

Peripheral IV Clinical Compendium

Letter to the Clinician

Dear Healthcare Practitioner,

Research on the prevention of central line-associated bloodstream infections (CLA-BSIs) has existed >20 years¹. In the early 2000s, these prevention interventions were packaged as evidence-based insertion and maintenance bundles. The critical importance of implementing these evidence-based CLA-BSI prevention interventions was further emphasized and highlighted in 2008 when the Centers for Medicare and Medicaid Services (CMS) began non-reimbursement for hospital-acquired vascular catheter-associated infection². Initially, these interventions were focused on central lines in intensive care unit (ICU) patients, often with dramatic results of achieving zero CLA-BSIs³. Nationwide in the United States, the Centers for Disease Control and Prevention (CDC) has estimated that from 2001 to 2008-2009, the CLA-BSI rate in ICU patients decreased by 58%, 6,000 lives were saved, and 1.8 billion dollars of excess healthcare costs were avoided⁴. Given that the pathophysiology of vascular catheter-associated infections are the same regardless of the type patient, vascular catheter—central, midline, peripheral or port, or site of insertion: namely, extraluminal or intraluminal contamination, it is logical that these evidence-based prevention intervention bundles be applied to all patients with any type of intravascular catheters.

Peripheral intravascular catheters (PIVs) are the most frequently used intravascular catheter. Recently, it has been recommended based upon several randomized controlled trials that PIVs should be replaced when clinically indicated rather than every 72-96 hrs^{5,6}. This has led to PIVs remaining in place for longer periods. Given the data showing that although the incidence of PIV infection is lower than with central lines, PIVs still are associated with serious complications, including insertion site or bloodstream infections^{7,8}. Because of this, the Infusion Nurses Society (INS) has recommended conducting surveillance for infections associated with PIVs⁹.

This compendium is intended to provide you with peer-reviewed published evidence evaluating PIV complication risk, PIV prevalence, and opportunities to improve PIV complication rates. I encourage you to consider the information presented, and to implement the recommended prevention bundle practices that best improve your clinical outcomes and best serve your patients.

Sincerely,

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Dr. William Jarvis is a paid consultant of Ethicon, US LLC.

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9. Infusion Therapy Standards of Practice, *Journal of Infusion Nursing*. 2016, V39 (1S)

Peripheral IV Clinical Compendium

This Peripheral IV (PIV) Clinical Compendium has been developed to provide clinical article summaries of established literature related to peripheral IVs. Topics include PIV bloodstream infections (BSIs), the impact of clinical indication, the importance of a PIV bundle, and improved patient experience. Each summary provided here touches on one or more of these topics with the purpose of providing a high level overview of the evidence and key takeaways within the literature.

	PIV BSI/ PVC BSI/ PLABSI	Clinically Indicated	PIV Bundle	PIV Bundle with BIOPATCH®	Improved Patient Experience	Page
Boyd 2011			X			4
DeVries 2016	X	X	X	X	X	6
Dychter 2012	X	X	X		X	8
Easterlow 2009	X		X			10
Guembe 2017	X					12
Hadaway 2012	X	X				14
Heinrich 2013	X					16
Ho 2011	X	X			X	18
Kovacs 2016	X					20
Maki 2006	X					22
Mermel 2017	X					24
Mestre 2013	X		X			26
Pien 2010	X					28
Pujol 2007	X					30
Rickard 2012	X	X	X		X	32
Rickard 2013	X	X	X	X	X	34
Sato 2017	X					35
Trinh 2011	X	X				37
Webster 2010	X	X			X	39
Zingg 2009	X	X				41

Boyd et al. 2011

Title	Peripheral Intravenous Catheters: The Road to Quality Improvement and Safer Patient Care
Author(s)	S. Boyd, I Aggarwal, M. Logan, D. Nathwani
Source	<i>Journal of Hospital Infection</i> , 2011; 77:37 - 41.
Key Takeaways	<ul style="list-style-type: none">• The care bundle approach can inspire, motivate and empower staff to improve patient outcomes in real time.• A major barrier to achieving timely removal was reluctance of nursing to remove catheters with no signs of infection

Objective

The objective of this pilot was to accomplish the following: introduce a “PVC bundle” as a tool to improve the management of PVCs; to audit compliance over a 25 week period; and to receive feedback in real time to assess the sustainability of the quality improvement measure with a long term goal of implementing the “PVC bundle” throughout a hospital system.

Methods

- Location: Ninewells Hospital, Dundee Infectious Disease Unit (IDU)
- Time Period: September 2007 through March 2008.
- Inclusion Criteria: Patients under the care of the infectious disease team (junior doctors, registrars, consultants, nurses, infection control practitioners, and nursing and medical students).
- Approach:
 - Health Protection Scotland PVC bundle in 2007 included the following elements as quality indicators for clinical performance related to PVC insertion and maintenance:
 1. Documentation of date of PVC insertion
 2. Documentation of PVC location
 3. Documentation of reason for access
 4. Documentation of insertion site appearance
 5. Documentation of daily review of necessity
 6. Timely removal of PVC (after 72 hours)
 - Senior medical students collected these data weekly on any given day for up to 5 patients
 - The “Model for Improvement”, promoted by the Institute for Healthcare Improvement, was used to help test the bundle in the ward setting.
 - The project aim was to implement a care bundle for PVCs and assess improvements resulting from changes made through using the model.
 - Plan → Do → Study → Act
 - A PDSA cycle was carried out every 4 weeks: Plan (setting targets), Do (executing interventions and data collection), Study (analyzing compliance data), Act (monthly patient safety meetings, change implementation, and preparation for the next cycle)

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- Data Interpretation and Statistical Models
 - Compliance with the bundle elements was assessed for each patient as a percentage.
 - The completion of one element was equivalent to 14.29% and the completion of all elements was equivalent to 100%.
 - Individual elements were used to measure longitudinal compliance, especially in the case when particular elements of the bundle were not achieved.
 - Results were collected using Microsoft Office Excel 2007.
 - Regression analysis was used to assess if the interventions resulted in a statistically significant overall improvement with compliance.

Outcomes Measured

- The outcome measure of this study was compliance with the bundle.

Results

- During a 25 week period, 100 PVCs were analyzed.
- Compliance with the PVC bundle elements improved gradually.
- After six months, there was 82% reliability with overall bundle compliance. This equates to an improvement of 28% over 6-months from the initial compliance rate of 54% during week 1.
- There was an improvement in the completion of the bundle by 1.11% per week (95% CI: 0.6 - 1.6%; P = 0.0001).
- Documentation of the PVC location improved significantly.
- Improvements were made in the documentation of the insertion date for the PVC, the reasons for intravenous access, the insertion site appearance, and daily reviews.
- The team did not perform as well over time with the timely removal of devices.

Study Limitations

- There was no study limitations mentioned.

Observational Study: DeVries et al. 2016

Title	Protected Clinical Indication of Peripheral Intravenous Lines: Successful Implementation
Author(s)	Michelle DeVries, Mary Valentine, Patricia Mancos
Source	<i>The Journal of the Association for Vascular Access</i> , 2016, Volume 21, Issue 2, 89 - 92
Key Takeaways	<ul style="list-style-type: none">• Clinically indicated replacement of peripheral IVs was selected over routine replacement because it can lower healthcare expenditures without involving any extra risks of complications.• As a result of the clinically indicated replacement protocol, the organization documented a 37% reduction (P= 0.03) in primary bacteremias (combining PIV and central line-associated bloodstream infections) and a 19% reduction in PIV bloodstream infections.• CLABSI standardized infection ratios for the publicly reported intensive care units decreased from 1.3 to 0.32 (P= 0.02).• IV start kit use decreased 48% during the year following bundle implementation.• Using an evidence based approach allowed for the adoption of the latest standards while taking proactive steps to mitigate risk proved to be a successful strategy.

Study Objective

To develop an insertion bundle to support the safe implementation of a policy of extended dwell time of inpatient peripheral intravenous lines (PIVs). The main objectives were to have fewer IV restarts with no increased bloodstream infection risk.

Methods

- Infection control and the nursing staff collaborated with key stakeholders to identify any concerns or barriers.
- Materials management collaborated in developing IV start kits for use by bedside staff in a community hospital that met the goal of extended dwell time, utilizing products that addressed concerns regarding safe insertion, and maintenance of a protected, intact dressing.
- Components of the Protected Clinical Indication Bundle included:
 - Chlorhexidine gluconate skin prep
 - Sterile gloves
 - Intravenous catheter with integrated extension set
 - Chlorhexidine gluconate-impregnated sponge dressing
 - Securement dressing
 - Alcohol disinfection caps
- The elements of the bundle were driven by internal evaluation of practices through direct observation.
 - PIV insertions were observed.
 - Staff huddles were conducted when an infection was identified.
 - Infection control, a nurse educator, and unit champions rounded on patients with PIVs, observing dressing integrity and the presence of blood in the connectors.
- Existing professional standards and literature were reviewed.
- Education was conducted to help staff become more confident and competent in implementing the changes made to the products being utilized.

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- The hospital is composed of 2 hospital facilities. Implementation was launched at one site and then the other one month later.
- Bloodstream infection surveillance was conducted following the Centers for Disease Control and Prevention National Healthcare Safety Network protocols.
- Bloodstream infections meeting the Laboratory Confirmed Bloodstream Infection event definitions were reviewed to determine which line types were present in the days before the infection.
- Infections with only peripheral access were categorized as PIV-associated bloodstream infections using the same requirements for CLABSIs.
- A statistical analysis to assess the influence of the policy was conducted at 12 months (February 2014 - January 2015).
- At 18 months, a further review was done to assess whether the policy resulted in practice changes at the bedside.

Outcomes Measured

Primary outcomes

- Fewer IV starts
- No increase in bloodstream infections

Secondary outcomes

- Successful implementation at the bedside level

Results

- At 12 months the surveillance data for primary bacteremia, which included central and peripheral lines, showed a 37% reduction (P =0.03).
- There was a 19% reduction in PIV related bloodstream infections.
- Standardized infection ratios for CLABSI in the intensive care units improved from 30% to 68% fewer infections (P=0.02).
- 35% of PIVs placed were remained in situ for 5 days or longer.
- Average dwell time was 4.2 days
- IV start kits used decreased by 48% the year following implementation, indicative of successful policy implemented at the bedside.

Study Limitations

- There is a lack of continuous surveillance for other vascular access indicators such as phlebitis, occlusion, and infiltration.
- Usage of surveillance definition may over represent the incidence of infections because there is no definitive link to the device required in the Centers for Disease Control and Prevention protocols.

Review Article: Dychter et al. 2012

Title	Intravenous Therapy. A Review of Complications and Economic Considerations of Peripheral Access
Author(s)	Samuel S. Dychter, David A. Gold, Deborah Carson, and Michael Haller
Source	<i>Journal of Infusion Nursing</i> 2012; 84 -91
Key Takeaways	<ul style="list-style-type: none">• US hospitals and clinics purchase 150 million intravascular devices annually.• Complications of IV therapy can be costly and can have an effect on the patients' quality of life, morbidity, mortality, and treatment expense.• Nurses' knowledge and skill in providing IV therapy can minimize complications and affect patient safety, satisfaction, health care costs, and length of stay.

Objective

To review the use of the IV route for administering therapy, to identify and analyze key risks and complications associated with achieving and maintaining peripheral access, examine measures to reduce these risks and discuss implications for nurses.

Definitions and Relevant Information Summary

Use of the IV Route for Administering Therapy

- IV therapy assures that prescribed medication is delivered directly into the systemic circulation for 100% bioavailability and avoids the need for absorption, problems with malabsorption or drug inactivation by the gut.
- There are 3 types of peripheral IV (PIV), each with their respective risks and benefits:
 - Bolus Injection
 - Intermittent Infusion
 - Continuous Infusion

Factors that can complicate the process of establishing IV access:

- Aging veins, obesity, dark skin color, IV drug abusers, individuals with multiple injuries, and hypotensive individuals can all pose problems for establishing venous access.
- The small size and fragility of pediatric patients also pose problems for establishing venous access.

Complications Associated with IV Therapy

- Phlebitis (inflammation of the wall of a vein)
 - Incidence ranges from 20% - 75%
 - Risk factors include being female, having poor quality veins, lower extremity insertion, cancer, immunodeficiency, catheter gauge and material
 - Newer polyurethane catheters have been associated with 30-50% decrease in phlebitis compared to Teflon catheters
- Thrombophlebitis (when a blood clot in the vein causes inflammation)
- Infiltration and Extravasation
 - Infiltration (inadvertent leakage of a nonvesicant solution into surrounding tissue)
 - Extravasation (inadvertent leakage of a vesicant solution into surrounding tissue)
 - Mechanical , physiologic and pharmacologic factors
 - Incidence difficult to determine

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- Infections
 - Range from local site infection to bloodstream infections
 - Risk factors include patient age, immunocompromise, immunosuppression, lower extremity insertion, large gauge catheter, Teflon catheter, and insertion in ER.
- Nurse skill levels, experience, and knowledge
 - Certified Registered Nurse Infusion credential - nationally accredited certification

Economic Considerations

- Infusion-related complications can significantly impact health care costs and extend a hospital patient's length of stay.

Liability Issues

- Failure to monitor and assess the patient's clinical status, take precautionary measures to prevent infection, use equipment properly, or protect the patients from avoidable injury can all result in serious legal issues for nurses.

Study Limitations

- Not applicable

Review Article: Easterlow 2009

Title	Implementing and Standardizing the Use of Peripheral Vascular Access Devices
Author(s)	Dean Easterlow, Phill Hoddinott, and Stephanie Harrison
Source	<i>Journal of Clinical Nursing</i> 2009; 19: 721 - 727
Key Takeaways	<ul style="list-style-type: none">• A change in approach to management of peripheral cannulae resulted in a decline in reported cases of peripheral cannula-related healthcare associated infections; including MRSA bacteremia.• The change initiative included implementation of both policy changes and product changes to reduce risk of infection and increase safety.• Although the product change required increased investment, a cost advantage was seen by reducing the expense associated with treating infections.

Study Objective

The objective was to assess the impact of a change initiative designed to reduce the incidence of peripheral line-related infections.

Methods

- The article describes a “top-down” change initiative program designed to reduce the incidence of peripheral line-related infections which took place in a 500 bed teaching hospital (St. Mary’s Hospital, London, UK) between November 2006 and January 2008.
- A taskforce was developed to implement the “Saving Lives Program”. The focus was to utilize best practices to reduce peripheral line infection rates.
- A baseline audit was conducted in December 2006. The objectives were as follows:
 - To understand the quality of peripheral line care across departments in the hospital
 - To review the completeness of documentation related to peripheral line care
 - To assess the appropriateness of peripheral lines in patients subject to audit
 - To review devices used to administer treatments
 - To consider the need to develop clear guidance for staff
 - To consider a specific, targeted education program for individuals responsible for inserting and maintaining peripheral lines.
- The audit was led by the Heads of Nursing and included data collection and observational techniques and involved reviewing patients’ medical records and nursing records as well as a review of devices used for administering treatments.
- The inclusion criteria consisted of patients with peripheral lines at the time of the audit in all 26 clinical areas including Accident & Emergency.
- Baseline audit findings:
 - The intravenous management was found to be very poor.
 - Cannulae were left in situ too long.
 - Insertion sites were poorly selected.
 - Phlebitis was not consistently monitored.

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- Final change initiative program recommendations:
 - Identify new cannulae that would be non-ported, needle-safe and without 3-way taps and lure locks to increase safety and decrease risk of infection.
 - Use 2% CHG in 70% alcohol for injection site disinfection.
 - Develop a new cannulation policy and perform monthly audits
 - Implement an intensive educational program addressing use of the new cannulae and policy.
 - Develop charts to reflect patients' cannulae insertion and removal dates and their Visual Infusion Phlebitis scores. The VIP score ensures consistency and comparability.
 - Recommendations were approved in March 2007. A new cannula device was selected to meet the needs of most of the hospital and introduced into practice in May 2007.
- Subsequent audits were performed in February, July and December 2007.

Outcomes Measured

- The incidence of healthcare acquired infections (HCAI) before and after the change initiative program.
- Audits of compliance with the new cannulae policy.

Results

- In the 8 months prior to the introduction of the new cannulae, there were 30 reported cases of Methicillin Resistant *Staphylococcus aureus* (MRSA) bacteremia with 17 classified as HCAIs. Nine of the seventeen were classified as cannulae related.
- In the 8 months after the introduction of the new cannulae, there were 14 cases of MRSA with 11 classified as HCAIs. Of these 11, 4 were definitely and 2 possibly cannulae-related.
- The number of reported MRSA and HCAI cases decreased by 53% and 35% respectively after the change initiative.
- Prior to the change initiative there were 15 cannula-related needle stick injuries and only one (unrelated to cannulae) after.

Repeat audits were performed in February 2007 (n=107), July 2007 (n=161), and December 2007 (n=108). During each audit, peripheral cannulae sites are inspected and practices observed by nurses. *Note: new cannulae were introduced in May 2007.*

- Documented evidence of cannulae replacement at 72 hours or rationale for leaving in place was available for 77% of patients in December 2006; 47% in February 2007; 67% in July 2007 and 49% in December 2007. The variability in results indicated a lack of clarity with respect to this documentation change and was targeted for improvement.
- A documented indication for continuing cannulae use was recorded in 84% of cases in December 2006; 75% in February 2007; 88% in July 2007; and 69% in December 2007. This variability was addressed by adding a new question to the audit tool.
- The percentage of patients without phlebitis was 94% in Feb 2007; 68% in July 2007 and 100% in December 2007. The lower rating in July was attributed to awkward wording of the question which was corrected for the next audit.
- The percentage of clean and secure dressings was consistently high: 90% in February 2007; 94% in both July and December 2007.
- Cannulae were replaced every 72 hours in 38% of cases in February 2007; 71% in July 2007 and 51% in December 2007.

Study Limitations

- Documentation is a primary concern as it relates to insertion sites, daily site assessments, and labeling of lines with dates and times and evidence of cannulae being replaced every 72 hours.

Prospective Observation Cohort: Guembe et al, 2017

Title	Nationwide study on peripheral-venous-catheter-associated-bloodstream infections in internal medicine departments
Author(s)	M. Guembe, M.J. Pérez-Granda, J.A. Capdevila, J. Barberán, B. Pinilla, P. Martin-Rabadán, E. Bouza et al.
Source	<i>Journal of Hospital Infection</i> (2017), 97(3): 260-6
Key Takeaways	<ul style="list-style-type: none">• The use of peripheral venous catheters (PVCs) has increased outside intensive care units, as has the rate of PVC-associated bloodstream infections (PVC-BSI).• Peripheral venous catheter bloodstream infections (PVC-BRIs) are still a major problem in internal medicine departments (IMDs).• Mandatory education and preventative measures are imperative to reduce the rate of PVC-BRIs and associated comorbidities, and cost.• Phlebitis rates were low at 62.9% supporting the observation that phlebitis is not a good indicator for bacteremia.

Study Objective

To assess the incidence of PVC-BSI detected in (IMD) in Spain.

Methods

- A multicenter prospective observation cohort study in 14 Spanish IMDs from June 2015-June 2016.
- Inclusion criteria included adult patients over the age of 18 admitted to an IMD with at least one PVC and significant bloodstream infection (BSI) due to PVC-BSI.
- The demographic and clinical data consisted of age; sex; Charlson Comorbidity Index; severity of sepsis; phlebitis; septic complications (septic metastasis, renal failure); days of antibiotic therapy; extra days of hospitalization; mortality; catheter tip culture; catheter indwelling time; catheter insertion site; location of catheter insertion; need for a catheter; and use of needleless connectors.
- All centers followed standard recommendations regarding prevention of infection related to catheter insertion and care.
- All removed catheter tips were included in the analysis regardless if they were sent for culture.

Outcomes Measured

The incidence of PVC-BSIs including patient demographics, catheter dwell time, etiology of PVC-BSIs, and risk factors for *S. aureus* PVC-BSI and phlebitis in the study population.

Results

- Seventy episodes of PVC-BSI occurred in 70 patients with a PVC-BSI rate of 1.64 episodes per 1000 IMD admissions and an estimated 0.28 PVC-BSI episodes per 1000 catheter days.
- Phlebitis was not present in 37.1% of the episodes.
- The mean age was 67.4 years with 60% being men.
- The median catheter dwell time was 6 days with 27.1% were inserted for \leq 96 hours.
- Most PVCs were inserted in the arm (34.3%) followed by the elbow flexure (25.7%).

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- Twenty-six PVCs (37.1%) were inserted in the emergency department. Twenty two of the 26 catheters (84.6%) that had been inserted in the ER were associated with phlebitis (OR of 5.44, P =0.009) which proved to be a independent predictor of catheter insertion in emergency departments.
- Microorganisms isolated included Gram-positive, 87.5%; Gram negative, 11.1%; and yeasts, 1.4%. *S. aureus* was the most frequently isolated micro-organism (41.7%), followed by *Staphylococcus epidermidis* and other coagulase-negative staphylococci (28.5%).
- Of the *S. aureus* bacteremia 21.0% were caused by methicillin-resistant *S. aureus* (MRSA).
- Only 37 (52.9%) out of the 70 catheter tips were sent for culture, of which 26 corresponded to microbiologically confirmed PVC-BSI episodes.
 - Isolated in the positive PVC tips were: *S. aureus*, 42.9% (26.7% MRSA); *S. epidermidis* and other coagulase-negative staphylococci, 25.0%; *Enterococcus faecalis*, 10.7%; *Klebsiella pneumoniae*, 10.7%; *Pseudomonas aeruginosa*, 7.1%; and *Candida albicans*, 3.6%.
- There were no risk factors associated with *S. aureus* PVC-BSIs. The only difference between *S. aureus* PVC-BSIs and non-*S. aureus* PVC-BSIs was the days of antibiotic therapy (43.01 vs 26.58. P < 0.001).
- Of the 70 episodes of PVC-BSIs, 25.1% of the PVC were no longer needed.

Study Limitations

- The data is limited to older patients admitted to IMDs from hospital with < 500 beds.
- Despite being a study requirement, 47.1 % of the removed PVC tips were not sent for culture.

Systematic Review: Hadaway 2012

Title	Short Peripheral Intravenous Catheters and Infections
Author(s)	Lynn Hadaway
Source	<i>Journal of Infusion Nursing</i> 2012;35(4): 230 - 240
Key Takeaways	<ul style="list-style-type: none">• While bloodstream infection rates associated with peripheral intravenous catheters is low, these rates should be compared against the number of these catheters used and may be underestimated due to short dwell times and early patient discharges.• There are significant knowledge gaps and inadequate clinical practices associated with these devices and the healthcare community needs more research on PIV infections to enhance its knowledge of rates, pathophysiology and appropriate prevention strategies.

Study Objective

The objective of this systematic literature review was to assess the published information regarding short peripheral venous catheters and infections.

Methods

- A systematic literature review was conducted with an integrative approach to evaluate studies of all designs.
- The search period consisted of January 2000 through June 2011.
- Search terms included: peripheral catheter; peripheral IV catheter; peripheral venous catheter; peripheral IV catheter insertion, venipuncture; peripheral catheter complication; peripheral catheter and infection/phlebitis, bacteremia and catheter; and bloodstream infection and catheter.
- Databases searched were: Medline; Ingenta, CINAHL; and Google Scholar.
- The search produced 1400 references of which 588 were examined in depth.
- The criterion to be included in the review was any article that included data or discussion of any type of infection associated with short peripheral catheters.
- Articles excluded from the review were those that included data only on central venous access devices or chemical and mechanical causes of phlebitis.

Outcomes Measured

The outcomes measured were possible causes, outcomes, and prevention methods for all infectious complications associate with short peripheral catheters.

Results

- 46 studies were identified as relevant. Abstracted outcomes data from these studies are available in tabular format at www.hadawayassociates.com/OutcomeData.pdf.
- Major themes, trends and issues from the studies are discussed.
- Types of Infections
 - Many types of infections are associated with short peripheral catheters including cellulitis, soft tissue infections, osteomyelitis, phlebitis, thrombophlebitis, suppurative thrombophlebitis, bloodstream infection or bacteremia.
 - Clinical signs and symptoms for these overlap making correct identification difficult without additional diagnostic tools.

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- Pathophysiology of the Infections
 - The most likely mechanism of BSI is colonization of the catheter tract followed by biofilm formation which may occur during catheter insertion or subsequent manipulation. The most prevalent pathogen is *S. aureus*.
 - Phlebitis has chemical, mechanical and bacterial causes.
- Infection Rates
 - Strongest evidence is from a systematic literature review dividing peripheral IV catheters into 3 groups of plastic catheters, steel needles, and venous cut-down. Plastic PIV catheters had lowest BSI rates (0.1 per 100 devices; 0.5 per 1000 device days).
- Issues which impacted the risk of bloodstream infections from peripheral catheter insertion and use included catheter design; skin antiseptics used; the inserters' experience inserting the catheters; the patients' predisposition to phlebitis; the use of vein visualization technology such as ultrasound when inserting catheters; catheter stabilization; patient age differences; health care settings; and changes in standards and guidelines).

Study Limitations

- The search was limited in scope and did not include larger biomedical literature databases such as Scopus, EMBASE, or BIOSIS Previews.
- The multitude of variables and study designs of the 46 studies leave numerous unaddressed issues and unanswered questions.

Heinrich et al. 2013

Title	Prospective Pilot Study on the Incidence of Infections Caused by Peripheral Venous Catheters at a General Surgical Ward
Author(s)	Ines Heinrich, Stephan Geßner, Christian Wegner, Claus-Dieter Heidecke, and Axel Kramer
Source	<i>GMS Hygiene and Infection Control</i> 2013; 8(1): 1 -5.
Key Takeaways	<ul style="list-style-type: none">• It is vital that health care practitioners and students are sufficiently trained on hygienic measures on a consistent basis.• Sufficient training on hygienic measures should be provided to medical students prior to their practical year to assure uniform hygienic standards.

Study Objective

The study objective was to assess the incidence of infections in peripheral venous catheters (PVC) and the possible sources of contamination.

Methods

- Study type: Prospective, observational
- Location: General surgical ward of a university hospital
- Time Frame: July 16 - November 17, 2012
- Patient Population: 89 adult patients (51 male aged 32 - 82 and 38 female aged 27 - 84) who received placement of a PVC from a hospital ward staff member.
- The Institute of Hygiene and Environmental Medicine, Greifswald developed an infection data collection form in adherence to the Centers for Disease Control standards for infections.
- Data was collected on the patient until the PVC was removed and if the same patient had to have another PVC inserted; new data would be collected on a new form.
- Patient data documented: identifier; sex; age; ward; date of admission; date of discharge; date of insertion of the device; localization of the device; removal date of the device; cause for the removal of the device; person collecting the data; and the serial number of the infection data form.
- Devices were recorded as "infectious" if the PVC was in situ 48 hours before the onset of symptoms or if the time interval between the removal of the PVC and the onset of the symptoms was at a maximum of 48 hours.
- Data forms were collected once a week and compared for accuracy with the patient medical records.
- The incidence rate was computed on a base of 1000 as follows:
 - $I=N/P$ (Incidence = number of new cases/persons at risk)

Outcomes Measured

- The outcome measured was the incidence of infections.

Results

- A total of 89 PVCs were inserted in the designated time frame.
- A total of 43% (38) PVCs were inserted in women and 57% (51) in men.

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- Infection was found in 20 of the inserted PVCs (7 women and 13 men).
- Calculated incidence rates were as follows:
 - July = 0.09 which was equivalent to 1 infection out of 11 patients
 - August = 0.08 which was equivalent to 3 infection out of 37 patients
 - September = 0.22 which was equivalent to 5 infection out of 23 patients
 - October = 0.69 which was equivalent to 11 infection out of 16 patients
 - November = 0 which was equivalent to 0 infection out of 2 patients
- The infection rate increased significantly between September and October.
- It was observed that students in their second trimester were more knowledgeable regarding proper insertion and hygiene as it relates to inserting PVCs and more infections were detected when students were in the first trimester as opposed to their second trimester. It was also observed that there were fewer infections when advanced students assisted the first trimester students.

Study Limitations

- Once the infection data form was introduced, the numbers of reported peripheral venous catheters were low in the first few months due to the lack of continuous instruction on hygienic precautions.
- The medical student compliance rate in the practical year was not considered satisfactory.

A Discursive Paper: Ho et al. 2012

Title	Guidelines on timing in replacing peripheral intravenous catheters
Author(s)	Ken HM Ho and Daphne SK Cheung
Source	<i>The Journal of Clinical Nursing</i> Volume 21, Issue 11-12, June 2012
Key Takeaways	<ul style="list-style-type: none">• Replacing peripheral intravenous catheters when clinically indicated is recommended over routine replacement.• Clinically indicated replacement of peripheral intravenous catheters resulted in lower healthcare expenditures without adding any extra risk of complications.• Clinically indicated replacement spares patients from unnecessary pain.

Study Objective

To develop clinical guidelines on the timing of replacing peripheral intravenous catheters in order to decrease complications and lower healthcare expenditures.

Methods

- The five-stage evidence-based healthcare model of Dawes et al. (2005) was utilized to guide the development of this guideline.
- A systematic review of the Cochrane Library was conducted utilizing the search terms, intravenous, infusion, infection, and timing. No time limits were set in the search.
- Eight review articles from 2008-2011 were identified. Seven of these were excluded.
 - Five excluded due to the focus on specific disease states
 - One due to the focus on neonates
 - One examined the results of changing the entire intravenous administration set
- A recent systemic review by Webster et al. (2010) was identified and used in formulating these clinical guidelines
 - Included 6 randomized controlled trials that compared routine replacement of peripheral IVs with clinically indicated replacement in patients in the hospital or community setting
 - All studies were assessed for quality by 3 independent reviewers
 - Inclusion criteria was patients requiring a peripheral IV for at least 3 days and undergoing intermittent or continuous therapy
 - Patients requiring parenteral nutrition or central venous catheters were excluded

Outcomes Measured

- Outcomes were phlebitis, CRBSI, blockage, infiltration, cost and local infections.

Results

- Phlebitis
 - Defined on two or more of the following symptoms pain, tenderness, warmth, erythema, swelling, and a palpable cord
 - The incidence increased by 24% in the clinically indicated group as compared to the routine replacement group. However, this was not significant (OR: 1.24; 95% CI, 0.97-1.60; p = 0.09).

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- CRBSI
 - Bacteremia during or up 48 hours after removal of the IV without an explainable source of infection
 - The incidence in the clinically indicated group led to a 43% decrease in CRBSI. This was not statistically significant (OR: 0.57; 95% CI, 0.17-1.94; p =0.37).
- Blockage
 - The inability to infuse or aspirate fluid through the IV.
 - Blockages increased significantly in the clinically indicated group (OR: 1.64; 95% CI, 1.05-2.56; p = 0.03).
- Infiltration
 - Intravenous fluid seeps into the interstitial compartment, causing swelling at the insertion site
 - There were no significant differences between the 2 groups (OR: 1.13; 95% CI, 0.19-1.42; p = 0.28)
- Cost
 - A significant cost reduction was achieved in the clinically indicated group (p = 0.0001)
- Local Infections
 - No significant difference was found between the groups

Recommendations

- Replacing peripheral IVs when clinically indicated is recommended over routine replacement
 - To prevent CRBSI, phlebitis, blockages, infiltration and local infections, peripheral IVs do not need to be routinely replaced
 - The clinically indicated replacement of intravenous peripheral catheters is safe for patients
 - The clinically indicated replacement of intravenous peripheral catheters can reduce the financial burden on organizations
- Daily and random checking of peripheral catheter should be carried out
 - Replace the peripheral intravenous catheter if phlebitis, blockage, infiltration or local infection is found.
 - Daily and random checking should continue to ensure a continuous evaluation
- Review clinical guidelines every 5 years
 - Education on guidelines for implementation
 - Clinical audits
 - Systematic review of outcomes and literature
 - Review of clinical guidelines and revise based on outcomes and literature review

Retrospective Review: Kovacs et al. 2016

Title	Hospital acquired <i>Staphylococcus aureus</i> primary blood stream infection: A comparison of events that do and do not meet the central line-associated bloodstream infection definition
Author(s)	Christopher S. Kovacs, Cynthia Fatica, Robert Butler, Steven M. Gordon, Thomas G. Fraser
Source	<i>American Journal of Infection Control</i> , doi:10.1016/j.ajic.2016.03.038
Key Takeaways	<ul style="list-style-type: none">• Primary <i>Staphylococcus aureus</i> (SA) hospital acquired blood stream infection (HABSI) was associated with significant 30-day and 1 year mortality.• Complicated SA HABSI was significantly more common in the non-CLABSI group.• The importance of non-device related HAIs and the benefits of HABSI surveillance beyond events that only meet the definition for CLABSI.• No line is risk free and vigilance is required with any vascular access placement.

Study Objective

To describe the incidence and outcomes of primary HABSI secondary to SA that did and did not meet the National Healthcare Safety Network's (NHSN's) definition for central line-associated bloodstream infection.

Methods

- A retrospective analysis was performed on all patients diagnosed with SA HABSI at the Cleveland Clinic from January 1, 2010 - December 31, 2013.
- Charts were reviewed to obtain the primary nature of each infection, key demographics, and clinical information.
- An HABSI was classified as primary or secondary as per the NHSN's definition.
- Primary HABSI was further evaluated to determine if the definition for CLABSI was met.
- All primary HABSI that did not meet the definition of CLABSI was considered non-CLABSI.
 - The potential portal of entry was determined by chart review
 - A PIV or midline catheter was considered the portal entry if the clinician documented signs of infections or purulent material from the insertion cultured positive.
- Demographics, microbiologic data, and outcomes of infection were collected and compared between the CLABSI and non-CLABSI group.
- The Charlson Comorbidity Index scores were calculated for each patient based on the degree of medical comorbidity and compared for each group as proxies for overall illness.
- Differences between CLABSI and non-CLABSI distributions of categorical and continuous measures were examined for significance using either the χ^2 or Fisher exact test as appropriate.
- Univariate Cox proportional hazard models were constructed to look for significant univariate correlations between categorical and continuous measures and survival to 30 and 365 days.

Outcomes Measured

Primary outcomes

- Mortality at 30 days
- Mortality at 1 year
- The presence of complicated bacteremia and the need for operative intervention secondary to the HABSI
 - Bacteremia was considered complicated if it was associated with cardiac implantable electrophysiologic device infection, vertebral osteomyelitis, or infective endocarditis.

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Results

- A total of 122 primary SA HABSIs were identified; 78 (64%) were CLABSI and 44 (36%) non-CLABSI.
- Twenty-six non-CLABSIs had documented evidence of either an infected PIV (n = 16) or a midline catheter (n = 10). The remaining 18 non-CLABSI events occurred in the presence of a PIV.
- The mean time from admission to the first positive blood culture was significantly shorter in the non-CLABSI group (6 vs. 16.3 days, P = .001).
- The mean Charlson Comorbidity Index scores were similar between the non-CLABSI (95% CI; 1.1-9.1) and CLABSI groups (95% CI, 1.8-8.4).
- Infection disease consultations were similar in both groups (82.1% CLABSI vs. 86.4 % non-CLABSI, P = .54).
- Overall, 30-day and 1-year mortality in the cohort were 21.3% and 38.5%, respectively.
 - Thirty day mortality was 21.8% (CLABSI) vs. 20.4% (non-CLABSI), P=.90
 - One year mortality was 39.7% vs 36.4% (P = .70) in CLABSI and non-CLABSI groups, respectively.
- Complicated SA HABSIs was significantly more common in the non-CLABSI group (15.9% vs 0%, P ≤ .001).
- An additional analysis was done comparing only the PIV and midline infections with the CLABSI group and no difference in mortality was noted, but overall more complicated infections were seen (11.5% vs 0%, P = .010).

Study Limitations

- This was only a single center study with a high case mix index, such that the findings may not be generalizable to all settings.
- This was retrospective in nature and events could have been misclassified as not having secondary source of bacteremia when one did exist.
- Further misclassification of transfer patients as non-CLABSI was also possible because the authors were not able to verify whether the patient had a central line during their admission.
- National Healthcare Safety Network's paradigm to classify the events provided a consistent working approach; the limitations of these definitions in their ability to accurately represent clinical events may have also resulted in misclassification of certain HABSIs as primary.

Systematic Review: Maki et al. 2006

Title	The Risk of Bloodstream Infection in Adults With Different Intravascular Devices: A Systematic Review of 200 Published Prospective Studies
Author(s)	Dennis G. Maki, Daniel M. Kluger, and Christopher J. Crnich
Source	<i>Mayo Clin Proc.</i> 2006; 81(9): 1159 - 1171
Key Takeaways	<ul style="list-style-type: none">• All types of IVDs pose a risk for IVD-related bloodstream infection.• It is more meaningful to express the risk of IVD-related BSI as BSI per 1000 IVD-days as opposed to per 100 IVDs.• When risk was expressed as BSIs per 1000 IVD-days, the highest rates were seen with peripheral IV catheters placed by surgical cut down (9 per 1000 device days). Rates for peripheral IV catheters when expressed as BSI per 100 IVD was 0.1%.

Study Objective

To determine the relative risks of various intravascular device (IVD)-related BSI, which can be used for decision making in the selection of IVDs and for benchmarking.

Methods

- A MEDLINE search was conducted identifying prospective studies on adults published between January 1, 1966 and July 1, 2005.
- The search strategy included bacteremia or septicemia or bloodstream infection and the specific type of intravascular device.
- Citations of reviews of IVD-related BSI published since 1973 were also identified and reviewed for relevance.
- The inclusion criteria used for study analysis comprised the following:
 - A description of the exact type of device studied
 - Prospective collection of all data on IVD-related BSI
 - Criteria for determining the presence of intravenous device (IVD)-related BSI was clearly specified
 - The study used criteria in alignment with that of the Centers for Disease Control (CDC) and the National Nosocomial Infections Surveillance System
 - The duration of device implantation in the study population is reported or can be determined from the data provided permitting quantification of risk
- Subgroup Analyses
 - For short term percutaneously inserted devices, outcomes for 3 subgroups were compared:
 - All studies including those meeting only the most minimal CDC criteria.
 - Studies where the assessment of IVD-related bloodstream infection (BSI) required microbial concordance between a culture of a segment of the removed catheter and a separate percutaneously drawn blood culture but the study protocol did not require culturing of removed devices in the study population unless there was clinical suspicion of infection.
 - Studies in which *all* of the devices were removed and cultured for evidence of colonization *and* criteria for IVD-related BSI required microbial concordance between a culture of the removed device and a separate percutaneously drawn blood culture.
 - For long term surgically implanted devices, outcomes of two subgroups were analyzed.
 - All studies including those that met minimal CDC criteria.

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- Studies in which the definition of IVD-related BSI required microbial concordance between a culture of the removed device and a separate percutaneously drawn blood culture or a 5-fold or greater differential quantitative positivity between paired quantitative blood cultures drawn from the IVD and from a peripheral vein or a quantitative blood culture from the device grew more than 1000 colony-forming units.

Outcomes Measured

Statistical Analyses

- The best estimates of the risk of IVD-related BSI for each type of IVD were calculated from the pooled rates of all studies that met inclusion criteria.
- Each study was weighted by the relative sample size in the IVD group
- The pooled rate was identical to the weighted mean and the data was reported in terms of the pooled rate for all studies of each device and expressed per 100 devices and per 1000 device days with 95% confidence intervals calculated using Microsoft Excel and SAS.

Results

- A total of 200 studies that prospectively examined the risk of IVD-related BSI with peripheral intravenous catheters and steel needles, midline catheters, arterial catheters for hemodynamic monitoring, PA catheters, PICCs, nonmedicated CVCs, medicated CVCs, short term non-cuffed and nontunneled hemodialysis CVCs, long-term cuffed and tunneled hemodialysis catheters, cuffed and tunneled all purpose Hickman-like CVCs, central venous ports, peripheral subcutaneous central venous ports, left ventricular assist devices, and intra-aortic balloon pumps fulfilled criteria for inclusion in the analysis.
- When risk was expressed as BSIs per 100 devices, the highest rates of infection were with percutaneous left ventricular assist devices (26.1%), surgically implanted cuffed and tunneled all-purpose CVCs (22.5%), and cuffed and tunneled hemodialysis catheters (21.2%).
- Infection rates were lower with temporary noncuffed hemodialysis catheters (8.0%), silver impregnated CVCs (5.2%), noncuffed but tunneled CVCs (4.7%), noncuffed and nontunneled CVCs (4.4%), benzalkonium chloride-coated CVCs (4.3%), silver iontophoretic CCs (4%), peripheral subcutaneous central venous ports (3.6%), outpatient PICCs (3.5%), intra-aortic balloon pumps (3.0%), chlorhexidine-silver sulfadiazine-impregnated CVCs (2.6%), inpatient PICCs (2.4%), PA catheters (1.5%), minocycline-rifampin-impregnated CVCs (1.0%), arterial catheters (0.8%), midline catheters (0.4%), and peripheral IV catheters (0.1%).
- When risk was expressed as BSIs per 1000 IVD-days, the level of risk differed substantially. The highest rates were seen with peripheral IV catheters placed by surgical cut down (9.0 per 1000 IVD-days), peripheral steel needles (8.6), intra-aortic balloon pumps (7.3), benzalkonium chloride-coated CVCs (4.8), short-term noncuffed hemodialysis catheters (4.8), silver impregnated CVCs (4.7), PA catheters (3.7), and silver iontophoretic CVCs (3.3).
- Risk estimates of the IVD-related BSI in the subgroups of studies of short-term devices using the most rigorous study design for determination of infection differed only slightly from the overall group of prospective studies of each device.
- For the long-term IVDs, the pooled estimates of the risk of IVD-related BSI with cuffed and tunneled CVCs were approximately 30% lower when studies requiring microbial concordance between a culture of the explanted device and peripheral blood cultures or a differential count greater than 5-fold in paired quantitative blood cultures or more than 1000-colony forming units of growth from an IVD-drawn quantitative blood culture were analyzed.

Study Limitations

- The study limitations include heterogeneity of patient populations; protocols for catheter insertion and site care; and manufacturers' devices used in the studies analyzed.
- The criteria used for defining IVD-related BSI were different throughout the studies.
- Due to various degrees of illness severity, a particular type of device may be associated with a higher risk of infection if used preferentially in a more critically ill or vulnerable patient population.
- Confounding factors could not be adjusted.

Systematic Review: Mermel, 2017

Title	Short-term Peripheral Venous Catheter-Related Bloodstream Infections: A Systematic Review
Author(s)	Leonard A. Mermel
Source	<i>Clinical Infectious Diseases</i> (2017), 65(10), 1757-1762 DOI 10.1093/cid/cix562
Key Takeaways	<ul style="list-style-type: none">• The incidence of PVC-related bloodstream infection (PVCR-BSI) was 0.18%.• Short-term peripheral venous catheters (PVCs) accounted for a mean 6.3% and 23% of nosocomial BSIs and nosocomial catheter-related BSIs.• A PVC dwell time > 3 days increases the risk of PVC colonization and PVCR-BSIs.• Prolonged dwell time and insertion of PVCs by ambulance or emergency services increased the risk of PVCR-BSIs.• PVCR-BSIs due to <i>Staphylococcus aureus</i> attributed to a greater mortality.

Study Objective

To determine the magnitude of bloodstream infections (BSIs) related to the use of short-term peripheral venous catheters (PVCs). To compare the risk with such infections such as infections due to central venous catheters (CVCs). To clarify the impact of PVC dwell time on the risk of PVC colonization and PVC-related bloodstream infection (PVCR-BSI).

Methods

- The Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines were followed.
- A PubMed search was conducted using search terms "*Staphylococcus aureus* bacteremia" AND "peripheral intravenous catheter" as well as "peripheral intravenous catheter" AND "bacteremia" from Jan 1, 1980 to Jan 1, 2017.
- Bibliographies from the above search were reviewed.
- Articles from the author's file of publications were also reviewed.
- Exclusion criteria included pediatric studies, studies solely using steel needle PVCs, and studies in the homecare setting.
- Only short-term PVCs were included; other PVCs such as midline catheters and peripherally inserted CVCs were excluded.

Outcomes Measured

- Risk of PVCR-BSIs
- Dwell time and risk of peripheral venous catheters colonization and PVCR-BSIs
- Risk of PVCR-BSIs due to *Staphylococcus aureus*
- Dwell time and risk of PVCR-BSIs due to *Staphylococcus aureus*

Results

- The incidence of PVCR-BSIs was 0.18% among 85063 PVCs (range 0-2.2%).
- The relative risk of CVCR-BSIs compared to PVCR-BSIs varied from 1.5 to 64.
- A mean of 22% (range 7-60%) of nosocomial CRBSIs were due to PVCs.
- Prolonged PVC dwell time has been shown to be an independent risk factor for catheter colonization (RR, 1.75; P<.001).
- PVC in situ > 3 days has shown to be an independent risk factor for catheter colonization (odds ratio 4.74; 95% CI, 2.04-10.99).
- PVC dwell time > 3 days was associated with the pooled risk of local site infection, phlebitis, and CR-BSI (adjusted OR 188; 95% CI, 23-1169).

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- This was associated with the risk of PVCr-BSIs (adjusted OR, 324; 95% CI, 21-1139).
- PVCr-BSI due to *Staphylococcus aureus* are significantly more likely to have a metastatic focus of infection compared to PVCr-BSI due to other pathogens, and they have significantly greater attributable mortality.
- A mean of 38% (range 12%-64%) of *Staphylococcus aureus* CR-BSIs were due to infected PVCs and a mean 19% of *Staphylococcus aureus* BSI were due to infected PVCs.
- Prolonged dwell time and insertion of PVCs by ambulance or emergency services increased the risk of PVCr-BSIs.

Study Limitations

- Some studies were conducted several years ago and the risk of PVCr-BSIs may have changed during the reporting period.
- Reporting bias may have limited access to data showing a higher risk of PVC infections.
- Only focused on the adult population.

Title	Successful Multifaceted Intervention Aimed to Reduce Short Peripheral Venous Catheter-Related Adverse Events: A Quasiexperimental Cohort Study
Author(s)	Gabriel Mestre, Cristina Berbel, Purificación Tortajada, Margarita Alarcia, Roser Coca, Mari Mar Fernández, Gema Gallemi, Irene García, Mari C. Aguilar, Jesús Rodríguez-Baño, and José A. Martínez
Source	<i>American Journal of Infection Control</i> , 2013; 41: 520 - 526.
Key Takeaways	<ul style="list-style-type: none">• 30-50% of PIV BSIs are associated with peripheral vein phlebitis.• A comprehensive multifaceted hospital approach can be successful in reducing PVC-related adverse reactions.• Using device-days as a method of risk adjustment to calculate device associated infection rates may underestimate the impact of a quality improvement intervention, if such intervention reduces the denominator (days at risk).

Study Objective

The objective was to evaluate an intervention to reduce adverse events related to peripheral venous catheter (PVC), mainly peripheral vein phlebitis (PVP) and PVC-related bloodstream infection (BSI).

Methods

Setting and Design

- Design: Quasiexperimental and the impact of interventions was measured by using Poisson exponentially weighted moving average control charts.
- Location: 200-bed private hospital with teaching nursing activity. (There are 8 medical surgical wards and a mixed 11-bed intensive care unit that admits mostly medical and surgical patients.)
- The Nosocomial Infection Control Unit consists of a specialist in epidemiology and infectious diseases and an infection control nurse.
- Inclusion Criteria: Patients with a short (length < 3 inches) PVC inserted from 2004 - 2011.
- Intervention Periods: The pre-intervention was from January 2004 through February 2005 and the intervention period was from March 2005 through December 2011.

Definitions

- Phlebitis was persistent pain, which lasted longer than 2 hours post infusion, referred to PVC and/or erythema and/or swelling and/or induration and/or purulence discharge at the PVC insertion site.
- Suspected PVC-related BSIs were defined as: bacteremia/fungemia with a positive blood culture taken from a peripheral vein; clinical manifestations of infection; and no identifiable source for BSI with the exception of the device with or without positive tip or entry site swab culture.

Interventions

- Multifaceted hospital-wide and composed of the following:
 - Education and training from March 2005 through June 2005
 - Bundle for appropriate maintenance of PVC from July 2005 through December 2011
 - PVP prevalence surveillance
- A period prevalence surveillance monitoring of all PVCs inserted in wards was conducted every November for each year of the study.
 - This was done in the form of a questionnaire to be filled out daily by attending nurses.
 - Information required included the dates of insertion, reasons for catheter removal, and severity of phlebitis.
- Statistical Analysis

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- A Poisson exponentially weighted moving average control chart was used for the purpose of describing the dynamics of incidence over time
- Categorical variables were compared using the χ^2 or Fisher exact test.

Outcomes Measured

- The primary outcome measured was the quarterly dynamics of suspected PVC-related BSIs and the incidence of PVP (proportions and rates) in both periods.
- The secondary outcomes were as follows:
 - The quarterly health care-acquired *S. aureus* BSI and quarterly CVC-related BSI during 2004 to 2011.
 - PVP severity
 - Compliance to the scheduled exchange policy
 - Reasons for catheter withdrawal

Results

- Pre-intervention Period
 - A total of 120 patients and 180 PVCs inserted onwards were monitored (896 catheter days).
 - Thirty-four PVPs were detected accounting for 23.3 PVP per 100 catheters (95% confidence interval 16.4 - 30.1) or 37.96 PVP per 1000 catheter days (95% confidence interval 24.5 - 51.4)
 - The median length of catheterization was 3 days.
- Intervention Period
 - A total of seven period prevalence studies were conducted for 1 month per year from 2005 - 2011.
 - A total of 2,145 catheters (5,333 catheter-days) were inserted on wards in 1,511 patients. These patients were monitored as well.
- The demographic characteristics and the number of patients and catheters were consistent throughout the tenure of the study.
- The median number of catheterizations per patient was 1 and the median length of catheterization was 2 days.
- Reasons for catheter withdrawal were discharge (31.4%) and completion of the intravenous treatment 14.7%.
- A total of 259 PVPs were detected during the prevalence periods with a median rate of 12.1 PVP per 100 catheter (95% confidence interval: 10.7 - 13.2) or 48.6 PVP per 1,000 catheter -days (95% confidence interval: 46.1-51.2).
- Fifty percent of the PVPs were classified as mild and 35% moderate.
- The main PVC-related adverse effects were PVP (12.1%) and infiltration (12.5%)
- PVP decreased by 48% during the intervention period versus 23.3% during the pre-intervention period ($P < 0.05$).
- There was no reduction of PVP measured as 1,000 catheter-days (48.6) versus (37.9) pre-intervention.
- Fifteen percent (320/2,145) of the PVCs were susceptible to routine resiting.
- A 120-hour schedule was implemented and the compliance rate for routine resiting improved significantly from 30.8% from 2005 - 2007 to 68.2% from 2008 - 2011 ($P < 0.05$).
- The median indwelling time of non-replaced catheters in the prefixed day was similar during both the pre-intervention (6 days) and the intervention periods (6 days).
- A total of 59 catheter-related BSIs were detected from 2004 - 2011.
 - 81% (48/59) were CVC-related BSIs
 - 19% (11/59) were PVC-related (*S. aureus* 81%; *coagulase negative Staph* 18%)
- There were few PVC-related BSI events.
- In 23 of 32 quarters, there were no BSIs detected.

Study Limitations

- The study was a single center study; therefore, the results may not be applicable to other facilities.
- The PVC-BSIs may have been underestimated due to blood and catheter cultures not being conducted on a routine basis.

Retrospective Study: Pien et al. 2010

Title	The Clinical and Prognostic Importance of Positive Blood Cultures in Adults
Author(s)	Brian C. Pien, Punidha Sundaram, Natalia Raoof, Sylvia F. Costa, Stanley Mirrett, Christopher W. Woods, L. Barth Reller, Melvin P. Weinstein
Source	<i>American Journal of Medicine</i> , 2010, 123(9), 819-828. doi:10.1016/j.amjmed.2010.03.021
Key Takeaways	<ul style="list-style-type: none">• Bloodstream infections due to intravenous catheters continue to grow• <i>S. aureus</i> and <i>E. coli</i> remain the most frequently isolated bloodstream pathogens• Most infections were acquired in the hospital or other healthcare setting• In-hospital case fatality ratios (CFRs) have decreased• Infection control practices need to extend beyond the in-patient setting to all healthcare facilities• Early diagnosis and intervention is likely to be crucial to achieve further decreases in mortality from bloodstream infection

Study Objective

To reassess bloodstream infections due to the increase in antibiotic resistance, increase in the number of patients receiving immunomodulatory therapy, improved antiretroviral therapy, and acquisition of infections from the community setting.

Methods

- Study Design
 - Multicenter retrospective study from January through December 31, 2004
- Study Cohort
 - Open cohort of adults with at least 1 positive culture
 - Patients were identified by the clinical laboratory database from each of the 3 institutions
 - Isolates that were referred from outside medical institutions were excluded
 - Subjects were screened by reviewing medical records
 - Eligible subjects were ≥ 18 years and hospitalized at one of the study institutions
- Data Collection
 - Medical charts were reviewed by an infectious disease physician
 - Data was abstracted into a standardized worksheet to assess 25 types of variables (medical institution, age, sex, service specialty, place of acquisition, microorganism, clinical significance, source of infection, presence of endocarditis, white blood cell count, blood pressure, body temperature, and underlying comorbidities).
 - Comorbidities of interest were diabetes mellitus, renal insufficiency, corticosteroid use, malignancy, HIV, stem cell and organ transplant, cirrhosis, trauma, and recent surgery within 2 weeks
 - Antimicrobial therapy was assessed before the positive culture, after the Gram stain, and at final identification.

Outcomes Measured

Primary outcome

- In hospital deaths attributed to a true bloodstream infection

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Results

- 2669 blood culture isolates from 2270 positive blood culture episodes in 1706 patients were reviewed
 - 51% represented true infection, 41% contamination, and 8% unknown clinical significance
- There were 1225 patients with true bloodstream infections (median age 60)
 - 60% male, 59% were white, and 80% had at least one comorbidity
- The most frequent isolates causing bloodstream infection were *Staphylococcus aureus* (23%), *Escherichia coli* (12%), *Enterococcus spp.* (9%), *Klebsiella pneumoniae* (9%), *coagulase-negative staphylococci* (8%), *Pseudomonas aeruginosa* (4%), *Candida albicans* (3%), *Enterobacter cloacae* (3%), and *Serratia marcescens* (3%)
 - CoNS grew 38% from of all positive cultures, however only 10% represented true bloodstream infections
- 71% of all true bloodstream infections had an identifiable source
 - IV catheters were the most common source at 23% with gram-positive pathogens being the most frequent cause
 - *S. aureus* (30%), CoNS (16%), and *Enterococcus spp.* (11%), *Candida spp.* (15%) and *K. pneumoniae* (7%)
 - Other sources identified included genitourinary (12%), respiratory (8%), bone or joint (4%), intra-abdominal abscess (4%), skin (4%), bowel or peritoneum (4%), biliary (4%), surgical wound (3%), other (4%), and unknown (29%)
- Most bloodstream infections (81%) were acquired in the hospital or other healthcare facilities
- The overall crude and attributable in-hospital case facility ratios (CFRs) were 20% and 12%
 - This was lower than previous studies
- Increasing age, hypotension, absence of fever, hospital acquisition, extreme white blood cell count values, and the presence of the acquired immunodeficiency syndrome, malignancy, or renal disease were significantly associated with an increased risk of in-hospital attributable death in multivariable analysis

Study Limitations

- The study lacked a validated comorbidity index
- Subjective assessments were used to determine whether a positive culture isolate represented a bloodstream infection

Observational Study: Pujol et al. 2007

Title	Clinical Epidemiology and Outcomes of Peripheral Venous Catheter-Related Bloodstream Infections at a University-Affiliated Hospital
Author(s)	M. Pujol, A. Hornero, M. Saballs, M.J. Argerich, R. Verdaguer, M. Císnal, C. Peña, J. Ariza, and F. Gudiol
Source	<i>Journal of Hospital Infection</i> 2007; 67: 22 -29
Key Takeaways	<ul style="list-style-type: none">• BSI rates associated with PVC were at least as frequent as CVC-BSIs underscoring the need to introduce prospective surveillance programs to detect these problems.• BSI, particularly caused by <i>S. aureus</i>, remains an underestimated and serious complication of PVC.• Better understanding of risk factors and targeted interventions in specific areas are needed to reduce the incidence of catheter-related <i>S. aureus</i> bacteremia.

Study Objective

To describe the clinical epidemiology and outcomes of peripheral vascular catheters-bloodstream infections (PVC-BSIs) among non-intensive care unit patients during an 18 month period, comparing the most relevant features to cases caused by central venous catheters (CVCs) during the same period.

Methods

- The study was a prospective study conducted in a 900 bed university affiliated hospital in Barcelona.
- Inclusion Criteria: Hospitalized patients on medical and surgical wards from October 2001 – March 2003
- Exclusion Criteria: Patients in intensive care units
- All episodes of nosocomial bloodstream infections were assessed and those caused by an intravascular catheter infection were selected for the study.
- Peripheral vascular catheters included short-line and mid-line peripheral catheters.
- PVCs were inserted and maintained by ward nurses using an aseptic technique (chlorhexidine ointment placed over the insertion site prior to dressing with sterile gauze or a sterile adhesive bandage).
- Catheter dressings were routinely changed when necessary and at least every 48 hours.
- Most of the PVCs were left in place unless a complication was indicated as present.
- CVCs were inserted in the operating room or on hospital wards using maximal barrier precautions during the insertion.

Outcomes Measured

- CRBSI associated with each catheter type.
- CRBSI was diagnosed via concordant bacterial species grown from semi-quantitative catheter tip culture and percutaneously drawn blood. If catheter tip culture was not done, diagnosis required either:
 - Presence of phlebitis (defined as presence of at least 2 of: erythema, swelling, tenderness or pain, warmth or cord induration) or
 - Clear resolution of the clinical symptoms upon catheter withdrawal. In the case of a common skin pathogen such as CoNS; at least 2 consecutive positive blood cultures were required.

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Results

- A total of 150 cases of CR-BSIs were identified in 147 patients (0.37/1000 patient days).
 - Seventy-seven (51%) of the CR-BSIs were PVC-BSIs (0.19 cases/1000 patient days)
 - 65% had shortline PVC; 35% had midline PVC
 - Seventy-three (49%) were CVC-BSIs (0.18 cases/1000 patient days).
- The mean monthly rate for PVC-BSIs was 4.2 episodes and 4.0 episodes for CVC-BSIs.
- The overall mortality was similar for both groups of BSIs, approximately 15 - 18%.
- The patients' mean age was 63.2 years and predominantly male (55%).
- Patients with PVC-BSIs had a significantly higher proportion of *S. aureus* infections than did patients with CVC-BSIs (41/77 versus 24/73).
- *S. aureus* contributed to a higher rate of complicated bacteremia and significantly higher overall mortality than did the PVC-BSIs caused by other pathogens
- Methicillin-resistant *S. aureus* was found in 5 (12%) cases of PVC-BSIs and in 5 (21%) of CVC-BSIs which was not significantly different.

Study Limitations

- The BSI rate for PVCs was a crude rate versus being risk-adjusted.
- No details about hand hygiene, skin antiseptics or catheter securement was provided.

Randomized Controlled Trial: Rickard et al. 2012

Title	Routine Versus Clinically Indicated Replacement of Peripheral Intravenous Catheters: A Randomized Controlled Equivalence Trial
Author(s)	Claire M. Rickard, Joan Webster, Marianne C. Wallis, Nicole Marsh, Matthew R. McGrail, Venessa French, Lynelle Foster, Peter Gallagher, John R. Gowardman, Li Zhang, Alice McClymont, and Michael Whitby
Source	<i>The Lancet</i> 2012; 380:1066 - 1074.
Key Takeaways	<ul style="list-style-type: none">• Clinically indicated replacement did not increase the risk of phlebitis, bloodstream infection or other complications compared to routine third day replacement in patients with peripheral intravenous catheters.• Clinically indicated replacement may substantially reduce the number of catheter insertions, staff workload and costs as well as reduce patient discomfort.

Study Objective

To establish that clinically indicated replacement of intravenous catheters results in equivalent rates of phlebitis and other complications and reduced costs and number of insertions when compared to routine third day replacement.

Methods

- The study was a multicenter, non-blinded, randomized controlled equivalence trial in 3 university-affiliated government hospitals in Queensland, Australia.
- Recruitment took place from May 20, 2008 through September 9, 2009.
- Inclusion Criteria: Patients at least 18 years of age with intravenous catheters in place and expected treatment of longer than 4 days.
- Exclusion criteria included emergency insertion, bloodstream infection, planned removal of intravenous catheters inserted within 24 hours, or intravenous catheter already in situ for more than 72 hours.
- Catheters could be inserted in any clinical area, by any nurse, doctor or insertion team.
- Patients were randomized to 2 groups:
 - Clinical Group: Intravenous catheters removed only for completion of therapy, phlebitis, infiltration, occlusion, accidental removal, or suspected infection.
 - Routine Replacement Group: Intravenous catheters replaced every third calendar day, unless clinical reasons made this impossible.
- The investigators and the research nurses did not resite the catheters and were not involved in the decision to remove intravenous catheters or to order cultures.
- The insertion site was prepped with 2% chlorhexidine in 70% ethanol. Autoguard 30 mm intravenous catheters and Tegaderm 1624W transparent dressings were used. The transparent dressings were replaced weekly or when soiled or loose. Chlorhexidine impregnated sponges were not used.

Outcomes Measured

- The primary outcome measured was the incidence of phlebitis during catheterization or within 48 hours of removal. Phlebitis was defined as two or more of the following, present simultaneously:
 1. patient-reported pain or tenderness with a severity of two or more on a ten-point scale;
 2. erythema extending at least 1 cm from the insertion site;

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3. swelling, extending at least 1 cm from the insertion site;
 4. purulent discharge; or
 5. palpable venous cord beyond the catheter tip.
- There were 9 secondary outcomes measured: catheter-related bloodstream infection; all cause blood stream infections; local venous infection; colonization of intravenous catheter tip; infusion failure; number of intravenous catheters needed per patient for course of treatment; overall duration of intravenous therapy; costs per patient for the course of intravenous therapy; mortality with intravenous catheter in situ or within 48 hours of removal.

Results

- A total of 3283 patients were randomized (1593 clinically indicated; 1690 routine replacement).
- A total of 5907 intravenous catheters and 17,412 catheter days were studied (clinically indicated 8693 days and routine replacement 8719 days).
- Protocol adherence was 85% in the clinically indicated group and 70% in the routine replacement group; however the primary analysis was on the intent-to-treat population.
- Mean dwell time for catheters in situ on day 3 was 99 h for clinically indicated group (range 48 - 561 h) and 70 h for routine replacement group (range 48 - 96 h).
- There was a 7% phlebitis rate in both groups.
- One patient in the routine replacement group had a catheter-related bloodstream infection.
- The groups had equal rates of all-cause bloodstream infections and catheter tip colonization.
- A total of 15 positive blood cultures from 13 patients (4 patients in the clinically indicated group and 9 in the routine replacement group) were identified. The bloodstream infections in the clinically indicated group were Gram positive organisms and Gram positive and negative organisms were similarly represented in the routine replacement group.
- No patient had a local venous infection.
- The infiltration, occlusion, accidental removal, total infusion failure, and in-hospital mortality rates were similar between the two groups.
- There was equal overall duration of intravenous treatment, but the clinically indicated group had significantly fewer significant intravenous catheters per patient, and significantly reduced hospital costs ($p < 0.0001$).
- There were no serious adverse events related to the trial interventions.

Study Limitations

- The study was a non-blinded design.
- The investigators had the inability to culture all of the intravenous catheter tips due to restrictions established by the hospital laboratories and budget.
- Identification of phlebitis and CRBSI was affected by strict definitions for both and may not be generalizable to settings where the incidence of those complications is high.

Editorial: Rickard 2013

Title	Prevention of Peripheral Intravenous Catheter-related Bloodstream Infections: the Need for a New Focus
Author(s)	Rickard CM, Webster J, and Playford EG
Source	<i>The Medical Journal of Australia</i> , 2013; 198(10): 519 - 520
Key Takeaways	<ul style="list-style-type: none">• PIVCs can be used safely beyond 96 hours.• Careful insertion, assessment, and maintenance of PIVCs is vital in preventing <i>Staphylococcus aureus</i> bacteraemias.• Chlorhexidine-impregnated dressings and bundles of care are suggested strategies to reduce infections associated with CVCs and PIVCs.

Study Objective

This is an editorial focusing on careful insertion and maintenance technique in healthcare settings when using peripheral intravenous catheters (PIVC) to avoid catheter related bloodstream infections.

Relevant Information

- Intravascular access device-related bloodstream infections, in particular, *Staphylococcus aureus* bacteraemias (SABs), impact patients both clinically and economically.
- Infections can take place at any time after a PIVC is inserted.
- Signs of early infection are indicative of the insertion procedure.
- SABs are more commonly associated with insertion by the ambulance services or in emergency departments.
- Ambulance and emergency department insertions are associated with 61% of early infections (up to 96 hours).
- PIVCs inserted in the emergency departments have been reported to have a six fold higher incidence of SAB than lines inserted in wards.
- It has also been noted that 65% of PIVC-related SAB infections occurring within 72 hours of insertion were inserted in hospital wards.
- SAB remains a problem with PIVCs despite the “3 day rule” and strict attention to insertion and maintenance practice is required regardless of dwell times.
- Chlorhexidine-impregnated dressings and bundles of care are suggested strategies to prevent PIVC-related infections.

Retrospective Observation Study: Sato et al, 2017

Title	Peripheral venous catheter-related bloodstream infection is associated with severe complications and potential death: a retrospective observational study
Author(s)	Akihiro Sato, Itaru Nakamura, Hiroaki Fujita, Ayaka Tsukimori, Takehito Kobayashi, Shinji Fukushima, Takeshi Fujii, and Tetsuya Matsumoto
Source	<i>BMC Infectious Diseases</i> (2017) 17:43, DOI 10.1186/s12879-2536-0
Key Takeaways	<ul style="list-style-type: none">• Peripheral venous catheter-related bloodstream infection (PVC-BSIs) are a significant cause of healthcare associated infection.• The reported incidence of PVC-BSIs is lower than CVC-BSIs but the cumulative duration of PVC insertion is 15 times that of CVC insertion because PVCs are inserted in 30-80% of inpatients.• Severe cases of PVC-BSIs required intensive long-term care and antibiotic therapy due to hematogenous complications and some patients died• <i>Staphylococcus aureus</i> bacteremia remains a major problem and may influence the prognosis

Study Objective

To describe the clinical characteristics and outcomes of PVC-BSIs along with associated risk of severe complications or death.

Methods

- A retrospective review of 62 patients diagnosed with PVC-BSIs by blood cultures from June 1, 2010 to April 30, 2015 was conducted at 2 regional hospitals in Tokyo.
- Clinical manifestations, underlying diseases, laboratory results, treatment methods, recurrence rates, and complications were evaluated.
- The diagnostic criteria for PVC-BSIs included; semi-quantitative tip culture and percutaneously drawn blood cultures without another apparent source of bacteremia or catheter tip culture was not performed but bacteremia was present with another condition.
 - Phlebitis
 - Resolution of clinical symptoms with catheter removal and no alternate explanation for the bacteremia.
- PVCs were resited every week or sooner if there was evidence of phlebitis.
- All patients were examined by the infectious disease specialist when blood cultures results were positive and excluded any other apparent source.
- Mortality was defined as death within 30 days after BSI.
- During the study period, there were no policy or protocol changes regarding PVC insertion.
 - Skin was prepped with 76.9 vol% to 81.4 vol% ethanol and allowed to dry.
 - Proper hand hygiene procedures before and after contact with patient and single use gloves utilized.
 - A sterile transparent semipermeable dressing was applied over the insertion site.
- Statistical analysis was done using SPSS for Windows.
- Mean values were compared using the two-sample t-test for independent samples and the chi-squared test or Fisher's exact test. The Mann-Whitney or Student's *t* test was used for continuous variables
- Statistical significance was defined as $p < 0.05$.

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Outcomes Measured

Clinical characteristics and outcomes of PVC-BSIs such as clinical manifestations, underlying diseases, laboratory results, treatment methods, recurrence rates, and complications.

Results

- The median time from admission to bacteremia was 17 days (range 3-142 days) and 6 days (range 2-15) for catheter insertion to bacteremia.
- Causative pathogens were 58% Gram-positive, 35.8% Gram-negative, 6.2% *Candida* spp., and 25.8% polymicrobials.
- Catheter insertion sites included 77.4% in the arm, 4.8% in the foot, and 17.7% in an unrecorded location.
- Twenty-three patients with complications (37.1%) required longer antibiotic therapy compared to the other 39 patients (33.5 vs. 15.8 days; $p = 0.004$).
- The 39 patients had phlebitis. None of the patients had endocarditis. Nine (14.5 %) patients were admitted to the ICU for changes in vital signs and multiple organ failure related to PVC-BSIs.
- Eight patients (12.9%) died within 30 days of the blood cultures becoming positive. *S. aureus* was the primary causative organism in 5 of 8 fatal cases. All had an underlying immunodeficiency.
- Patients who died of PVC-BSIs had higher proportions of *Staphylococcus aureus* infections than patients who survived (odds ratio 8.33; $p = 0.004$).
- Among patients who died within 30 days, the time from catheter insertion to bacteremia ranged from 2 to 9 days, and the time from bacteremia to death ranged from 5 to 23 days.

Study Limitations

- The retrospective nature of the study.
- The lack of records concerning the insertion site in 17.7 % of the cases and duration of catheter insertion in 41.9% of the cases.
- The investigators were not able to identify cases with only local infections that did not lead to bacteremia.
- Due to the lack of data regarding the causative organisms of PVC-BSIs and lack of surveillance data, the investigators were not able to compare data.
- The sample size was not adequate to determine confounding factors.

Retrospective Observational Study: Trinh et al. 2011

Title	Peripheral Venous Catheter-Related <i>Staphylococcus aureus</i> Bacteremia
Author(s)	T. Tony Trinh, Philip A. Chan, Omega Edwards, Brian Hollenbeck, Brian Huang, Nancy Burdick, Julie A. Jefferson, Leonard A. Mermel
Source	<i>Infection Control and Hospital Epidemiology</i> 2011;32 (6):579 - 583
Key Takeaways	<ul style="list-style-type: none">• PVC-related <i>S. aureus</i> bacteremia is an under recognized complication.• Hospitals should assess for and implement interventions to mitigate risks of PVC-related infections.• Minimizing the PVC placement in the antecubital fossa and consideration for removing catheters within 24 hours if they were placed under emergent conditions may reduce the risk of infection in adult patients.

Study Objective

To determine the incidence, risk factors, treatment, and outcome of peripheral venous catheter (PVC) PVC-related *S. aureus* bacteremia at a Rhode Island hospital.

Methods

The study was a retrospective medical review of adult patients admitted to a tertiary care teaching hospital from July 1, 2005 through March 31, 2008 with *S. aureus* bacteremia.

- A case of definite PVC-related *S. aureus* bacteremia was defined as a patient with blood cultures and PVC tip or insertion site growing *S. aureus* and physician or nursing team documentation noting the PVC as the source.
- A case of probable PVC-related *S. aureus* bacteremia was defined as a patient with only physical findings suggesting PVC infection and no other source on medical record review.

Rhode Island Hospital infection control software was searched for all microbiologic cultures growing *S. aureus* from adult inpatients during the study period.

- Patients with *S. aureus*: reviewed all other cultures growing *S. aureus* for 3 months after the *S. aureus* bacteremia was documented.
- *S. aureus* bacteremia with a PVC tip or insertion site wound culture growing *S. aureus* within 3 days of *S. aureus* bacteremia were included in the study.
- Patients with *S. aureus* bacteremia without an identified microbiologic source were reviewed using electronic patient data. If the bacteremia had no identifiable source, it was cross-referenced with the IV nursing team records.
- Hospital administrative data was used to determine the total number of adult inpatient-days, multiplied this number by the fraction of adult inpatients with a PVC during a point-prevalence survey performed on all adult inpatient units.

Outcomes Measured

- Total cases of *S. aureus* bacteremia
- PVC-related *S. aureus* bacteremia rates and characteristics
- Total PVC-days during the study period

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Results

- There were 544 total cases of *S. aureus* bacteremia identified from sources including soft tissue/bone (204); CVC or PICC (172), Pulmonary (88), PVC (24), endovascular (12), Urinary tract (12), other (9) and unknown (23).
- There were 24 cases of PVC related *S. aureus* bacteremias identified (18 definite and 6 probable) in patients with a mean age of 63 years.
- For 16 (67%) of the PVC-related *S. aureus* bacteremias, the PVC was placed in the emergency department, 4 (17%) were placed in the inpatient unit, 2 (8%) by the emergency medical services prior to admission, and 2 (8%) at outside hospitals.
- Forty-six percent of the PVCs were placed in the right antecubital fossa, 21% in the right forearm, 4% in the right hand, 21% in the left antecubital fossa, 4 % in the left forearm, and 4% in the left hand.
- There were 451,366 adult patient days during the study period.
- The point prevalence survey revealed that 298 of 392 (76%) of adult inpatients had a PVC.
- During the study, there were 343,130 PVC days which lead to an estimated incidence density of PVC-related *S. aureus* bacteremia of 0.07 per 1,000 PVC days.
- More patients with PVC-related *S. aureus* were likely to have their PVC inserted at the emergency department or outside the hospital and more likely to have it placed in the antecubital fossa.
- The mean duration of PVC dwell time before the blood culture was obtained that grew *S. aureus* was 3 days.
- The mean hospital duration for patients with PVC-related *S. aureus* bacteremia was 15 days and the mean prescribed antibiotic course was 19 days.
- Two patients needed incision and drainage of the PVC insertion site; 3 patients had complications related to the antibiotics prescribed; 2 patients died; and 1 patient was admitted to hospice care.

Study Limitations

- The true incidence of PVC-related *S. aureus* bacteremias may have been underestimated because of the retrospective study design as well as health care practitioners' tendency to overlook PVC as source of bacteremia.
- The comparison group was based on a 1-day point prevalence survey and may not have been a representative sample of the patients with uninfected PVCs.

Systematic Reviews: Webster et al. 2010

Title	Clinically-indicated Replacement Versus Routine Replacement of Peripheral Venous Catheters
Author(s)	Joan Webster, Sonya Osborne, Claire Rickard, and Jennifer Hall
Source	Cochrane Database of Systematic Reviews 2010; 3: 1- 41.
Key Takeaways	<ul style="list-style-type: none">• The review found no conclusive evidence to support changing catheters every 72 to 96 hours.• Health care organizations may consider changing to a policy where catheters are changed only if clinically indicated. This would provide significant cost savings and would be welcomed by patients, who would be spared the unnecessary pain of routine resites.

Study Objective

The objective was to determine the impact of removing peripheral intravenous catheters when clinically necessary as compared to removing and resiting the catheters on a routine basis.

Methods

- The study was a systematic literature review consisting of all published randomized controlled trials comparing the routine removal of peripheral intravenous catheters with removal only when clinically necessary.
- Inclusion Criteria:
 - Patients requiring peripheral intravenous catheters to be in situ for at least 3 days were included.
 - Any duration of routine replacement versus clinically indicated was included.
 - Catheters could be made from any type of material, coated, non-coated, or covered with any type of dressing.
- Exclusion Criteria:
 - Patients receiving parenteral fluids and Cross-over trials were excluded.
- The search method resources used were the Special Register (MEDLINE, EMBASE, CINAHL, AMED, and other relevant journals) and the Cochrane Central Register of Controlled Trials (CENTRAL) in The Cochrane Library (last searched issue 4, 2009).
- There was no restriction on language, and articles were translated if necessary if the initial translation of the abstracts were not identified.
- Reference lists of potentially useful articles were searched.
- Researchers and manufacturers were contacted to obtain unpublished data.
- Titles and abstracts identified through the search process were reviewed by the authors. In the event the review author was an author of a paper he/she was reviewing, another reviewer was selected to review the paper.
- Any conflicting opinions were handled by consensus or another reviewer.
- There was no blinding of authorship.
- Data Extraction and Management: The first review author entered the data into RevMan and another author would check for accuracy.
- Assessment of Risk of Bias in Included Studies: Two review authors independently assessed the quality of eligible trials.
- For the studies selected, the randomization process and allocation concealment was checked for adequacy.
- The following factors were all accounted for in the review: blinding; intention-to-treat analysis; completeness of follow-up; measures of treatment effect; unit of analysis issues; dealing with missing data; assessment heterogeneity; assessment of reporting biases; data synthesis; subgroup analysis and investigation of heterogeneity; and sensitivity analysis.

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Outcomes Measured

- The primary outcomes measured included the following: catheter-related bacteremia; phlebitis; and cost.
- The secondary outcomes measured included the following: infiltration; catheter occlusion; the number of catheter resites per patient; local infection; mortality; pain; and patient satisfaction.

Results

- The electronic search yielded 198 titles with 13 considered useful.
- Seven of the 13 titles did not meet the inclusion criteria.
- The included studies consisted of 4 published randomized controlled trials (Barker 2004; Van Donk 2009; Webster 2007; and Webster 2008) and 2 unpublished trials (Rickard 2008 and Rickard 2009).
 - Suspected catheter related bacteremia was assessed in 5 trials (3408 patients) - Rickard 2008, Rickard 2009, Van Donk 2009, Webster 2007, and Webster 2008.
 - Phlebitis was found in 6 trials (3455 patients) - Barker 2004, Rickard 2008, Rickard 2009, Van Donk 2009, Webster 2007, and Webster 2008.
 - Cost was assessed in 2 trials (961 patients), Webster 2007 and Webster 2008.
 - Local infection was assessed in 3 trials (1323 patients) - Rickard 2008, Webster 2007, and Webster 2008.
 - Catheter blockage was assessed in 4 trials (1523 patients) - Rickard 2008, Van Donk 2009; Webster 2007, and Webster 2008.
 - Infiltration was assessed in 3 trials (1323 patients) - Rickard 2008, Webster 2007, and Webster 2008.
- The suspected device related bacteremia rate was reduced by 43% when the catheters were changed on a clinically indicated basis. This rate was not statistically significant.
- There was a non-statistically significant increase in phlebitis by 24% in the clinically indicated group.
- Cannulation costs decreased in the clinically indicated group.
- The incidence of local infection was not statistically different between the groups.
- The clinically indicated group had a higher catheter failure due to blockage rate and there was a non-significant 13% increase in the number of catheter failures due to infiltration in the clinically indicated group.
- There were no statistical differences in the incidence of phlebitis per 1,000 device days in the Rickard 2008, Rickard 2009, Van Donk 2009, Webster 2007, and Webster 2008 trials.
- When sensitivity analyses were conducted the phlebitis rate was higher in the clinically indicated group but was not statistically significant.

Study Limitations

- The studies were not blinded.

Review Article: Zingg 2009

Title	Peripheral Venous Catheters: An Under-Evaluated Problem
Author(s)	Walter Zingg and Didier Pittet
Source	<i>International Journal of Antimicrobial Agents</i> , 2009; 34S: S38 – S42
Key Takeaways	<ul style="list-style-type: none">• The risks and benefits of PVCs are largely under evaluated in clinical medicine.• There is a surprising lack of information on PVC-BSI.• Well-designed and conducted prospective studies are needed to put PVC-BSI into perspective in the overall picture of device associated infections and to identify effective interventions.

Objective

Literature review to determine if complications arising from peripheral venous catheter (PVC) use are under evaluated and in particular, whether peer-reviewed literature appropriately reflects the wide use of the device, whether potentially harmful complications are well addressed, and the type of prevention and intervention measures proposed.

Definitions and Relevant Information Summary

- PVC catheter days are estimated to be 15 times higher than the cumulative dwell time of central venous lines.
- It is estimated that 20-50% of PVC catheter days are unnecessary.
- The mean dwell time of PVCs is 3 – 4 days with a median dwell time of 2 days.
- The most frequent PVC complication is phlebitis or thrombophlebitis with rates ranging from 2-80%. The wide variation in rates is due primarily to inconsistent clinical definitions across studies.
 - Thrombophlebitis is local vein inflammation and thrombus formation.
 - Damage to vascular integrity is a prerequisite for thrombophlebitis formation.
 - Vascular endothelium can be damaged by irritating infusates, stiff catheter material, or bacterial colonization; leading to inflammation of the vascular wall, subsequent fibrin deposition and thrombus formation.
 - Early thrombus formation is found close to the puncture site and late thrombus formation is found around the catheter tip.
- Risk factors for thrombophlebitis:
 - Catheter-related risk factors
 - Increased catheter dwell time (in adults).
 - Catheters made with tetra fluoroethylene-hexafluoropropylene.
 - Rigid, less elastic catheters are more likely to irritate the vascular wall.
 - Smooth and flexible catheters cause less endothelial damage and are less likely to cause thrombophlebitis than Teflon catheters.
 - Drug-related risk factors
 - Infusates with low pH or high osmality such as potassium chloride affect the integrity of the vein endothelium and damage the vascular wall.
 - There is a debate over the effect of heparin flushes on thrombophlebitis.
 - Thrombophlebitis may be provoked by particles in the infusates.

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- Patient-related risk factors
 - High hemoglobin levels
 - Thrombophilic predisposition
 - Poor vein quality or fragile vessels susceptible to mechanical irritation.
- Healthcare-related risk factors
 - Insertion and maintenance by untrained or inexperienced healthcare workers
- PVC-associated bloodstream infection (PVC-BSI)
 - Mechanism is colonization of the vascular catheter tract followed by biofilm formation.
 - Colonization can occur during catheter insertion and when manipulating the catheter.
 - Incidence of PVC-BSI is estimated at 0.2 - 0.7 per 1000 device days.
 - Even though rates are low, absolute PVC-BSI numbers approach absolute CLABSI numbers outside the ICU.
 - Colonization of peripheral catheters may be better associated with PVC-BSI as opposed to thrombophlebitis.
 - PVC-BSI episodes may be missed due to lack of surveillance.
 - There is a lack of well-designed, published studies that focus on PVC-BSI.
- Local PVC Infections (exit site infections)
 - PVC-associated exit site infections occur at a rate of approximately 2.3% and are provoked by skin flora that migrates into the catheter tract.
 - Skin colonization depends on local disinfection measures and the dressing type used to protect the catheter insertion site.
 - Several studies and a meta-analysis showed that gauze dressings are not superior to transparent dressings in the context of skin colonization and thrombophlebitis.
 - Transparent polyurethane dressings are the standard of care.
- Scheduled Catheter Changes
 - Controversy exists regarding scheduled catheter change as a means of thrombophlebitis prevention.
 - A threshold of 3 days has been challenged in various studies where PVCs were in place for 4 days or more without detecting increased thrombophlebitis.
 - Opponents have challenged the methodology of these studies, citing the loss of many PVCs after 4 days and removal for reason other than scheduled change.
 - It is questioned whether scheduled catheter changes actually occur in clinical practice as chart documentation is lacking.
 - In general practice it may be that PVCs are left in place until no longer needed or when complications arise.
- Clinical Intervention Strategies
 - Few studies have been done and those that do exist focus on thrombophlebitis versus infection.
 - Performance feedback may be effective although the effect may only be small to moderate.
 - Specialized intravenous teams have been shown to be effective in reducing the incidence of catheter related complications and associated costs.

