



# Bloodstream infection and occlusion of central venous catheters in children

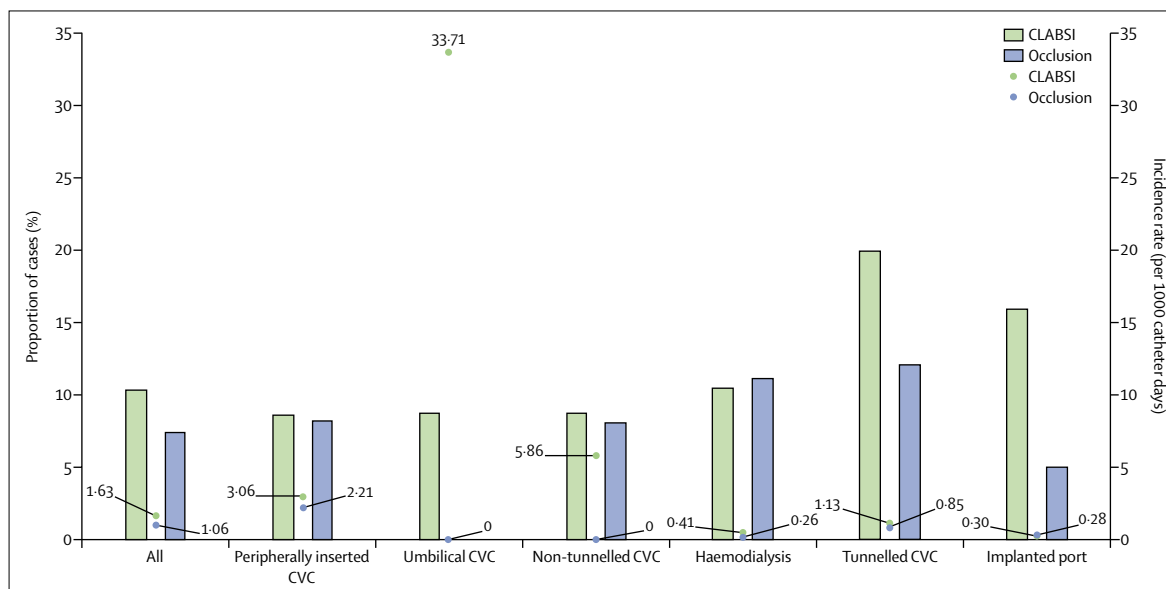
One in ten children with a central venous catheter (CVC) develops a central line-associated bloodstream infection (CLABSI),<sup>1</sup> which is a life-threatening complication and harmful distraction from time-sensitive treatment. However, across CVC types (figure), device occlusion is also troublesome and might increase CLABSI risk, presumably through the complementary interactions of fibrin, thrombus, and biofilms.<sup>2</sup> The question arises as to what antimicrobial, antithrombotic, or other solution can be periodically instilled (known as locked) within the CVC to prevent one, or preferably both, of these complications. Furthermore, which solutions could effectively treat such complications, should they arise, without needing to remove the CVC? Few high-quality randomised controlled trials have addressed these questions, and it is difficult to find two health-care institutions that share identical policies for lock solution type, concentration, frequency, or duration of dwell. This situation has probably resulted in preventable injuries in children who rely on CVCs to administer treatment.

Published in *The Lancet Infectious Diseases*, research by Wolf and colleagues<sup>3</sup> at last provides insight as to whether ethanol locks can treat existing CLABSI and prevent its recurrence, compared with heparinised

saline controls. The trial was stopped early for futility, in line with the protocol, with identical treatment failure (44%) in the two groups. Randomised controlled trials in children with cancer or a haematological disorder can be difficult to do because of the small number of cases in single institutions. Perhaps the introduction of the mucosal barrier injury laboratory-confirmed bloodstream infection classification by the US Centers for Disease Control and Prevention will make recruitment easier.<sup>4</sup> Although the trial by Wolf and colleagues predated these definitions and thus included them in their primary endpoint, future studies in this population are likely to see 50% of CLABSI cases reclassified as mucosal barrier injury laboratory-confirmed bloodstream infections.<sup>5</sup> As a result, the prevalence of CLABSI in children with cancer will become similar to that of other acutely ill children with CVCs, thus making trials recruiting mixed populations of both cancer and non-cancer participants more feasible and generalisable.

Successful CLABSI treatment with an effective locking agent, thus avoiding device removal, would help to minimise treatment disruption without causing negative sequelae. The Infectious Diseases Society of

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**Figure: CLABSI and occlusion in paediatric CVC complications across 74 studies**  
 Data from Ullman et al.<sup>1</sup> Columns are proportion of cases. Dots are incidence rate. CLABSI=central line-associated bloodstream infection. CVC=central venous catheter.

America recommends that long-term vascular access devices, such as tunnelled and implanted port devices, should be removed if CLABSI is associated with specific conditions (eg, severe sepsis, endocarditis) or infectious organisms (eg, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, fungi, or mycobacteria).<sup>6</sup> In patients without such devices or organisms, conservative treatment with antibiotics, and not CVC removal, avoids the potential harm associated with the insertion of CVC replacements. However, these recommendations assume that established bacteria within biofilms can be effectively decontaminated. Wolf and colleagues report that ethanol lock therapy did not achieve such decontamination, at least with the protocol used and in the silicone tunnelled and port device types studied. So, what else might be effective? Data from studies of newborn babies suggests that antibiotic locks prevent CLABSI, and data from children suggests that taurolidine-citrate locks do also, but neither is established as a treatment lock for after CLABSI develops.<sup>7-9</sup>

In general, best practice for the prevention of CLABSI in children involves skin preparation with chlorhexidine-alcohol, antimicrobial or antithrombotic CVCs, and antimicrobial dressings, although trials have not covered all paediatric populations or CVC types.<sup>8,10,11</sup> New needleless connector designs and alcohol impregnated connector caps might prevent intraluminal colonisation, but evidence from randomised controlled trials is not yet available. Some of the most effective strategies to prevent CLABSI are the basics: handwashing, injection-site decontamination before use, timely device removal, and frequent site assessment for complications and suboptimal dressings.<sup>12</sup>

CLABSI cannot be discussed without mentioning occlusion. Mechanical, infusate precipitate, and thrombotic occlusions are common and might further potentiate CLABSI.<sup>3</sup> Wolf and colleagues reported that occlusion was significantly more common with ethanol locks—58% compared with 33% for heparinised saline. Although this finding was a secondary outcome and might have been an incidental finding, it should give us pause for thought. Both groups received intermittent heparinised saline flushes. Ethanol was withdrawn after each lock, but was often detectable in blood drawn through the CVC, suggesting that some remained in the lumen. Because of ethanol's incompatibility with heparinised saline, precipitation could have contributed to some occlusion

episodes.<sup>8</sup> Clinics using ethanol locks should consider use of saline alone as their intermittent flush agent. An alternative explanation for the trial's finding of less occlusion in the control group is that heparinised saline used for locks and for regular flushes might have reduced this effect, despite the low concentration of heparin (10 units per mL). A meta-analysis of trials testing saline alone versus heparinised saline at concentrations of 50–200 units per mL used for intermittent flushes found no significant difference in occlusion rates, although the evidence was rated as low quality.<sup>13</sup>

Both infectious and occlusive complications are unacceptably common across CVC types and paediatric populations, causing many devices to fail prematurely. Ongoing efforts are needed to find effective flush and lock solutions for CVCs that lead to fewer infected and occluded devices being replaced.

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