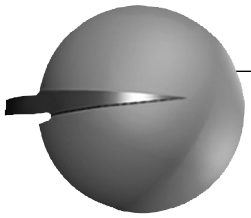

Evidence Review

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The Effectiveness of Clinically Indicated Replacement of Peripheral Intravenous Catheters: An Evidence Review With Implications for Clinical Practice

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Keywords
peripheral intravenous catheter-related infections, clinically indicated peripheral intravenous catheter replacement, peripheral intravenous catheter phlebitis, phlebitis

ABSTRACT

Background: Current clinical guidelines from the Centers for Disease Control and Prevention (CDC; 2011) state that peripheral intravenous catheters are to be replaced every 72–96 hr to prevent infection and phlebitis in the adult patient. It is unclear whether this practice reduces the incidence of phlebitis or other infections.

Aim: The aim of this study was to examine levels I and II evidence to determine if replacing peripheral intravenous catheters only when clinically indicated compared to every 72–96 hr increases the adult patient's risk for infection or phlebitis.

Methods: The following patient or population, intervention, comparison, outcome question was used to search the literature databases PubMed, ClinicalKey, ProQuest, Ovid SP, and CINAHL: In the adult patient requiring a peripheral vascular catheter (P), does replacing the catheter only when clinically indicated (I) compared to replacing the catheter every 72–96 hr (C) increase the occurrence of phlebitis and infection (O)? A set of specific search criteria along with critical appraisal tools was used to identify relative studies.

Results: Four level II randomized controlled trials with no less than 155 subjects, and two level I meta-analyses reviewing a total of 13 research studies indicated that the replacement of peripheral intravenous catheters only when clinically indicated does not increase patient risk of phlebitis or infection when compared to the current practice of routine replacement between 72 and 96 hr in the adult patient population.

Linking Evidence to Action: The current practice of replacing peripheral intravenous catheters every 72–96 hr does not decrease the incidence of phlebitis or infection when compared to replacing catheters when clinically indicated in the adult population. By translating this research into current practice, healthcare costs and nursing care time will decrease, and unnecessary invasive procedures would be eliminated thereby increasing patient safety and satisfaction.

BACKGROUND

Insertion of a peripheral intravenous (IV) catheter, also known as a peripheral IV device, is an invasive procedure experienced by adult patients requiring IV medical care. These catheters are used when a patient requires treatment such as hydration, medication administration, nutrition, or in anticipation of an emergent need. Over 200 million peripheral IV catheters are inserted each year in the United States. Each IV catheter insertion is painful and invasive, bringing increases in healthcare resources such as personnel, finances, and even iatrogenic infections (Rickard et al., 2012). The most common adverse outcomes experienced by the patient with a peripheral IV catheter are "an irritation of the vein characterized by pain, tenderness on palpation, erythema, warmth, swelling, induration, or palpable cord (i.e., thrombosis) of the cannulated vein," known as phlebitis or, more rarely, a catheter-related blood stream infection (CRBSI; Rickard, McCann, Munnings, & McGrail, 2010, p. 1). Symptoms of phlebitis are most commonly associated with a reaction to the mechanical irritation of catheter placement rather than infection, according to Rickard et al. (2010); the incidence of infection from a peripheral IV catheter is about 0.1% of catheters and 0.5 per 1,000 device days.

Currently, the Centers for Disease Control and Prevention (CDC, 2011) requires that peripheral IV catheters be replaced "every 72–96 hours to reduce risk of infection and phlebitis in adults" (p. 16). The CDC (2011) references studies by Tager et al. (1983) and Lai (1998), which focused on the time frame of 72 versus 96 hr replacement, and by Maki

and Ringer (1991), which focused on the catheter material's effect on phlebitis, as the basis for this guideline. The Tager et al. (1983) and Lai (1998) studies both found that the rates of phlebitis and infection are not substantially different in peripheral catheters left in place 72 hr compared with 96 hr; however, they did not focus on catheters left in place past the 96 hr point. In the Maki and Ringer (1991) study, a small number of peripheral catheters were left in place beyond the 96-hr point; however, the sample size was not large enough to produce statistically significant results. A recent review of the research on this topic completed by Webster, Osborne, Rickard, and Hall (2010), however, found "no conclusive evidence of benefit in changing catheters every 72–96 hours" (p. 2). In fact, according to a study by Rickard et al. (2010), "the risk of phlebitis is relatively stable after the first 24 to 48 hours as the peak in phlebitis between 24 and 48 hours is likely associated with time taken by the body to mount a biological response after instigation of therapy; those most likely to develop phlebitis will do so at this time" (p. 8). In addition, the current CDC guidelines for peripheral vascular catheters in children and those with poor veins require catheter change only when clinically indicated, making it unclear why this practice could not be extended to the adult population (Van Donk, Rickard, McGrail, & Doolan, 2009). Seventy percent of all adult admissions in acute care hospitals now require IV therapy for an average of 7–10 days. Replacing these necessary indwelling catheters without clinical indication to do so, exposes these patients to invasive needle sticks, risk of infection, and financial costs, while exposing their healthcare providers to increased workloads (Rickard et al., 2012). The purpose of this paper is to present evidence on the effectiveness of replacing peripheral IV catheters only when clinically indicated compared to the practice of routine catheter changes every 72–96 hr in the adult patient requiring peripheral venous catheter access.

METHODS

The patient or population, intervention, comparison, outcome (PICO) question is: In the adult patient requiring a peripheral vascular catheter (P) does replacing the catheter only when clinically indicated (I) compared to replacing the catheter every 72–96 hr (C) increase the occurrence of phlebitis and infection (O).

In searching the PubMed database to answer this question, search terms "phlebitis" and "catheter-related bloodstream infection" resulted in three results. When using the Boolean AND to adjoin the term "peripheral IV catheter" and, by using the Boolean OR, also its interchangeable term, "peripheral IV device" by using the Boolean OR, to the previous search, the results expanded to 229. This was due to the use of the term "device" which is a very broad term used to describe a wide variety of medical equipment. To narrow these results, the term "routine replacement" was added to the search. This resulted in a more focused search producing six articles. To further focus the search results, the term "routine" was replaced with the term "clinically indicated" and articles were retrieved (Table 1). All searches performed on the Medline PubMed database were performed with the following filters: clinical trials, reviews, randomized controlled trials (RCTs), meta-analyses, and 5 years. To further focus the results, the filter for time frame was changed from 5 years to 1 year and the search preformed. All four resulting articles were reviewed for relevance to the topic and those that proved relevant were saved.

Table 1. PubMed Search Terms and Search Results

Search terms	Number of hits
Phlebitis AND CRBSI	3
Phlebitis AND catheter-related bloodstream infection AND peripheral IV catheter OR peripheral IV device	229
Phlebitis AND catheter-related bloodstream infection AND peripheral IV catheters OR peripheral IV device AND routine replacement	6
Phlebitis AND catheter-related bloodstream infection AND peripheral IV catheters OR peripheral IV device AND clinically indicated replacement	4(1)*

Note. Search range 2009–2014.
*Indicates articles published in last 12 months.

Within the ClinicalKey database, search terms "phlebitis AND catheter-related bloodstream infection AND peripheral IV catheters OR peripheral IV device AND clinically indicated replacement," the same search procedures and filters were used producing 180, 231, 227, and 218 results, respectively (Table 2). To further focus the results, the filter for time frame was changed from 5 years to 1 year on the last search, "phlebitis AND catheter-related bloodstream infection AND peripheral IV catheters OR peripheral IV device AND clinically indicated replacement," resulting in 65 articles. Those 65 articles were reviewed for relevance, validity, reliability, and credibility.

ProQuest nursing and allied health source database was also searched using the same terms and search progression as searches done in PubMed and ProQuest. The filters on this database were set to search for full text, peer-reviewed, scholarly journal articles with humans as the subject published in the last 5 years, producing 27, 5,564, 1,013, and 375 results, respectively (Table 3). When the final search was completed with a filter of full text, peer-reviewed, scholarly journal articles with humans as the subject published in the last year, 34 articles resulted. Those articles were reviewed for relevance to the topic and those that met the search criteria saved for critical appraisal.

The Ovid database was also employed in searching for evidence, utilizing Ovid Medline, Ovid Healthstar, and

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Table 2. Clinical Key Search Terms and Search Results

Search terms	Number of hits
Phlebitis AND CRBSI	180
Phlebitis AND catheter-related bloodstream infection AND peripheral IV catheter OR peripheral IV device	231
Phlebitis AND catheter-related bloodstream infection AND peripheral IV catheters OR peripheral IV device AND routine replacement	227
Phlebitis AND catheter-related bloodstream infection AND peripheral IV catheters OR peripheral IV device AND clinically indicated replacement	218(65)*

Note. Search range 2009–2014.
*Indicates articles published in last 12 months.

Table 3. Proquest Search Terms and Search Results

Search terms	Number of hits
Phlebitis AND CRBSI	27
Phlebitis AND catheter-related bloodstream infection AND peripheral IV catheter OR peripheral IV device	5,564
Phlebitis AND catheter-related bloodstream infection AND peripheral IV catheters OR peripheral IV device AND routine replacement	1,013
Phlebitis AND catheter-related bloodstream infection AND peripheral IV catheters OR peripheral IV device AND clinically indicated replacement	375(34)*

Note. Search range 2009–2014.
*Indicates articles published in last 12 months.

Journals@Ovid Full Text were set as resource filters for the search. Filters also applied to focus results were research articles involving RCTs or meta-analysis published within the last 5 years. Following the same search term progression as searches in the previous three databases resulted in 126, 258, 231, and 236 articles, respectively (Table 4). Changing the filter from 5 years to 1 year within the last search term led to a reduction in results from 236 to 74 articles. Articles relevant to the topic

Table 4. Ovid SP Search Terms and Search Results

Search terms	Number of hits
Phlebitis AND CRBSI	126
Phlebitis AND catheter-related bloodstream infection AND peripheral IV catheter OR peripheral IV device	258
Phlebitis AND catheter-related bloodstream infection AND peripheral IV catheters OR peripheral IV device AND routine replacement	231
Phlebitis AND catheter-related bloodstream infection AND peripheral IV catheters OR peripheral IV device AND clinically indicated replacement	236(74)*

Note. Search range 2009–2014.
*Indicates articles published in last 12 months.

were saved for further evaluation against articles saved from the previous three database searches.

The final database selected to search was the Cochrane Library, which is a collection of databases that contain high-quality, independent evidence geared toward healthcare decision making and determining best practice. Cochrane reviews represent the highest level of evidence on which to base clinical treatment decisions. Cochrane reviews are systematic reviews that adhere to a strict design in order to make them more comprehensive, thus minimizing the chance of bias, and ensuring the reliability of their results. When performing the search in this database, utilizing the same search terms and progression as the four previous database searches, the only filter placed was on publication year resulting in 0, 45, 8, and 5 articles, respectively (Table 5). When the final search was completed with a filter of publication within the last 12 months, all five articles previously identified for review fell into this category. These five articles were reviewed for relevance to the research topic, leading to the identification of one additional article for inclusion in this review.

All articles saved from the five searches were reviewed by two independent researchers utilizing critical appraisal tools modified from those developed by Melnyk and Fineout-Overholt (2005; Figures S1 and S2, available with online version of this article). Articles were chosen based on their ability to meet the following criteria: level I (meta-analysis or systematic reviews of RCTs) or level II evidence (RCTs indicating high reliability; Table 6), published within the last 5 years, and dealt with the frequency of peripheral IV catheter replacement and adverse outcomes in the adult (age greater than 18 years) patient population. This process led to the

Table 5. Cochrane Library Search Terms and Search Results

Search terms	Number of hits
Phlebitis AND CRBSI	0
Phlebitis AND catheter-related bloodstream infection AND peripheral IV catheter OR peripheral IV device	45
Phlebitis AND catheter-related bloodstream infection AND peripheral IV catheters OR peripheral IV device AND routine replacement	8
Phlebitis AND catheter-related bloodstream infection AND peripheral IV catheters OR peripheral IV device AND clinically indicated replacement	5*

Note. Search range 2009–2014.
*Indicates articles published in last 12 months.

Table 6. Rating System for the Hierarchy of Research Evidence

Level I strongest evidence	Systematic reviews or meta-analyses
Level II	Well-designed randomized controlled trials
Level III	Well-designed controlled trials lacking randomization
Level IV	Well-designed case controlled and cohort studies
Level V	Systematic reviews of descriptive and qualitative studies
Level VI	Single descriptive or qualitative studies
Level VII weakest evidence	Opinion of authorities and/or reports of expert communities

selection of six relevant articles that answer the PICO question representing the strongest evidence available on this topic.

RESULTS

A nonblinded RCT performed by Webster et al. (2008) focused on phlebitis and infiltration rates in 755 medical and surgical inpatients 18 years or older, mentally stable, and without current bacteremia or immunosuppression, from general tertiary referral teaching hospital in Queensland, Australia, with IV catheters in place for at least 4 days. Randomization into two groups, clinically indicated IV catheter replacements (376 patients) and routine replacements (376 patients), occurred by computer-generated random list with telephone confirmation by the inserting registered nurse (RN). The results of this study found 33% (123 patients) of patients in the "routine replace" group and 38% (143 patients) of patients in the "clinical indication" group had an IV catheter removed due to phlebitis or infiltration (relative risk 1.5, 95% CI 0.95–1.40), indicating no significant difference between the development of phlebitis or infiltration.

Over an 18-month period, Van Donk et al. (2009) performed a nonblinded RCT focusing on the incidence of phlebitis and IV catheter occlusion in an adult population with prescribed IV antibiotics and referred to the hospital in the homecare program of a regional hospital in Australia by their primary care physician or the emergency department. Allocation of group assignment was concealed via sealed opaque envelopes. A total of 105 patients representing 151 IV catheters and 16,765 dwell hours were placed in the clinical indication replacement group and 95 patients representing 161 IV catheters and 12,192 dwell hours were placed in the routine (72–96 hr) replacement group. Six in the homecare RNs, overseen by the principal researcher, assessed each site daily, performed replacements, and collected data. The instrument used for measurement was a phlebitis assessment scale and a clear definition of occlusion. The results found that there was no difference in the rate of complications between IVs being routinely replaced and those only changed when clinically indicated ($p = .71$).

Rickard et al. (2010) identified similar findings. A 10-month randomized nonblinded controlled trial was conducted in a regional teaching hospital in Australia. Three-hundred and sixty-two adult patients admitted as inpatients to the acute medical and surgical units who were expected to have an IV catheter in place for at least 4 days were considered eligible for the study. Exclusion criteria for this study included patients with current bloodstream infections, those who were immunosuppressed, those with an IV catheter in place greater than 48 hr, or those patients on pediatric, same-day, mental health, obstetrical, critical care, or dialysis units. Randomization into treatment or control groups, clinical replacement (177) and routine replacement (185), occurred by computer-generated random assignment. All IV sites were assessed by clinical RNs caring for the patients using hospital protocols and a phlebitis identification tool. IV catheter insertion, removal, reason for

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removal, and reason for not following protocol were recorded in the patients' charts. Complications of phlebitis, infiltration, occlusion, accidental removal, local infection, and IV-related blood stream infection causing unplanned device removal were analyzed. The results found that the complication rates ($p = .86$), time to first complication ($p = .39$), phlebitis ($p = .34$), infiltration ($p = .57$), occlusion ($p = .75$), and accidental removal ($p = .43$) were not statistically significant between groups.

Rickard et al. (2012) performed another nonblinded RCT with similar outcomes that studied 3,283 patients (1,593 clinical indication groups and 1,690 routine groups) admitted to medical and surgical units of three university-affiliated hospitals in Queensland, Australia. Randomization occurred via computer assignment in 1:1 allocation ratio at the patients' point of entry into the hospital with exclusion criteria set as existing blood stream infections, IV catheters in place greater than 72 hr, IV catheters inserted in emergency situations, and planned removal of the catheter within 24 hr. IV sites were evaluated daily and 48 hr after catheter removal, with replacements on routine or clinical indications. A research RN employed to assist with the study rated all items, with the exception of pain or tenderness, on the structured phlebitis assessment tool utilizing direct assessment of the patient and review of clinical data. A blinded medical rater diagnosed device-related infections and all blood stream infections. The results of this study found phlebitis rates between groups to be not statistically significant when analyzed per patient ($p = .64$) and per 1,000 IV dwell days ($p = .67$). Findings also indicated that rates of infiltration, occlusion, accidental removal, total infusion failure, and hospital mortality also were not statistically significant between groups (Rickard et al., 2012; Table 3).

A meta-analysis of six RCTs representing 8,779 IV catheter dwell days was performed by Webster et al. (2010). Trials compared routine catheter replacement to clinically indicated replacement of peripheral IV catheters. Inclusion criteria were peripheral IVs in place for at least 3 days, undergoing any duration of IV replacement versus clinically indicated replacement with catheters made up of any material with intermittent or continuous therapy located in hospitals, nursing homes, or in the community. A statistically insignificant increase in phlebitis in the clinically indicated replacement group was found in the six trials (*OR* 1.24, 95% CI 0.97 to 1.60; $p = .09$) per patient, which was also the finding when measurement was expressed for five of the six trials per 1,000 IV catheter device dwell days (i.e., clinically indicated 1.6 cases per 1,000 catheter days vs. 1.5 cases per 1,000 catheter days in the routine-replacement group). These findings were validated when this study was updated by Webster, Osborne, Rickard, and New (2013) in April 2013.

The Webster et al. (2013) updated version of this meta-analysis included a consideration of 10 additional research papers from those presented in the prior studies. The results of seven RCTs were reviewed in this study, including six previously discussed in the 2010 study plus one additional study found on an updated literature search. These trials involved a total of 4,895 participants, ranging from 42 to 3,283 participants, located in three different countries, and included a large multisite study. The guidelines for timing peripheral IV replacement findings from the original version of this review were replicated in this study. The findings of this study support those of the original study and indicate no difference in phlebitis rates, whether catheters are changed according to clinical indications or routinely and are not affected by infusions being continuous or intermittent (clinically indicated 186/2,365; 3-day change 166/2,441; RR 1.14, 95% CI 0.93 to 1.39). The authors also analyzed the data by number of device days, as completed in the original study, and also found no difference in phlebitis rates between the two groups (RR 1.03, 95% CI 0.84 to 1.27; $p = .75$). Again, catheter-related bloodstream infection (CRBSI) was assessed in 4,806 of the 4,895 patients in this review and no significant difference between routine (2/2,441) and clinically indicated (1/2,365) groups (risk ratio: 0.61), though a wide confidence interval (95% CI 0.08 to 4.68; $p = .64$) did create some uncertainty around this estimate. The results of this study mirror those of the Webster et al. (2010) study and provide support for the conclusion that peripheral IV catheters can be changed only when clinically indicated without increased risk to the patient and with cost savings for healthcare organizations.

In all seven studies presented in this meta-analysis, no evidence was found supporting the current CDC guideline of routinely replacing IV catheters every 72–96 hr to prevent phlebitis or infection. All seven studies were RCTs. This meta-analysis included two studies of the four RCTs reviewed in earlier articles (Webster et al., 2008; Van Donk et al., 2009) and two published since that time (Rickard et al., 2010, 2012). Rickard was involved in four studies (Van Donk et al., 2009; Rickard et al., 2010, 2012; Webster et al., 2010) and Webster was involved in three (Webster et al., 2008, 2010; Rickard et al., 2012). Three of the four RCTs took place in acute care hospital inpatient setting (Webster et al., 2008; Rickard et al., 2010, 2012) and the fourth took place in an outpatient homecare setting (Van Donk et al., 2009) with demographics on participants being similar (Table 7). Phlebitis was measured with a tool indicating a positive diagnosis when two or more factors are present in three of the four RCTs (Webster et al., 2008; Rickard et al., 2010, 2012), and in the fourth (Van Donk et al., 2009), a positive diagnosis of phlebitis was documented when a patient scored two or more points when assessment of all factors was completed (Table 7). Two studies (Rickard et al., 2010, 2012) presented data on catheter-related outcomes other than phlebitis and infection (Table 7) and four studies (Webster et al., 2008, 2009; Rickard et al., 2010, 2012) presented data on cost related to IV catheter replacement.

Assessing Potential Bias

Participants in all of the RCTs selected for this study were randomly allocated by computer selection via a sequence generator program. Allocation was then communicated utilizing a telephone (Webster et al., 2008) or computer-based service.

Table 7. Evidence Table

Webster et al. (2008)	Nonblinded randomized controlled trial Level II	755 adult med-surgical inpatients tertiary referral teaching hospital in Queensland, Australia Computer-generated random list allocation assignment to RN via phone Inclusion: ≥ 18 years of age, no current bacteremia, not on immunosuppressive therapy, scheduled to have IVD at least 4 days Exclusion: altered mental state, immunocompromised, current blood stream infection Site assessment: daily	Validity check on 5% of data, 95% Confidence intervals, relative risk, failure rate per 1,000 catheter days Two-tailed fisher exact test, independent t tests, Composite measure of catheter failure due to phlebitis or infiltration, Two-sided test $\alpha = .05$ and 90% power need 380 patients/group (376)	Adequate powered detect differences in primary outcome, broad range of patients, no limit how or who could insert IVD	Site assessment: daily & IV addition or change by IV team RN and floor RN Infusion related costs: decreased 25% w/clinically indicated $28.84 continuous infusions per insertion replacement
Van Donk et al. (2009)	Non-blinded Randomized Controlled Trial Level II	316 IVs in home setting over 18-month period Adults in the hospital in the home program prescribed IV antibiotic therapy Clinical Indication replacement group: 155 IVs, 105 patients, 16,765 IV hours, n = 151 Routine (72–96 hr) replacement group: 161 IVs, 95 patients, 12,192 hr, n = 161	Incidence of phlebitis and/or occlusion Power calculations 96 patients = 80% power detect a risk ratio of 1.5 (α=.05) Between group comparison: Kaplan-Meir survival curve with log rank Mantel-Cox test, Cox regression, Intention-to-treat analysis $p < .05$ indicated significance Assessment: 6 RNS overseen by principal investigator daily	Scales require 2 or more factors to determine phlebitis Occlusion defined as inability to inject or aspirate 61 cases of phlebitis and/or occlusion found in clinically indicated replacement group (87.3 events per 1,000 catheter days, 95% CI, 65.4-109.2 events per 1,000 catheter days) compared to 39 events (76.8 events per 1,000 catheter days, 95% CI, 52.7-100.9 per 1,000 catheter days) in the routine replacement group (p = .71)	Results consistent with other current studies that there is no difference in rate of complications for IVs replaced every 72–96 hr vs. those replaced only when clinically indicated as p=.71 which was greater than the set significance level of p=.05 Larger studies needed to verify results

(*Continued*)

Table 7. Continued

Rickard et al. (2010)	Non-blinded Randomized Controlled Trial Level II	Adults admitted to inpatient acute medical and surgical wards, expected peripheral IVD in-dwelling for at least 4 days Exclusion criteria: immune-suppression, current blood-stream infection, IVD already in place >48 hr, patients on pediatric, day-surgery, mental health, obstetrics, critical care, and dialysis units. Sample size calculated using PASS 2008 identi- fying sample size of n =756 (378 per group) was required for study power of 90%. Study ended early with a total at that time of n=606 which lowered the study power to 80% (required n=282 per group)	Intent to treat, Kaplan-Meir survival curve, per protocol analysis, Cox proportional hazard regression modeling with Prentice-Williams-Peterson conditional risk-set, Mann-Whitney test Composite measure due to low rates of individual outcomes was used. Hours of catheterization from insertion to removal per patient and device Number of peripheral devices inserted to complete treatment More patients in routine group with active infection (53% vs 44%) receiving abx (73% vs. 64%) Other than this two groups generally comparable	50,173 IVD hr studied (23,288 hr routine group, 26,885 hr clinical indicated group) Complication rates: 66.0 per 1,000 IVD routine vs. 67.8 per 1,000 IVD clinical; 95% CI 0.74-1.43, p = .86 Total complication rates: clinical (76/185, 41%) and routine (64/177, 36%) not significant p = .39 Rate of complications: 92/1,000 IVD days routine vs. 68/1,000 IVD days clinical, p = .16 Outcomes between groups: Phlebitis p = .34, Infiltration p = .57, Occlusion p = .75, Accidental removal p=.43 No blood stream infection found 22%; 3 or more IVD routine group compared 9%, in clinical group 28% Compliance with intervention: 78% routine group, 100% in clinical group	Cost per patient for IVD: routine group ($55.42) vs. clinical ($43.35) p<0.001 Changing policy: 1/2 patients: only need 1 IVD for treatment, with current practice: 1/5 patients Results consistent with other RCTs; 2 million courses of IV therapy were managed with clinical indication replacement; 660,000 IVD insertions avoided, 280,000 staff hr and AUD $24 million could be saved (based on Australian pricing) annually

(*Continued*)

Table 7. Continued

Rickard et al. (2012).	Non-blinded Randomized Controlled Trial Level II	5,907 IVD and 17,412 IVD days (clinical 8,693, routine 8,719) studied in total Randomization: hand-held computer program in 1:1 allocation ratio at patient hospital point of entry Inclusion: adults 18 year or older with IVD in place with expected treatment ≥ 4 days Exclusion: existing blood stream infection, planned removal of IVD in 24 hr, IVD in place >72 hr, IVs inserted in emergency situations 3,283 (1,593 clinical indication group, 1,690 routine group) med- surg patients Daily RN screening	3,283 patients in intention to treat with phlebitis occurring in 7% in both groups with absolute risk difference of 0.41% (95%CI, -1.33-2.15, within equivalence margin of 3%) Phlebitis between groups equivalent including per patient (p=.64) and per 1,000 IVD days (.67)	Rates of infiltration, occlusion, accidental removal, total infusion failure and hospital mortality similar between both groups (Table 3 p. 1070) Sample size detects equivalence at 4% phlebitis with 5% significance and more than 95% power Sample size detect equivalence at 4% phlebitis with 5% significance and more than 95% power	Medical rater: diagnosed device related infections and all blood stream infections, blinded inter-rater reliability Weakness: non-blinded 200 million IVD inserted/year if 15% needed for more than 3 days changing only when clinically indicated would prevent 6 million unnecessary IVD insertions, save 2 million hr of staff time, save $60 million in health costs Independent data and safety monitoring committee reviewed blinded data at two prior points (n=1,000 and n=2,000) and recommend trial continue
Webster et al. (2010)	Meta-Analysis Level I Evidence	8,779 device days in acute hospital setting Inclusion: IV in place for at least 3 days, any duration of IV replacement vs. clinically indicated replacement, IVD made of any material, intermittent or continuous therapy, hospitals, nursing homes, or in community Exclusions: Crossover trials,	Post hoc analysis on 4/6 trials show 11% increase in phlebitis when 2 or more signs or symptoms were used to identify phlebitis, however, not significant (OR 1.11, 95% CI 0.84 to 1.48, p=.47) 5/6 trials with a combined patient population of 3,410, the rate of phlebitis was 17% higher in the	198 research articles identified, 13 met review criteria, 6 met inclusion criteria 5/6 trials with a combined patient population of 3,410, the rate of phlebitis was 17% higher in the clinically indicated group, not statistically significant	Catheters placed by RNs and IV teams receiving continuous or intermittent infusions of all types of drugs Adequacy of randomization process, adequacy of allocation concealment Blinding, intent-to-treat analysis, completeness of follow up (% of participants whose data was included at study

(*Continued*)

Table 7. Continued

		patient receiving parenteral fluids Pretested data review form used no blinding of authorship	clinically indicated group, not statistically significant (OR 1.17, 95% CI		endpoint), unit of analysis (per patient), and Intermittent versus continuous infusion Sensitivity studies: effect of concealment of allocation, size of studies (< 100 patients versus at least 100 patients), duration of follow up, unpublished studies
Webster et al. (2013)	Meta-Analysis Level I Evidence	4,895 participants (individual trial sizes ranging between 42 and 3,283) in India, Australia and England Inclusion: Any language, IV in place for at least 3 days, any duration of IV replacement vs. clinically indicated replacement, IVD made of any material, intermittent or continuous therapy, hospitals, nursing homes, or in community Exclusion: Cross over trials, patients receiving parenteral fluids, studies performed in single site acute care centers, multicenter community setting	Used a standard definition of two or more of the following: pain, warmth, erythema, swelling, or a palpable cord Two studies further classified phlebitis as either mild, moderate, or severe depending on the area of erythema or on the number of symptoms one study included the same definitions as the other trials but scored them as either one or two depending on the severity. A score of two or more was classified as phlebitis, consequently a patient may have had only one symptom to receive a positive diagnosis no difference was found between changing IVs routinely vs. when clinically indicated, (clinically indicated 186/2,365; 3-day change 166/2,441; RR 1.14, 95% CI 0.93 to 1.39; p = .20)	Incidence of phlebitis 4,895 participants Heterogeneity of combined results 65%, after sensitivity two studies with less than 100 participants removed which eliminated heterogeneity (I2 = 0). Remaining studies (4,806 participants) results unaffected by length of infusion, continuous vs. intermittent All-cause bloodstream infection assessed by one study, no difference between changing catheters routinely vs. when clinically indicated clinically indicated costs were lower by AUD 7.00 in the clinically indicated group (MD - 6.96, 95% CI -9.05 to -4.86; p ≤ .00001) Five trials compared routine replacement and clinically indicated changes and the remaining two trials compared 48 hr changes with removal for clinical indications	Two authors independently extracted data to a pretested data extraction form with disagreements resolved by discussion and, when necessary, by a third review author Two authors also independently assessed bias in the included studies via the Cochrane Collaboration tool for assessing risk of bias. Investigators of included trials were consulted when necessary to resolve ambiguities and disagreement

Due to the nature of the intervention required, none of the participants or healthcare providers involved in these RCTs could be blinded. Nurses providing care to the patient or working on a dedicated IV insertion team, who were not associated with the trials, performed the site assessments in all RCTs. A principal investigator (Van Donk et al., 2009) and research RNs (Rickard et al., 2010, 2012) were utilized in some of the RCTs to perform patient screening and data collection. All four RCTs utilized preplanned data analyses reporting methods and discussed their study protocols in detail. All four RCTs also included the course of participants through each stage of the study and provided the intent-to-treat analysis in their study design discussions. Study protocol violations were found in one-third of the participants in the Webster et al. (2008) and Van Donk et al. (2009) studies and in 16% of the participants of the Rickard et al. (2012) study. These violations were primarily within the routine IV replacement groups and occurred when the peripheral IV catheter could not be removed or replaced within the specified 72–96 hr time frame, and reflects actual clinical conditions and practice (Webster et al., 2013). Complete data reporting was found in all four of these studies.

In the two systematic reviews selected for this study, Webster et al. (2010, 2013), the four RCTs discussed in this paper were selected for inclusion in both studies. When choosing the articles for this review, note that two authors, Rickard and Webster, are listed as secondary or primary authors on more than one article—Rickard in three (Rickard, 2010, 2012; Van Donk 2012) and Webster in two (Webster et al., 2008; Rickard et al., 2012). The potential for selection bias was considered and rejected. There was no blinding of authorship in either study and both utilized specific analysis criteria including assigning these studies to a review author who was not an author of the study. All selected studies were assessed against the following list of five criteria created by the authors, limitations in design and implementation, indirectness of evidence or generalizability of results, inconsistency of results, imprecision of results where confidence intervals were wide, and other potential biases such as manufacturer involvement. Differences of opinions on the selection of studies were settled by either consensus or referral to a third party for review. The Cochrane Collaboration tool for assessing risk of bias was utilized in both studies with differences of opinion again being settled by consensus or third-party review. Authors of both systematic reviews contacted the authors of the published and unpublished studies being considered for inclusion when additional data were determined to be needed, and all studies included in both systematic reviews provided complete data. Both reviews also acknowledged receiving grant funding for another research project unrelated to the topic of peripheral IV catheter replacement from a manufacturer of peripheral IV catheters and indicate that this manufacturer had no involvement in any part of this study. Overall, the authors of these reviews provide complete data on their selection, review, and analysis processes and have taken adequate steps to decrease the risk of bias.

DISCUSSION WITH CLINICAL IMPLICATIONS

The evidence from the four RCTs and the two meta-analysis reviewed for this study indicate no statistically significant difference in rates of phlebitis or infection for patients when having IV catheters replaced routinely compared to when clinically indicated. These findings call for a change in practice from the current guideline of the CDC (2011) that requires peripheral IV catheters to be replaced routinely every 72–96 hr for adults to replacing peripheral IV catheters only when clinically indicated. Given the strength of the evidence currently available from these studies, the existing CDC (2011) guideline for children and those with poor peripheral access requiring IV replacement only when clinically indicated, and the current practice of obtaining orders to extend IV dwell times in cases of poor access or imminent discharge, petitioning the CDC to change the guideline for adults at this point is recommended (Van Donk et al., 2009).

The guideline change for adults to peripheral catheter replacement only when clinically indicated would represent a large modification to nursing practice. IV insertions are time-consuming, unpleasant, and sometimes expensive procedures that nurses are required to perform on multiple patients daily. One study estimated that an average of 280,000 hr of staff time and AUD $24 million could be saved and 660,000 unnecessary IV insertions prevented by changing practice to IV replacement only when clinically indicated (Rickard et al., 2010). For the United States, whose healthcare costs in 2010 alone averaged $375.9 billion with an average length of hospital stay of 4.8 days, the nursing time and cost saved by the practice change could be redirected to other areas of patient care and assist in decreasing healthcare costs, (Pfunter, Wier, & Steiner, 2013). The nursing time and cost saved by the practice change could be redirected to other areas of patient care and assist in decreasing healthcare costs. Patients would benefit as the number of unnecessary, painful, and invasive IV insertions experienced during hospitalization would dramatically decrease. It is clear that in order for nurses to provide evidence-based nursing practice regarding changing IV catheters and provide patients with quality care, a guideline change must occur.

Presenting the CDC with the evidence currently available in favor of clinically indicated IV replacement for adult patients should facilitate the guideline change, especially considering the existing CDC guideline of clinically indicated IV replacement for children and patients with poor vascular access. A successful implementation of the change in practice to IV replacement when clinically indicated would ease the workload of nursing staff, decrease unnecessary, painful procedures for patients, and increase patient satisfaction.

CONCLUSIONS

Practicing IV catheter replacement only when clinically indicated does not increase patient risk of phlebitis or infection when compared to the current practice of routine replacement

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between 72 and 96 hr based on current research evidence. According to Sackett, Straus, Richardson, Rosenberg, and Haynes (2000), "Evidence-based medicine is the integration of best research evidence with clinical expertise and patient values" (p. 1). The abundance of current research in support of replacing peripheral IV catheters only when clinically indicated aligns with our clinical expertise, which affirms that exposing patients to multiple invasive procedures increases risk of infection, and patient valuation of safe, high-quality care. Some healthcare facilities have already made the change in practice to replacement of peripheral IV catheters only when clinically indicated based on the research and the culture of healthcare supporting evidenced-based practice as the accepted method to ensure patients receive safe, high-quality care.

Given the evidence and costs associated with IV insertion to patients and healthcare facilities, the CDC should change the guideline for IV replacement in the adult patient from routine to only when clinically indicated to ensure their guidelines reflect the most current evidenced-based nursing practice. **WVN**

LINKING EVIDENCE TO ACTION

- Practicing IV catheter replacement only when clinically indicated does not increase patient risk of phlebitis or infection when compared to the current practice of routine replacement between 72 and 96 hr.
- Potential cost savings for IV catheter replacement only when clinically indicated are (a) an average of 280,000 hr of staff time, (b) AUD $24 million, and (c) unnecessary IV cannulations: 660,000. For the United States, this could translate into decreasing healthcare costs which in 2010 alone averaged $375.9 billion with the average length of stay of 4.8 days.
- Rates of phlebitis and CRBSI are not substantially different in peripheral catheters left in place 72 hr compared with 96 hr in adult patients.
- Considering a change in the published guideline authored by the Centers for Disease Control and Prevention to ensure that the guidelines reflect the most current evidenced-based nursing practice is warranted.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article at the publisher's web site:

Figure S1. Rapid Critical Appraisal of Randomized Clinical Trials (RCTs)
Figure S2. Rapid Critical Appraisal of Systematic Reviews of Clinical Interventions/Treatments

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