Care Bundles and Peripheral Arterial Catheters: A Scoping Review

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Highlights

What we know about the topic:

- Recommendations for the use of vascular access care bundles to reduce infection are followed for different devices.
- The risk of arterial catheter-related infection is comparable with short-term, non-cuffed central venous catheters.
- There are practice concerns for clinicians inserting and caring for peripheral arterial catheters.

What this paper adds:

- The selected studies had a theme of decreased infection after using bundled strategies for all devices.
- Few studies addressed use of bundles for care of peripheral arterial catheters.
- High quality research should be performed about using care bundles for insertion and care of arterial catheters.

Abstract

Introduction: A scoping review of the literature was performed.
Aims/Objectives: To find information on the use of care bundles for care of arterial, central, and peripherally inserted venous catheters.
Methods: Data was extracted by 2 independent researchers using standardized methodology
Results: Results of 84 studies included 2 (2.4%) randomized controlled trials, 38 (45.2%) observational studies, 29 (34.5%) quality projects, and 15 (17.9%) reviews. Populations had more adults than pediatric patients. All studies had the most prominent theme of decreased infection in all devices after using bundle strategies.
Discussion and Conclusions: The mapping of available evidence strongly supports the use of care bundles to reduce infection in the care of all intravascular devices. However, deficiencies regarding practice concerns about insertion and care of arterial catheters highlight areas for future research with the aim to eliminate the gap in the evidence of studies of care bundles for peripheral arterial catheters.

Keywords: catheterization, peripheral, vascular access devices, patient care bundles

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Background and Significance

A frequently performed practice in anesthesia, critical care, and emergency medicine is insertion of a peripheral arterial catheter (AC) for hemodynamic monitoring and frequent blood sampling. With millions inserted annually in the United States, peripheral AC associated complications include dislodgement, mechanical failure, and infection.[1] The risk of AC related infection has been known for over a decade to be comparable with short-term, noncuffed central venous catheters (CVCs).[1–6] ACs have been described as the most manipulated intravascular device in Intensive Care Units and the operating room increasing risk factors, with the need for an AC bundle described in 2008 and 2010[1,5–8] to decrease risk and improve patient safety. The literature also shows that guidelines recommended by the Centers for Disease Control for AC insertion have often not been followed.[9] Such evidence indicates a need for a standardized approach for insertion and care of peripheral ACs to improve practice by featuring the specified interventions of patient assessment, an appropriate aseptic technique, and correct insertion and/or securement methods. A standardized safe insertion bundle incorporating ultrasound-guidance for ACs has recently been published to promote procedural excellence.[10] Standardization with a structured framework has been achieved using insertion and care bundles, initially with CVCs, incorporating specified interventions that improve practice, effectiveness, and patient safety in an efficient and cost-effective manner to minimize complications.[11] To clarify, the key features of a *care bundle* are collective, reliable, and continuous performance to improve care.[12,13] Many *bundles* focus on hospital-acquired infections,[14–18] particularly central line associated blood stream infections (CLABSIs). The landmark Michigan Keystone Intensive Care Unit Patient Safety Program in 2006 resulted in the large (66%) and sustained decreased rate of catheter related blood stream infections (CRBSIs).[19] However, audit processes report improved care in many aspects of care delivery following implementation of care bundles.[20] An AC care bundle to facilitate best practice for AC insertion and care is overdue.

This scoping review will map the existing literature about care bundles for all intravascular devices, with a focus on peripheral ACs. Such a review is a useful tool for evidence reconnaissance by providing a broad topic overview.[21] Conceptual analysis will describe and interpret aspects of the *care bundle*, as developed by the Institute for Healthcare Improvement, to inform about future research about ACs.[22–24] The extent of available research and research methodologies will be examined. Analysis of the range of research literature will provide conceptual clarity about the topic, as well as providing an overview of the field and breadth of evidence. We will incorporate the key concept of scoping by clarifying definitions and providing a narrative overview of the literature. This will outline what is already known, and thus identify important clinical practice concerns that exist for ACs. Thus, gaps in the research will be identified.

Aims and Objectives

The aim of this scoping review is to identify the features of bundled interventions for vascular access devices that determine care outcomes and to highlight research gaps about care bundles for peripheral ACs. The objectives are to examine and map an overview of the research.

We focused our review on the following research questions:

What types of care bundles for vascular access devices have been reported?

What are the bundle components of existing vascular access device bundles?

What are the outcomes of the introduction of care bundles for specific intravascular access devices?

Design and Methods

A review design was selected and a scoping review of literature was performed, modelled on the frameworks of Arksey and O'Malley[25] and the Cochrane Health Group,[22] and carried out according to the Methodology for Joanna Briggs Institute Scoping Reviews.[21]

Literature about "care bundles" and "arterial catheters" published in English with no time limit was included, with the following broad criteria of intervention type, population, and geographical location: (1) all intravascular devices; (2) adult and pediatric populations; and (3) all operating rooms and critical care units.

The investigators adopted a consultative approach to the scoping framework, to ensure a consistent application of the inclusion criteria.

Search Strategy

A health sciences librarian performed a preliminary search of the topic "care bundle and arterial catheters/lines", and no literature was found. A subsequent search required broadened search criteria, so the databases Cochrane Database of Systematic Reviews, Evidence for Policy and Practice Information (EPPI) Reviewer, Joanna Briggs Institute of Systematic Reviews and Implementation Reports (JBISRIR), Scopus, PubMed, Cumulative Index of Nursing and Allied Health Literature (CINAHL), and Excerpta Medica Database (EMBASE) were searched.

Study Identification and Selection

References were imported from Endnote™ (Clarivate Analytics, Pheladelphia, PA) and considered using the inclusion/exclusion process. Two independent investigators (HR and JG) screened each reference, title, and abstract. The full text of assessed studies deemed as relevant were then evaluated by the same 2 reviewers using a standard evaluation tool. Data was extracted from the full text of eligible studies according to the inclusion/exclusion criteria, using a standardized data extraction form. Discrepancies were resolved by discussion and consensus. If consensus could not be reached, a third reviewer (CW) was available to adjudicate.

Data Charting and Collation

Data were extracted from Endnote (Clarivate Analytics) to Excel (Microsoft, Redmond, Washington) by 1 reviewer (HR) with the articles organized according to authors, publication year, study type, the study's details, profession of first author, location, clinical setting, population, outcomes, and funding. A 10% sample was checked for accuracy by the second reviewer (JG). The 2 investigators (HR and JG) then independently reviewed each article and met to consider findings to achieve consensus. Study quality was not fully assessed, but a brief commentary for each publication was included. Data were collated in accordance with study type. Risk of bias was not assessed according to the goals of a scoping review, designed to evaluate the breadth of research rather than the depth. Emphasis was placed on the methodological quality of available studies. Authors were not contacted to provide additional information or full text, if not readily available.

Data Synthesis

Data were synthesized in a descriptive manner, mapping the aspects of the literature specified in our research questions. The research was grouped in accordance with study design, device type, first author's profession, geographical study location, and outcomes.

Reporting of Results

Tables were created to demonstrate the flow of inclusion/exclusion for study selection, characteristics, and study outcomes, as follows. The search results were collated using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method,[26] an evidence-based minimum set of items that may be applied to scoping reviews. Our literature search was summarized in the PRISMA Flow Diagram (Figure). Characteristics of included studies are presented in Table 1, and study outcomes are listed in Table 2.

Results

Characteristics

The final review included 2 randomized controlled trials, 38 observational studies, 29 quality projects, and 15 reviews.

More than half of the studies were published in the United States (35.7%) and the United Kingdom (20.2%), while the remainder were published worldwide in Europe (22.6%), Asia

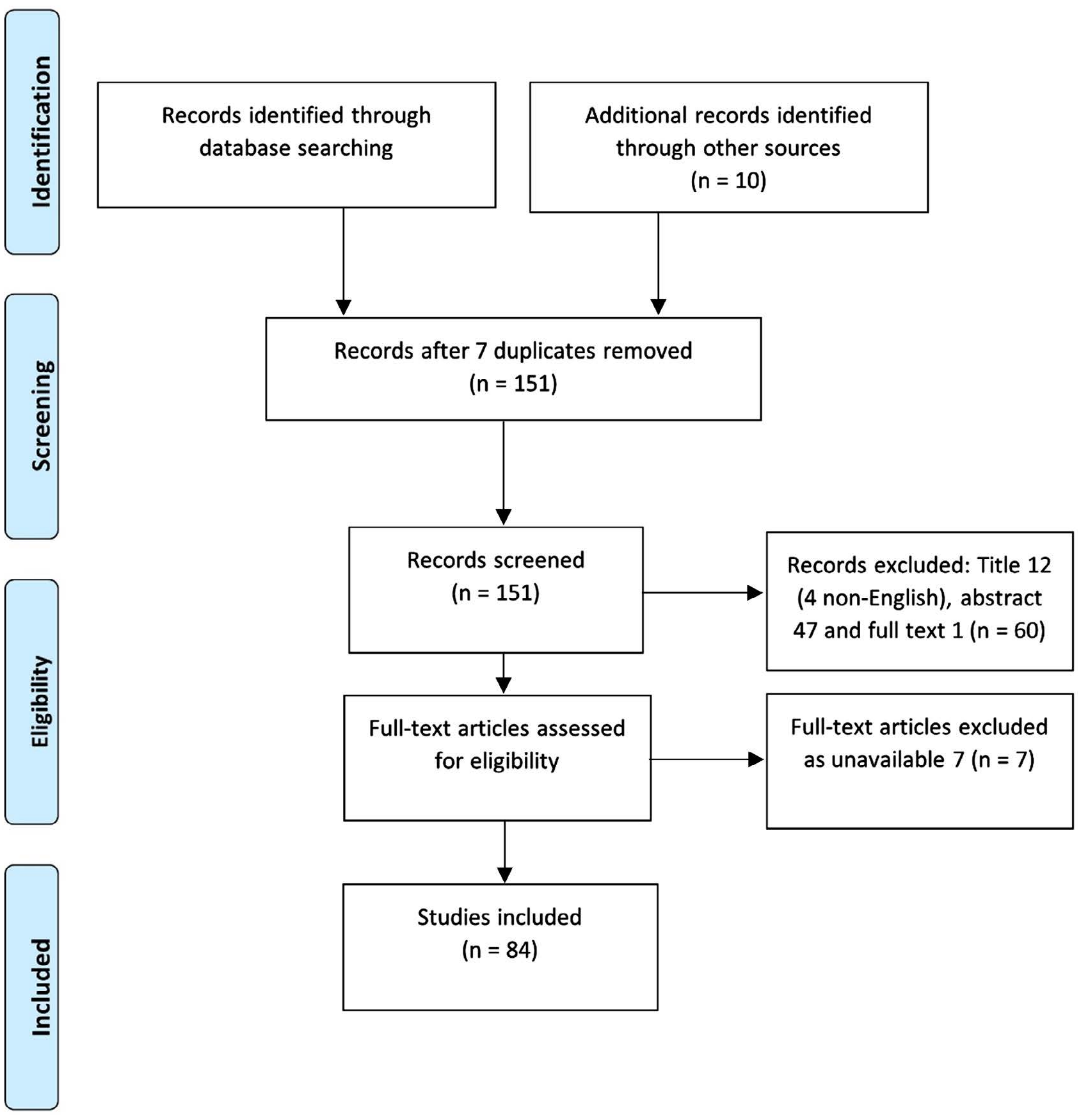

Figure. **PRISMA Flow Diagram.[26]**

(8.3%), Australia (7.1%), the Republic of Ireland (2.4%), the Middle East (1.2%), and South America (1.2%). First author professions were predominantly medical doctors (69%), followed by nurses (26.2%) (Table 1).

Population Demographics

Patient populations were primarily adults (n = 60, 71.5%), with fewer pediatric patients (n = 24, 28.5%). These populations were divided by device type. The pediatric population studies were only about CVCs (n = 24, 28.5%). The adult studies involved various devices, but CVCs were the most frequently studied device (51, 60.7%). Other devices less frequently studied were peripherally inserted central catheters (n = 4, 4.8%), peripherally inserted venous catheters (n = 4, 4.8%), and ACs (1, 1.2%) (Table 1).

Outcome Themes of Bundled Interventions

The most prevalent outcome studied was infective for all vascular access devices of ACs, CVCs (adult), CVCs (pediatric), peripherally inserted central catheters, and peripherally inserted venous catheters (n = >69 individual studies, 82.1%). Review articles also discussed infective outcomes (n = 5, 5.9%). Many were statistically significant, while others did not report significance. All studies of each vascular access type reported decreases in CLABSI, CRBSI, and health care related blood stream infection after implementation of bundle strategies. Other outcome themes were improved compliance (n = 7, 8.3%), knowledge, risks, and barriers (n = 6, 7.1%), and the concept and components of the bundle (n = 4, 4.7%).

Limitations

This scoping review has the following limitations. It did not assess the risk of bias, as in systematic reviews. Studies in a language other than English were excluded.

Discussion

This scoping review identifies the available evidence, which strongly supports the use of care bundles to reduce infection in several intravascular devices. The highest prevalence of improvement for all infection types across all devices was reported for adult CVCs, with a significant decrease of CLABSI by 21.4% ($P > 0.0001$ to $P = 0.043$) in 18 observational studies. Thus, the emphasis in reporting outcomes for use of care bundles in all intravascular devices was a reduction in the incidence of infection. This important outcome was the primary discussion, with the features of care bundles and their significant role in insertion and care of the different intravascular devices for improved practice was generally not addressed. The components of bundles were

Table 1. **Characteristics of Included Studies, N = 84 (100%)**

First author profession	**n (%)**
Medical doctor	58 (69.0%)
Nurse	22 (26.2%)
Scientist	2 (2.4%)
Pharmacist	1 (1.2%)
Healthcare administrator	1 (1.2%)
Study location	
United States of America	30 (35.7%)
United Kingdom	17 (20.2%)
Australia	6 (7.1%)
Spain	5 (5.9%)
Taiwan	5 (5.9%)
Germany	4 (4.8%)
The Netherlands	3 (3.6%)
Italy	2 (2.4%)
Switzerland	2 (2.4%)

Table 1. ***(Continued)***

Republic of Ireland	2 (2.4%)
Belgium	1 (1.2%)
Brazil	1 (1.2%)
Turkey	1 (1.2%)
Korea	1 (1.2%)
France	1 (1.2%)
Colombia	1 (1.2%)
United Arab Emirates	2 (2.4%)
Study design	
Randomised controlled studies[27,28]	2 (2.4%)
Observational studies[5,14,15,29–52,55–57,59–64,80,106]	38 (45.2%)
Quality and/or safety projects[10,20,37,41,44,52–54,58,65–84]	29 (34.5%)
Reviews[42,85–92,94,97,99,103,104,106]	15 (17.9%)
Devices	
CVCS Adult[13,15,20,27,33,34,38–40,42–44,46,47,49–52,54,56,58,61–64,68–77,81,83–85,89,92–102]	
Arterial catheters[27]	1 (1.2%)
Central venous catheters (adult)[13,15,20,27,33,34,38–40,42–44,46,47,49–52,54,56,58,61–63,65,69–78,82,84–86,90,93–103]	51 (60.7%)
Central venous catheters (pediatric)[28,30–32,35–38,48,53,55,57,60,64,68,69,79,83,89,90,92,104–106]	24 (28.5%)
Peripherally inserted central catheters[32,63,80,106]	4 (4.8%)
Peripherally inserted venous catheters[29,38,65,79]	4 (4.8%)
CVC Ped[28,30–32,35–38,48,53,55,57,60,63,67,68,78,82,88,89,91,103–105]	

infrequently specified and explained (4.7%), and this data was not provided for ACs. The important evidence gap is the lack of studies about use of care bundles for improved practice regarding insertion and care of ACs. The review identified only 1 study (1.2%) that included ACs in a study of CVCs. This study provided randomized controlled trial data that focused on infection reduction and was 1 of only 2 randomized controlled trials reviewed for all devices. The lack of research about ACs does not reflect the historical evidence of the equivalent risks for infection in ACs as in nontunnelled CVCs,[7,8] or the need for study of the components of care bundles for insertion and care to address practice concerns about patient assessment, aseptic technique, and insertion and securement methods.

Conclusion

The lack of randomized controlled trial evidence is highlighted for all device types in this review of care bundles and importantly identifies the lack of studies of ACs. Such a lack of research of ACs shows a need for study of best practice techniques involving the implementation of care bundles to minimize infection risk in line with all intravascular devices, as well as promoting the use of bundled strategies for insertion and care. The need for high quality evidence is a priority for studying ACs. This will inform a process to provide procedural excellence for optimal care of ACs using the bundled approach to minimize the complications of dislodgement and mechanical failure, as well as infection.

Table 2. **Outcomes of Included Studies, N = 84 (100%)**

Device type	Bundle outcomes	References
CVCs with ACs and CVCs only	↓CABSI (2.3%) ↓CLABSI $P \le 0.001$ (2.3%)	27,28
PICCs	↓CRBSI $P = 0.02$ – $P < 0.05$ (4.7%)	32,63,80,106
CVCs pediatric	↓CLABSI $P < 0.0001$ – $P = 0.001$ (4.7%)	29,36,37,55,57
	↓CRBSI $P = 0.04$ (3.5%)	30,31,60
	↓HCABSI (2.3%)	35
CVCs adult	↓CLABSI $P > 0.0001$ – $P = 0.043$ (21.4%)	15,33,38,40,42–50, 52,56,62–64
	↓CRBSI $P = 0.005$ – $P = 0.04$ (4.7%)	39,42,51,61
	↓CLABSI team approach and education (3.5%)	34,41,59
	↑Compliance ↓CRBSI (8.3%)	58,65,67,69,71,72,75
PIVCs	↓CRBSI (14.2%)	20,37,52,66,68,70,73, 74,77–79,84
PICCs	↓CRBSI (7.1%)	45,53,56,81–83
CVCs	↓CLBSI (4.7%)	41,44,54,76
	Improved knowledge of risks and barriers (7.1%)	89–92,94,97
	↓CLABSI ↓CRBSI (5.9%)	42,85–88
	Concept and nature of bundle (4.7%)	99,103,104,106

AC = arterial catheter; CABSI = catheter associated blood stream infection; CLABSI = central line associated blood stream infection; CRBSI = catheter related blood stream infection; CVC = central venous catheter; HCABSI = health care related blood stream infection; PICC = peripherally inserted central catheter; PIVC = peripherally inserted venous catheter.

Disclosure

The authors have no conflict of interest to disclose.

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