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Editorial

Central line-associated bloodstream infection (CLABSI) rates: achieving the elusive goal of zero

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Abstract. Zero-risk for CLABSI is achievable – but not without applying distinctively different strategies. Currently, the majority of ICU patients have a short dwell time, <9 days, and with aseptic insertion will remain infection-free for their entire ICU stay. But the minority of patients have a longer dwell time, contribute the majority of CLABSI and require more than aseptic insertion to reduce the risk of infection. Consequently, aggregating short and longer dwell times prevents us from evaluating care.

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Central line-associated bloodstream infections (CLABSIs) are serious healthcare-associated infections (HAIs) with an attributable mortality of 12 to 25%. Prevention of CLABSIs is high on the patient safety agenda.[1] Concerns have been expressed about current CLABSI rates, with experts calling for zero tolerance of CLABSIs.[2] The Keystone Project's CLABSI prevention insertion bundle was rolled out to 103 intensive care units (ICUs) in Michigan in the United States and achieved remarkable reductions (67%) in CLABSI rates.[3] Similar experiences have been seen at hospitals in Australia[4] and the United Kingdom.[5] In New South Wales (NSW), the Clinical Excellence Commission and the Intensive Care Co-ordination and Monitoring Unit introduced only the CLABSI prevention insertion bundle (not the maintenance bundle) in 34 ICUs between July 2007 and December 2008. This intervention resulted in a significant CLABSI reduction from 3.0 CLABSIs per 1000 line-days to 1.2 CLABSIs per 1000 line-days.[4] Similarly, in the intervention in the UK, the 'Matching Michigan' intervention'[5] resulted in a reduction of CLABSIs from 3.7 to 1.48 per 1000 central venous catheter (CVC)-days ($P < 0.0001$). In Australia[4] and the UK[5] neither intervention reached a rate of zero CLABSIs. It is clear from decades of data that HAI (including CLABSI) surveillance alone will not magically reduce the rate to zero[1] and a multitude of intervention strategies have been investigated and recommended, some of which are costly.[6–8]

There are an estimated 15 000 central lines inserted annually in NSW ICUs alone, of which up to 0.3% or ~45 patients will acquire a CLABSI.[4] Bloodstream infections extend length of stay by an average of 1 to 6 days.[9] With an average cost for a single ICU day, excluding consumable costs, in Australia estimated at $2670 to $6801,[10,11] the annual cost associated with 45 infected patients in NSW could range from $128 160 for 1 additional day to as high as $1.9 million for 6 additional days. The impetus for Australian ICUs to reduce CLABSI to zero on cost alone is compelling.

Few infection-prevention programs have been able to achieve and sustain a rate of zero CLABSIs.[8] Some have questioned whether zero-risk for CLABSIs is realistic. We argue that it is! The problem is that the current surveillance and calculation methods for CLABSI use aggregated data that obscures where zero-risk occurs.[12,13] When one considers that early CLABSIs are caused predominantly by extra-lumenal colonisation and the later CLABSIs are caused predominantly by intra-lumenal colonisation,[15] then it is clear that strategies to prevent both of these pathogenic mechanisms, an insertion bundle to prevent extra-lumenal colonisation and a maintenance bundle to prevent intra-lumenal colonisation, are necessary. In fact, for many patients around the world, the duration of catheterisation is much longer than 7 to 10 days (often weeks, months or even years). In such patients, the maintenance bundle is even more important than the insertion bundle. We argue that cost-effective CLABSI maintenance and preventive strategies,[16,17] including daily chlorhexidine bathing[18] of ICU patients and the chlorhexidine-impregnated sponge dressing, are justifiable additional assistance to the insertion bundle to reach zero CLABSIs.

The probability of CLABSI increases with dwell time[14] and logic dictates that with increased dwell time, other risk factors become increasingly influential in the development of CLABSI. Therefore, we set to prove that aseptically inserted

Box 1. The rationale for having two CLABSI rate thresholds

- Zero CLABSI rate threshold for the first 9 line-days is potentially achievable[13]
  - Majority of patients in ICU have a short dwell time
  - Aseptic insertion technique extends the closest to zero-risk period to the first 9 line-days[13]
  - Rate per 1000 line-days: all CLABSIs developed in the first 9 days divided by the aggregation of all first 9 line-days
- The new threshold will see the majority of ICU patients remaining infection-free[13]
- CLABSI rate threshold for extended dwell-times[13]
  - Dwell times of 10–14 line-days have a risk probability for CLABSI of 5 in 100 chances; dwell times of >14 line-days have a cumulative risk of 13 in 100 chances. The aggregate rate for prolonged dwell time is 5.5 per 1000 line-days.[13]
  - These lines have a different risk for infection and cannot achieve zero-risk with just aseptic insertion (insertion bundle)
  - Rate per 1000 line-days: all CLABSIs developed after line-day 10 divided by the aggregation of all line-days for dwell times of ≥10 days.
- Strategies to reduce infection in ICU
  - Daily review CVCs for possible early removal[2,3]
  - Post-insertion care of CVCs[2]
  - CVCs with prolonged dwell time may never achieve zero risk threshold without maintenance bundle technological preventive strategies[1]
    - Chlorhexidine-impregnated sponge dressings, chlorhexidine bathing, antimicrobial/antiseptic locks/flushes and antiseptic/antimicrobial-impregnated catheters used for CVCs with expected extended dwell time past 9 days[7,8,16-18]
    - Units having difficulty achieving zero-risk may consider a limited intervention of technological strategies to help reduce intractable infection rates

central lines provide a low-to-zero risk for infection, in the case of a limited dwell time in the absence of additional preventive strategies.[16–18] Additional maintenance and preventive strategies include the prevention of biofilms on CVCs and hand hygiene before accessing central lines. We used probability estimates to identify the dwell time with the closest zero-risk probability for CLABSIs (≤1 in 100 chance)[13] and we found that before the NSW CLABSI intervention[4] this minimal risk for CLABSIs was already occurring routinely in the first 7 days from insertion;[13] aseptic insertion extended this period of close-to-zero-risk by 2 additional days to the first 9 days after insertion (when the CLABSI rate was <1 per 1000 line-days).[13]

The USA Centers for Disease Control and Prevention's (CDC's) National Healthcare Safety Network[19] estimates CLABSI rates by dividing all CLABSIs by the total aggregated central line-days. That includes all dwell times, long and short. Yet, 50% of Australian ICU patients have a short dwell time of ≤4 days and 75% have a dwell time of ≤7 days.[13] Only 25% of catheters have dwell times of ≥8 days.[13] However, these 25% of patients with prolonged dwell times are overly-represented in counts of CLABSIs.[13] By simply separating CLABSI surveillance data into the two different patient groups, short dwell times (<7 days) and prolonged dwell times (>7 days), it will become clear that a close-to-zero-risk of CLABSI is occurring in the majority of Australian ICU patients with short dwell times and that this infection-free period can be extended by an additional two days with the insertion bundle (Box 1). Patients with expected prolonged dwell times will benefit from interventions such chlorhexidine-impregnated sponge dressings, chlorhexidine bathing of ICU patients, use of antiseptic- or antimicrobial-impregnated catheters and using the safest needleless connectors.

In conclusion, we have made enormous progress in reducing and/or eliminating CLABSIs in our ICU patients. Yes, zero-risk for CLABSI can be expected for the first 9 days after aseptic insertion of CVCs. This leaves the use of other technologies that prevent or reduce the risk of intra-lumenal colonisation, such as chlorhexidine bathing, chlorhexidine-impregnated sponge dressings, and antiseptic- or antibiotic-impregnated catheters for patients expected to have a CVC for >7 days. Through the application of both insertion and maintenance bundles, zero CLABSI rates may be achieved.

Conflicts of interest

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