

Preventing peripheral venous catheter-related *Staphylococcus aureus* bacteraemia

Vascular access devices are a critical and ubiquitous health-care intervention, with peripheral venous catheters the most common modality of venous access in hospital practice. Peripheral venous catheters are an important but under-recognized source of nosocomial bacteraemia, most frequently caused by *Staphylococcus aureus* (Pujol et al, 2007). Peripheral venous catheter-associated *S. aureus* bacteraemia is associated with a 17% risk of metastatic infection (septic arthritis, infective endocarditis and empyema) and an attributable mortality of 19.5% (Pujol et al, 2007).

In a recent systematic review, peripheral venous catheters were found to be the source of 6.3% of nosocomial bacteraemias and 23% of nosocomial vascular access device-associated bacteraemias (Mermel, 2017). Implementing preventative strategies is a challenge because of the lack of a robust evidence base, in particular addressing the question of timing of peripheral venous catheter replacement. This article discusses modifiable risk factors and recommendations for preventing peripheral venous catheter-associated *S. aureus* bacteraemia.

Peripheral venous catheter dwell time and risk of bacteraemia

A central issue in preventing peripheral venous catheter-associated *S. aureus* bacteraemia is how long the device can be left in situ before it should be replaced. Should replacement

be routine, after a fixed period of time (e.g. 72 hours after insertion), or only be performed when felt to be clinically indicated?

A Cochrane review identified seven randomized controlled trials that sought to address this question (Webster et al, 2015). Five of the trials specifically reported peripheral venous catheter-associated bacteraemia as an outcome (encompassing 4806 patients) and found no significant difference in the incidence of bacteraemia between routine (0.08%) and clinically-indicated (0.04%) replacement.

The review concluded that there is no evidence to support routine replacement but the authors would challenge this conclusion for two reasons. First, none of the analysed studies used peripheral venous catheter-associated bacteraemia as a primary outcome (most used phlebitis or a composite measure) so were not powered to detect changes in this outcome. Assuming an incidence of 0.06% (based on the review's meta-analysis) then a study powered to detect a 50% reduction in peripheral venous catheter-associated bacteraemia would need 156 904 patients (based on power 80%, type 1 error rate 0.05; clincalc.com).

Second, standard practice in peripheral venous catheter insertion is difficult to define, but it is notable that three of the studies had an 'intravenous insertion team'. Detailed information on the anatomical location of peripheral venous catheter insertion was provided in two studies and the peripheral venous catheter was placed in the hand in >60% of patients in one and distal to the antecubital fossa in ~50% of patients in the other. These factors may also have contributed to peripheral venous catheter safety.

Data from observational studies consistently support an association between dwell time (time since insertion) and bacteraemia. In a retrospective analysis of patients with peripheral venous catheter-*S. aureus* bacteraemia, compared to non-infected controls identified by a point prevalence survey of patients with a peripheral venous catheter in situ, the median dwell time at diagnosis of

bacteraemia was 3 days, compared to 1 day in the control patients (Trinh et al, 2011). Similarly, in a prospective cohort, the mean dwell time for a peripheral venous catheter-associated *S. aureus* bacteraemia was 3.5 days and 45% of cases of peripheral venous catheter-associated *S. aureus* bacteraemia were linked to peripheral venous catheters which had been in place for ≥4 days (Stuart et al, 2013). Data from other prospective studies found a mean dwell time of 3.9 days before bacteraemia and a median of 4 days in another study (Pujol et al, 2007; Freixas et al, 2013). Although observational, these data cumulatively suggest that peripheral venous catheter-associated *S. aureus* bacteraemia usually occurs 3–4 days after insertion.

Other modifiable risk factors for peripheral venous catheter-associated bacteraemia

Anatomical location may be relevant, with proximal forearm or antecubital fossa insertion associated with bacteraemia and insertion in the hand or wrist having lower risk (Trinh et al, 2011; Austin et al, 2016). Insertion in the emergency department rather than an inpatient ward has been associated with more bacteraemia and a shorter time from insertion until bacteraemia (mean 3.7 vs 5.7 days) (Pujol et al, 2007; Trinh et al, 2011).

In a study of infectious disease consultation in cases of peripheral venous catheter-associated *S. aureus* bacteraemia, the device was identified as the source of infection when this had not previously been recognized by the parent team in 29% of cases (Austin et al, 2016). This study also showed that old peripheral venous catheter sites (from where the device had since been removed) could still be a source of bacteraemia and a further study has reported peripheral venous catheter-associated *S. aureus* bacteraemia up to 6 days after device removal (Sanchez et al, 2012).

Phlebitis and bacteraemia

The development of phlebitis or thrombophlebitis are complications in their own right and should prompt peripheral

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venous catheter removal, partly because of the risk of progression to bacteraemia. However, it is important to note that peripheral venous catheter-associated *S. aureus* bacteraemia can occur without these signs, which were absent in 51% of cases in one prospective cohort (Pujol et al, 2007).

Conclusions

Peripheral venous catheters are an important but under-recognized source of nosocomial *S. aureus* bacteraemia. Despite a Cochrane review concluding that peripheral venous catheter replacement 'as clinically indicated' (*vs* routinely at 72 hours) is not associated with an increased risk of bacteraemia, the authors contend that the data do not support this conclusion because of the absence of adequately powered studies using bacteraemia as a primary outcome measure.

The authors are concerned that false reassurance is drawn from the results of these trials and that a 'replacement as clinically indicated' policy exposes patients to an unnecessary increased risk of peripheral venous catheter-associated *S. aureus* bacteraemia. The absence of phlebitis or thrombophlebitis does not reliably exclude a peripheral venous catheter as a source of bacteraemia, highlighting the frailty of relying on clinical indications for replacement.

Furthermore, there are consistent data from cohort studies supporting the observation that peripheral venous catheter-associated *S. aureus* bacteraemia occurs 3–4 days post-insertion. An adequately powered trial investigating replacement strategies would be difficult to conduct because of the large sample size required. In the absence of such a trial, the authors argue that a pragmatic approach is routine replacement at 72 hours. Further data on dwell time and other modifiable risk factors from prospective studies would be a welcome addition to the literature in this area. The authors encourage all doctors to be aware of peripheral venous catheters as a source of bacteraemia. *Table 1* summarizes suggested points for practice to prevent peripheral venous catheter-associated *S. aureus* bacteraemia, based on the limited data currently available. **BJHM**

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KEY POINTS

- Peripheral venous catheters are an important but under-recognized source of *Staphylococcus aureus* bacteraemia.
- Risk factors include device dwell time, insertion in the antecubital fossa and insertion in the emergency department.
- Implementing preventative strategies is a challenge because of the lack of a robust evidence base.
- The authors believe that a peripheral venous catheter should be removed within 72 hours, because of the association between dwell time and bacteraemia and the inability to use phlebitis as a reliable marker of the risk of bacteraemia.

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Table 1. Practice points to reduce risk of peripheral venous catheter-associated *Staphylococcus aureus* bacteraemia

Area of practice	Recommendation(s)
Insertion	Careful aseptic technique
	Peripheral venous catheter placement in hand or distal forearm is recommended; avoid the antecubital fossa and lower extremities
	Dedicated intravenous access teams should be considered
	Document catheter gauge, insertion date and site
Maintenance and review	Consider peripheral venous catheters inserted in the emergency department at higher risk of infection
	Peripheral venous catheters should be examined at least daily for signs of exit site inflammation and removed if present
	The necessity of a peripheral venous catheter should be evaluated daily and the device removed if no longer required
	Dressings should be kept intact and replaced if needed
	Requirement for peripheral venous catheter review should be incorporated into daily review 'checklists'
Replacement	Peripheral venous catheters should be replaced by 72 hours, outwith circumstances of extreme intravenous access difficulties
	Peripheral venous catheter replacement should be performed earlier if there are signs of exit site inflammation or infection, or other reasons to suspect peripheral venous catheter-associated bacteraemia
Evaluation of nosocomial <i>Staphylococcus aureus</i> bacteraemia	In the event of a patient developing nosocomial bacteraemia, a high degree of suspicion should be directed towards any peripheral venous catheter in situ or old peripheral venous catheter sites
Longer term intravenous access	Consider placing a midline or peripherally-inserted central catheter in patients requiring a prolonged course of intravenous therapy

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