Although it remains unproven that the Bair Hugger or other FAW devices may cause surgical site or implant-associated infections,[6] we recommend that alternative patient-warming methods[8] be used, especially in immunosuppressed patients and in procedures involving surgical implants. We believe that FAW devices may represent an unnecessary risk in these cases. Unfortunately, no randomized controlled clinical trials have been conducted to directly answer this question. Future studies should investigate a possible link between higher Bair Hugger run hours and increased SSI.

In conclusion, we recommend that institutions track Bair Hugge run time and change filters at least every 500 hours or at 1 year, whichever comes first. 3M should also consider implementing a 500-hour filter use alarm or installing a disposable HEPA filter at the end of the hose as it enters the warming blanket.

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Recurrent central-line–associated bloodstream infection in a single high-risk patient

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To the Editor—We report the case of a 44-year-old man with total parenteral nutrition (TPN) for short-bowel syndrome who was diagnosed with his 17th central-line–associated bloodstream infection (CLABSI). He had primarily been admitted to a single hospital unit during the period of his multiple infections. A timeline of his infections is provided in Figure 1. This case report was reviewed by the IRB of the University of Maryland, Baltimore and determined to be not human-subjects research. The patient provided consent to have his case information published.

Short-bowel syndrome arose from complications of an abdominal gunshot wound. During a difficult and prolonged recovery, he developed extensive bowel necrosis and eventually required total colectomy, partial enterectomy, and placement of a jejunal ostomy. With his entire colon and most of his small bowel removed, he developed severe malnutrition. Bowel transplant was declined due to lack of social support.

TPN, which the patient had required for >5 years, was administered through a tunneled catheter in his right external jugular vein. Repeated placement and removal of central lines had rendered other options for venous access unavailable. Bilateral internal jugular veins, brachiocephalic veins, and subclavian veins were either occluded or stenosed. Previous femoral access had been placed and removed in the context of bacteremia and sepsis. He declined placement of permanent transhepatic or translumbar venous access. Consultants from interventional radiology and vascular surgery advised that his current catheter was a "lifeline." Its removal would likely result in permanent loss of upper-extremity central venous access.

The current line had been placed by exchange over a guidewire 6 months earlier in response to a CLABSI. Gentamicin lock therapy was instilled daily for prophylaxis. Alcohol-impregnated caps were used on all ports. Regular central-line care was provided by attentive staff who reviewed the plan for central-line maintenance with nursing leadership, infection prevention, and the attending physician. Examination of his chlorhexidine-impregnated central-line dressing did not reveal any breaches or areas of concern. He received daily bathing with chlorhexidine gluconate in the preceding week, and he had not recently left the unit. Manipulation of the central line by the patient was not suspected.

Peripheral blood cultures collected after a fever of 39.3°C grew *Escherichia coli* that was resistant to gentamicin. No localizing symptoms suggested metastatic focus of infection or source besides the catheter. Blood cultures remained positive the following day but subsequently cleared. After initially receiving intravenous

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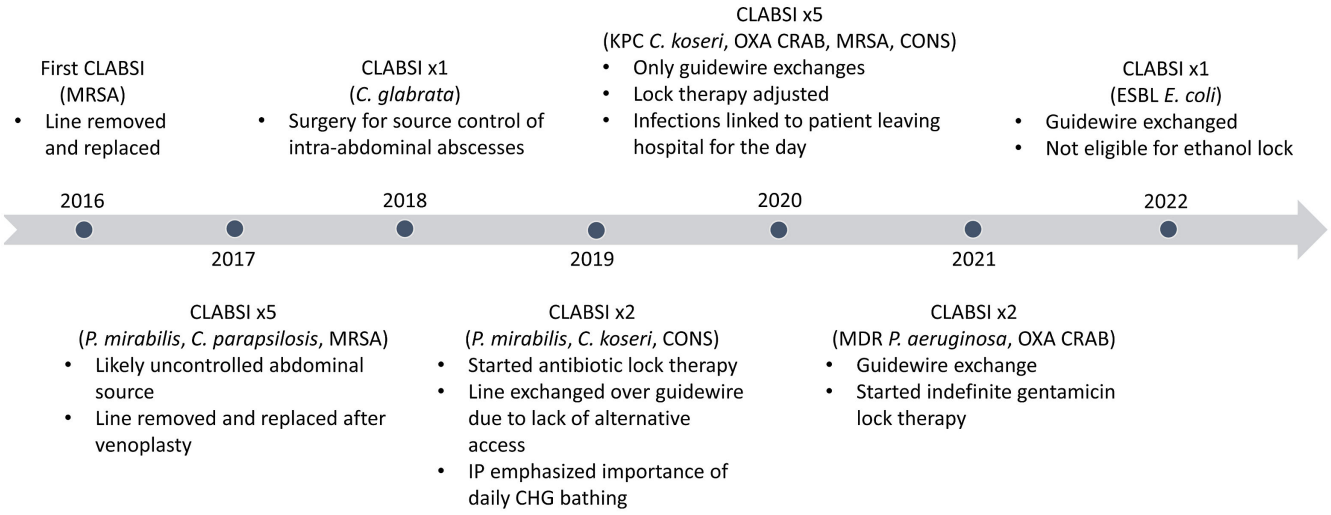

Fig. 1. Timeline of CLABSIs and major interventions. Note. CLABSI, central-line–associated bloodstream infection; MRSA, methicillin-resistant *Staphylococcus aureus*; *C. glabrata, Candida glabrata*; KPC, *Klebsiella pneumoniae* carbapenemase; *C. koseri*, *Citrobacter koseri*, OXA, OXA-type beta-lactamase; CRAB, carbapenem-resistant *Acinetobacter baumanii*; CONS, coagulase-negative staphylococci; ESBL, extended-spectrum β-lactamase; *E. coli*, *Escherichia coli*; *C. parapsilosis*, *Candida parapsilosis*; *P. aeruginosa, Pseudomonas aeruginosa*.

meropenem, his line was exchanged over a guidewire, and he was transitioned to ertapenem to complete 14 days of therapy. The antibiotic lock was changed to amikacin. Ethanol lock therapy was considered but was not compatible with the polyurethane catheter.

Discussion

Among healthcare-associated infections, CLABSI has the greatest potential negative impact on patient outcomes, including increased mortality risk and prolonged length of hospital stay.[1–3] CLABSI rates are also linked to hospital reimbursement through the Medicare hospital-acquired conditions reduction program and the State of Maryland's Quality-Based Reimbursement. For these reasons, CLABSI has been declared a "never event," and significant efforts have been undertaken to prevent its occurrence.[4]

Most US states legally require public reporting of healthcare-associated infections via the National Healthcare Safety Network (NHSN).[5] According to NHSN definitions, any bloodstream infection that develops in the context of a central line and cannot be attributed to an alternative source is counted as a CLABSI. If the blood culture is positive for a qualifying pathogen, signs or symptoms of infection are not required. Determination of an alternative source of infection depends on the quality of documentation and can be subjective, introducing variability based on who does the chart review.[6–8]

On average, the rate of CLABSI in the United States is 1.7 events per 1,000 central-line days.[9] Based on 17 CLABSIs over a single 2,000-day period, this patient's individual CLABSI rate was 8.5 events per 1,000 central-line days. These CLABSIs accounted for 27% of all CLABSIs occurring at his admitting hospital. During this period, the NHSN-defined CLABSI rate reflected the largely unmodifiable circumstances of a single patient instead of the quality of care received by most patients at this hospital.

CLABSI prevention is difficult and requires engagement by the entire healthcare team. Efforts to maintain that engagement can be undermined when publicly reported rates are biased to suggest that infection prevention practices do not make a difference. When staff are less motivated, the expectation of recurrent CLABSI can become self-fulfilling. These unintended consequences of public reporting are likely most relevant when options for out-of-hospital care are limited, as is often true for socioeconomically disadvantaged patients.

Although CLABSI is a considered a "never event," CLABSIs may be inevitable for some patients. For this patient, multiple CLABSIs occurred despite attentive delivery of evidence-based preventive measures. Although this case is an extreme example, recurrent infections are not uncommon in our experience. We have observed similar occurrences for other NHSN-defined infections, including catheter-associated urinary tract infection, *Clostridioides difficile* infection, and methicillin-resistant *Staphylococcus aureus* bacteremia.

We suggest that recurrent NHSN-defined infection of the same type in a single patient is more likely to be a consequence of the unmodifiable susceptibility of the patient than the quality of care delivered. To reduce bias, NHSN should consider revising the definition of CLABSI and other healthcare-associated infections to exclude patients who have already developed the same infection during the same hospitalization, regardless of the time elapsed between episodes.

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Homogeneity and standardization in hand hygiene compliance

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To the Editor—Healthcare-associated infection (HAI) is a major problem for patient safety and hand hygiene is recommended as one of the most effective strategies for preventing HAI.[1,2] In 2004, WHO launched the global hand hygiene campaign to improve hand hygiene practices, which included 5 indications for hand hygiene: before patient contact, before an aseptic task, after body fluid exposure risk, after patient contact, and after contact with patient surroundings.[3]

Monitoring healthcare workers' adherence to recommended hand hygiene practices is considered an important element of an effective hand hygiene program. Because many factors (eg, observation bias, selection bias, information bias and the Hawthorne effect) can occur during monitoring, increasing attention has been given to reduction of these biases to achieve more accurate measurement of hand hygiene compliance.[4–6] Notably, overall hand hygiene compliance observed in different studies should not be compared directly, due to heterogeneity among the studies. That is, the overall hand hygiene compliance should not be directly compared when the proportion of observations conducted among each of the 5 indications for hand hygiene differs among the studies.

Taking the following research studies as an example (Table 1), hand hygiene indications 1 and 2 in study 1 show lower compliance than those in study 2. However, study 1 (53.8%) exhibits a higher overall compliance than study 2 (46.3%). The main reason for this inconsistency is the difference in the proportion of various indications for hand hygiene between these 2 studies.

Accordingly, we believe that homogeneity and standardization should be considered not only at the design stage of every hand hygiene monitoring scheme but also at the time of compliance analysis. We also recommend that these factors should be added to the new version of the *WHO Guidelines on Hand Hygiene in Health Care*.

Homogeneity in design

To allow accurate comparison of hand hygiene compliance, researchers should ensure that each hand hygiene indication has the same proportion of observed opportunities during each study period. For example, in each study period, 40% of total observations are conducted in relation to indication 1, 20% of observations are conducted in relation to indication 4, and 40% of observations are conducted in relation to indication 5. Using this scheme, all observational samples will be homogeneous and the overall compliance rates will be comparable because the proportion in each sample is equal for the same indication. When publishing compliance results, it is necessary to report the total number of hand hygiene opportunities and actions regarding the 5 individual indications as well as total hand hygiene opportunities.

Standardization in comparison

When hygiene compliance from different studies is compared, standardization is needed. Direct and indirect standardization can be applied, and the use of these 2 standardized methods should depend on the availability of data. Direct standardization can be carried out using the following formula:

$$p' = \frac{N_1 p_1 + N_2 p_2 + \ldots + N_i p_i}{N_1 + N_2 + \ldots + N_i} = \frac{\sum N_i p_i}{\sum N_i} \quad (1)$$

The numerator of p' may be recognized as the number of standardized actions and the denominator of p' is the overall standardized opportunity number. N_i represents the standardized opportunity number (the sum of opportunity numbers of every corresponding hand hygiene indication in all studies), and p_i is the respective original compliance of each hand hygiene indication. In this example, the values of N_1, N_2, p_1, and p_2 were 500 (ie, 300 + 200), 700 (ie, 100 + 600), 60.0%, and 35.0% in study 1, respectively. Therefore, the overall standardized compliance should be calculated as 45.4% for study 1 and 50.4% for study 2 using the direct standardization method, which corrected for the effect of having different proportions of observations performed among the various hand hygiene indications during the 2 studies.

Additionally, when the total number of hand hygiene actions (r) in all studies and the opportunity number of every indication (n_i) are available but compliance is missing or the opportunity number

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