdam, The Netherlands
[b] Department of Neonatology, Wilhelmina Children's Hospital, University Medical Centre Utrecht, Utrecht, The Netherlands
[c] Department of Pediatrics, VU University Medical Center, Amsterdam, The Netherlands
[d] Department of Pediatrics, Emma Children's Hospital, AMC, Amsterdam, The Netherlands

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ABSTRACT

Background: Bloodstream infections are associated with increased morbidity and mortality in very low birth weight infants admitted to neonatal intensive care units.
Objective: To evaluate the available evidence for the effectiveness of non-pharmacological bloodstream infection-preventive measures in infants admitted to a neonatal intensive care unit.
Design: A systematic review of randomized, controlled trials, controlled clinical trials, interrupted time series and pretest–posttest studies.
Data sources: PubMed, CINAHL, Web-of-Science, Cochrane Central Register of Controlled Trials, and Embase were searched.
Review methods: The systematic review was carried out according to the guidelines of the Center for Reviews and Dissemination. The methodological quality of the individual studies was evaluated with the quantitative evaluation form of McMaster University. The review included randomized, controlled trials, controlled clinical trials, interrupted time series, and pre–posttest studies published from January 1990 to January 2011.

Quantitative pooling of the results was not feasible due to the high heterogeneity of the interventions, methods and outcome measures. Instead, we present the studies in tabular form and provide a narrative account of the study characteristics and results.
Results: Fifteen studies out of 288 generated hits were selected and categorized as research on: hand hygiene (5), intravenous (IV) bundles (4), closed IV sets/patches/filters (4), surveillance (1), and percutaneously inserted central catheter teams (1). IV bundles including proper insertion and proper maintenance showed to be the most effective intervention for preventing bloodstream infection in infants; in three out of four studies on IV bundles, a statistically significant reduction of bloodstream infections was mentioned.
Conclusions: Although the methodological quality of most studies was not very robust, we conclude that IV bundles may decrease bloodstream infections in infants. However, differences in IV bundle components and in practices limited the underpinning evidence. There is limited evidence that the introduction of a percutaneously inserted central

* Corresponding author at: Department of Pediatrics, Division of Neonatology, Erasmus MC – Sophia Children's Hospital, Room Sk-1286, PO Box 2060, 3000 CB, Rotterdam, The Netherlands. Tel.: +31 107037455; fax: +31 107036542.
E-mail address: o.helder@erasmusmc.nl (O. Helder).
[1] Helder and Van den Hoogen equally contributed to this paper.

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catheter team results in bloodstream infection reduction. Hand hygiene promotion increases hand hygiene among healthcare workers, but there is inconclusive evidence that this intervention subsequently leads to a bloodstream infection reduction in infants. Future studies must be well designed, with standardized outcome measures.

What is already known about the topic?

- Infants admitted to neonatal intensive care units are at increased risk for bloodstream infections.
- Previously designed preventive measures do not unanimously reduce the number of bloodstream infections.

What this paper adds

- IV bundles may effectively reduce bloodstream infections in infants.
- A 'percutaneously inserted central catheter' team is promising; however, additional studies are needed to confirm this finding.
- Hand hygiene promotion programs improve hand hygiene compliance; however, there is inconclusive evidence that this intervention subsequently leads to a bloodstream infection reduction in infants admitted to neonatal intensive care units.

1. Introduction

Bloodstream infections are a major health threat to hospitalized patients worldwide (Aziz et al., 2005; Grol and Grimshaw, 2003; Stoll et al., 2004). Infants admitted to neonatal intensive care units are at increased risk for bloodstream infections. In particular, very low birth weight infants (<1500 g) are at risk for bloodstream infections due to their compromised immunological defense systems and multiple invasive procedures. Neonatal bloodstream infections are acquired during hospitalization and, according to the Centers for Disease Control and Prevention (CDC), are defined as bloodstream infections starting at least 48 h after birth (Horan et al., 2008) or at least 72 h after admission (Kaufman and Fairchild, 2004; Payne et al., 2004).

The incidence of bloodstream infections among very low birth weight infants in different neonatal intensive care units ranges from 11% to 53% (Aziz et al., 2005; Ng et al., 2004; Stoll et al., 2002). Very low birth weight infants affected by bloodstream infections are at higher risk for chronic lung disease (Aziz et al., 2005), periventricular leukomalacia (Stoll et al., 2004), necrotizing enterocolitis (Aziz et al., 2005), severe retinopathy of prematurity (Aziz et al., 2005), poor neurodevelopmental outcomes (Stoll et al., 2004), prolonged hospitalization (Mahieu et al., 2001), and death (Makhoul et al., 2005). In Europe, the additional costs of one bloodstream infection in a neonatal intensive care unit are €11.750 (Mahieu et al., 2001), and in the United States of America, the costs can be as much as $25.090 (≈€17.469) (Gray et al., 1995).

Various interventions to reduce bloodstream infections in infants have been studied, with their focuses on healthcare professionals' hands (e.g., the improvement of compliance with hand hygiene protocols, the use of gloves, the introduction of hand alcohol), the usage of intravenous (IV) devices (e.g., closed IV administration devices, the introduction of IV teams, IV care bundles) or 'other aspects' (e.g., multimodal interventions, neonatal intensive care unit design, and feeding the infant with human milk). However, the results of these studies have not been unanimous, and a recent systematic overview of the effectiveness of various interventions is lacking.

1.1. Objective

The objective of this review is to present a systematic overview of the available evidence for the effectiveness of non-pharmacological bloodstream infection-preventive measures in infants admitted to a neonatal intensive care unit.

2. Methods

2.1. Study design

To conduct this systematic review, the 'Center for Reviews and Dissemination Guidance for Undertaking Reviews in Health Care' (CRD, 2009) was used. The review team (OH and AvdH) a priori adapted this protocol to the study purposes, and post hoc changes were not made. The advisory group (RK, CdB, MV) critically commented on this adjusted review protocol and later discussed the findings presented in this paper.

2.2. Study identification

To list all possibly relevant studies that may have met the inclusion criteria, the following databases were searched from January 1990 to January 2011: PubMed, CINAHL, Web-of-Science, Cochrane Central Register of Controlled Trials, and Embase. The following keywords were identified if they appeared in the title or abstract: 'nosocomial infection', 'infection prevention', 'infant', and 'cross-infection'. For example, we used the following syntax for the PubMed search: (cross infection/pc[mesh] OR ((infectio*[tw] OR pathogen*[tw]) AND (cross[tw] OR transmiss*[tw] OR nosocom*[tw] OR hospital*[tw]) AND prevent*[tw])) AND (blood-born*[tw] bloodborn*[tw] OR blood-stream*[tw] OR bloodstream*[tw] OR catheter-relat*[tw] OR catheterrelat*[tw] OR catheter-associat*[tw] OR catheterassociat*[tw]) AND (infan*[tw] OR newborn*[tw] OR neonat*[tw]) AND (newborn intensive care unit*[tw] OR neonatal intensive care unit*[tw]). In the second phase, reference lists of the relevant studies were screened to retrieve additional literature. Furthermore, we contacted three international experts in the field of bloodstream infection prevention in neonatal intensive