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Original Article

Central venous catheter bundle adherence: Kamishibai card (K-card) rounding for central-line–associated bloodstream infection (CLABSI) prevention

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Abstract

Objective: To institute facility-wide Kamishibai card (K-card) rounding for central venous catheter (CVC) maintenance bundle education and adherence and to evaluate its impact on bundle reliability and central-line–associated bloodstream infection (CLABSI) rates.

Design: Quality improvement project.

Setting: Inpatient units at a large, academic freestanding children's hospital.

Participants: Data for inpatients with a CVC in place for ≥1 day between November 1, 2017 and October 31, 2018 were included.

Intervention: A K-card was developed based on 7 core elements in our CVC maintenance bundle. During monthly audits, auditors used the K-cards to ask bedside nurses standardized questions and to conduct medical record documentation reviews in real time. Adherence to every bundle element was required for the audit to be considered "adherent." We recorded bundle reliability prospectively, and we compared reliability and CLABSI rates at baseline and 1 year after the intervention.

Results: During the study period, 2,321 K-card audits were performed for 1,051 unique patients. Overall maintenance bundle reliability increased significantly from 43% at baseline to 78% at 12 months after implementation ($P < .001$). The hospital-wide CLABSI rate decreased from 1.35 during the 12-month baseline period to 1.17 during the 12-month intervention period, but the change was not statistically significant (incidence rate ratio [IRR], 0.87; 95% confidence interval [CI], 0.60–1.24; $P = .41$).

Conclusions: Hospital-wide CVC K-card rounding facilitated standardized data collection, discussion of reliability, and real-time feedback to nurses. Maintenance bundle reliability increased after implementation, accompanied by a nonsignificant decrease in the CLABSI rate.

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Central-line–associated bloodstream infections (CLABSIs) remain an important target for quality improvement efforts given their impact on patients and healthcare institutions. CLABSIs in pediatric patients are associated with an increased hospital length of stay of 19 days and a cost of US$16,000–$69,000 per event.[1,2] CLABSI infection rates serve as metrics for hospital rankings and reimbursement negotiations.[3]

In 2001, the Institute for Healthcare Improvement introduced the concept of a "bundle": a set of evidence-based interventions that, when implemented together, improve patient outcomes when compared with individually implemented interventions.[4] Central venous catheter (CVC) maintenance bundles are associated with decreased CLABSI rates in children.[5-13] Bundle elements include discussing the CVC need daily, limiting CVC entries, disinfecting needleless connectors, changing the CVC dressing every 7 days, and replacing needleless connectors and administration sets per hospital policy.[14-16] Furuya et al[17] demonstrated ICUs that monitored bundle adherence and maintained ≥95% compliance had significantly lower CLABSI rates. In pediatric patients, attaining high adherence with a CVC maintenance bundle presents a continued challenge.[6,12,18,19] Previously published studies have not described sustained CVC maintenance bundle reliability in a children's hospital.

Kamishibai cards (K-cards) are tools that provide scripting for interactions between clinicians and auditors. The concept

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originated as a form of storytelling in Japanese Buddhist temples, and Toyota has used it as a management tool for auditing.[20] K-cards minimize differences between auditors in style and attention to detail; this standardization reduces variability in outcomes for audits conducted by different people. Jurecko et al[21] reported an association between hospital K-card use and increased bundle adherence. Shea et al[22] found K-card interactions beneficial for reminding unit leaders and frontline nurses about bundle elements. Many institutions have adopted K-cards for monitoring adherence for healthcare-associated infection prevention, but published data demonstrating the impact on outcomes are limited.

The aims of this quality improvement (QI) initiative were to implement hospital-wide CVC K-card audits and to evaluate their impact on maintenance bundle reliability and CLABSI rates.

Methods

Setting and population

This QI initiative was implemented at a 415-bed academic pediatric hospital with 25,000 annual inpatient admissions. The intervention was implemented in 4 intensive care units, 1 intermediate care unit, 3 medical units, 2 oncology units, 1 cardiology unit, and 3 surgical units. The infection prevention and control (IPC) program at this institution includes 7 infection preventionists, a data analyst, and 2 physician medical directors. Each inpatient unit has a unit-based nurse with protected time for infection prevention activities. All inpatients with a CVC in place for ≥1 day(s) between November 1, 2017, and October 31, 2018, were eligible for inclusion. Inpatients with only dialysis and/or pheresis catheters were excluded because bedside nurses who participated in K-card rounds are not responsible for the daily maintenance of these specialized catheters. Results are reported using Standards for Quality Improvement Reporting Excellence (SQUIRE) version 2.0 guidelines as a framework.[23]

Intervention

Infection preventionists developed a CVC K-card with interdisciplinary input (Supplemental Fig. 1 online). Because maintenance bundle reliability is the main driver of CLABSI reduction in pediatric ICUs, these elements were the focus of the card.[7] The card was based on CLABSI prevention recommendations from the Centers for Disease Control and Prevention (CDC) and other expert groups.[14,16,24,25] K-card audits assessed the following elements: (1) scrubbing the needleless connector hub for at least 15 seconds; (2) on-time dressing changes; (3) daily discussion of need for the CVC; (4) respondent identification of at least 1 way they limited CVC entries during their shift; (5) on-time needleless connector changes; (6) daily bathing; and (7) presence of alcohol-impregnated caps on all unused ports. Operational definitions for these elements are shown in Table 1. Before the introduction of K-cards, unit-based nurses conducted adherence monitoring using self-report audit tools, and maintenance bundle adherence averaged 94% in the 12 months prior to K-card implementation.

Using plan–do–study–act (PDSA) methodology, a 1-month pilot of the tool to assess feasibility and guide refinement was conducted in June 2017 in the cardiac intensive care unit (CICU), the solid-organ transplant unit, and a surgical unit. Following the pilot, feedback was obtained from stakeholders and a measurement plan was developed. On November 1, 2017, audits were expanded to all inpatient units.

Data collection

K-card audits were performed by an infection preventionist and a unit-based nursing leader. A convenience sampling approach was used to select the patients to be audited. Using the card as a guide, the auditors asked the bedside nurse a standardized series of questions and recorded feedback about the tool and general CVC maintenance. Bedside nurses reported their adherence with 5 of the bundle elements, and K-card auditors obtained information about adherence with on-time dressing and needleless connector changes through review of the electronic health record (EHR).

Audit data were recorded in REDCap[26] and included adherence to bundle elements; the patient's medical record number and date of birth; CVC information including the type, number of lumens, and number of days since insertion; patient receipt of parenteral nutrition, lipid-based products, or blood products in the previous 24 hours; reason(s) for nonadherence with bundle elements; and comments from the bedside nurse. Demographic data (including sex, race, ethnicity, and dates of hospital admission) for audited patients were collected retrospectively from the enterprise data warehouse (EDW).

Units with >0.3 CVC days per patient day were defined as high risk, and those with ≤0.3 CVC days per patient day were defined as low risk. High-risk areas required at least 20 audits per month, while low-risk areas required at least 10 audits per month.

Measures

The primary process measures were (1) adherence with all bundle elements and (2) adherence with each individual bundle element. Overall reliability was assessed using an "all-or-nothing" approach; if any element was not performed, the entire audit was considered nonadherent, as recommended by the Institute for Healthcare Improvement.[27] To ensure accuracy, data were reviewed and cleaned monthly prior to analysis. Audit data were shared with units each month during established infection prevention committee meetings.

The primary outcome was the institution-wide CLABSI rate per 1,000 CVC days using National Healthcare Safety Network (NHSN) definitions.[28] Our preimplementation period was November 1, 2016, to October 31, 2017, and the implementation period was November 1, 2017, to October 31, 2018. No new products or CVC policies were introduced during the implementation period. To monitor whether changes were sustained, we also defined a postimplementation "sustainability" period of November 2018–September 2019.

Analysis

Quantitative analysis

Characteristics of audited CVCs and patients were summarized using descriptive statistics. Maintenance bundle reliability was calculated monthly and expressed as a proportion. Change in reliability from the initial to final month of the implementation period was compared using χ^2 tests. CLABSI rates were displayed using statistical process control charts. The change in CLABSI rate between the 12-month preimplementation period and the implementation period was assessed using Poisson regression. Analyses were performed using Stata version 13.1 software (StataCorp LP, College Station, TX) and SAS version 9.4 software (SAS Institute, Cary, NC).

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Table 1. Kamishibai Card (K-Card) Maintenance Bundle Elements and Adherence

Maintenance Care Bundle Element	Definition of Adherence	Median Monthly Adherence During Implementation Period, %
1. Scrubbing the needleless connector hub for at least 15 s with alcohol	If the CVC was accessed on the day of the audit, the bedside nurse scrubbed the needleless connector for a minimum of 15 s with each entry to the CVC.	100
2. On-time dressing changes	Dressing was changed within 7 d before the audit or earlier if dressing was not clean, dry, or occlusive/intact. This element was not assessed in the NICU because dressings are permitted to be in place longer if the risk of catheter dislodgment during dressing changes is thought to be high.	99
3. Daily discussion of need	The medical team discussed need for the CVC during rounds that day. At least 1 physician must have been present at rounds. If the nurse was not present on rounds, adherence was not assessed for this element. CVCs could be considered "exempt" from the discussion of need if any of the following criteria were met: • Patient in active chemotherapy treatment • SCT patient at day −5 to day +100 posttransplant • SCT patient at day +100 posttransplant with active GVHD • Permanent CVC used for home parenteral nutrition • Implanted vascular access device (ie, port-a-cath) • Pulmonary hypertension on IV infusion therapy	84
4. Limit entries	The bedside nurse could identify at least one way that entries to the CVC were limited during the shift. No opportunities to limit entries to the CVC was also considered to be adherence. Examples of opportunities included batching cares, batching labs, converting IV medications to enteral, or drawing blood from peripheral veins.	99
5. On-time NC changes	At the time of the audit, no NC changes were overdue per documentation in the EHR. On-time NC change was defined as at least every 96 hours, or every 24 hours if lipid-based solutions or blood/blood products were being administered via the CVC.	94
6. Daily bathing	At the time of the audit, the bedside nurse verbalized that a bath was given or the bath was documented in the medical record. Bathing via bath, shower or disposable cloth were considered to be adherence. Chlorhexidine gluconate bathing was also recorded (and considered to be adherence) for applicable patients.	86
7. Alcohol-impregnated caps on all unused NCs and Y sites	At the time of the audit, the bedside nurse indicated that all unused Y site(s) and port(s) were covered with alcohol-impregnated caps.	99

Note. CVC, central venous catheter; NICU, neonatal intensive care unit; SCT, stem cell transplant; GVHD, graft-versus-host disease; IV, intravenous; NC, needleless connector.

Qualitative analysis

Interviews and free-text responses from nurses were recorded and deidentified. Data were independently coded and analyzed by 2 team members (J.A.O. and J.A.C.) using established grounded-theory methods.[29] Themes were generated through the constant comparison method, where new responses are compared with prior data and categories are continually developed. Initial codes were identified by line-by-line coding. These codes were placed into larger categories, ideas, and concepts. Intermediate concept codes were ultimately categorized into major themes. Saturation was reached when no new themes emerged with subsequent transcription analysis. Investigators discussed and resolved all discrepancies in concept categorization and themes.

Ethical considerations

Because this was a quality improvement initiative, our institutional review board did not review this project.

Results

Intervention modifications

Based on feedback from clinicians, the K-card was modified in February 2018 for the element regarding discussion of CVC need. During rounds, providers could indicate that a CVC was "exempt" from discussion of need if the patient met certain diagnostic criteria (Table 1).

Quantitative results

During the implementation period, 2,444 audits were performed on 1,096 patients, with an average of 204 audits per month. We removed 24 audits with missing or erroneous patient data and 99 audits with missing data for at least 1 bundle element, resulting in a final sample of 2,321 audits performed on 1,051 patients (1,292 inpatient encounters). The demographics of patients whose CVCs were audited and properties of audited CVCs are shown in Table 2.

Figure 1 displays overall reliability for all 7 elements of the CVC maintenance bundle, which increased from 43% (80 of 188; 95% confidence interval [CI], 36%–50%) in November 2017 to 78% (183 of 235; 95% CI, 73%–83%) in October 2018 ($P < .001$). The most common nonadherent element was daily discussion of need for the CVC. However, reliability for this bundle element increased from 66% in November 2017 to 89% in October 2018 ($P < .001$). Reliability for all other individual elements either increased or stayed constant throughout the implementation period. Median monthly adherence by element during the implementation period is shown in Table 1. During our sustainability period of November 2018 to September 2019, the overall monthly reliability ranged from 73% to 81%.

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Table 2. Characteristics of Inpatient Encounters with Central Venous Catheter (CVC) Kamishibai Card (K-Card) Audits Performed Between November 1, 2017, and October 31, 2018

Characteristic	Total (N=1,292 Inpatient Encounters), No. (%)
Demographics	
Age, median y (IQR)	4 (0–13)
Age	
<1 y	377 (29.2)
1–4 y	301 (23.3)
5–9 y	178 (13.8)
10–14 y	172 (13.3)
≥15 y	264 (20.4)
Sex, male	727 (56.3)
Race (N=999)	
White	635 (63.6)
Black or African American	96 (9.6)
Asian	43 (4.3)
American Indian or Alaska Native	3 (0.3)
Other not specified race	233 (23.3)
Ethnicity: not Hispanic (N = 936)	793 (84.7)
CVC characteristics	
Catheter type (N=2,445)	
PICC	1,266 (51.8)
Tunneled catheter (ie, Broviac)	438 (17.9)
Temporary nontunneled single/double/triple	435 (17.8)
PAC	252 (10.3)
Intracardiac[a]	24 (1.0)
UVC	18 (0.7)
Pheresis[a]	11 (0.5)
Dialysis[a]	1 (0.0)
Reason for CVC (N=2,300)	
IV nutrition	891 (38.7)
IV medications	666 (29.0)
IV drips	611 (26.6)
Long-term chemotherapy	445 (19.3)
Labs	326 (14.2)
Poor IV access	177 (7.7)
Hemodynamic monitoring	64 (2.8)
Pheresis	7 (0.3)
Dialysis	6 (0.3)
Days from CVC insertion to audit, median (IQR) (N=2,004)	14 (6–38)

Note. IQR, interquartile range; PICC, peripherally inserted central catheter; PAC, implanted vascular access device; UVC, umbilical venous catheter; IV, intravenous.
[a]These patient encounters had an included CVC with an excluded CVC.

Moreover, 78 CLABSIs occurred during the baseline period and 67 occurred during the implementation period. The hospital-wide CLABSI rate per 1,000 CVC days decreased from 1.35 during the baseline period to 1.17 during the implementation period, but this change was not statistically significant (incidence rate ratio [IRR], 0.87; 95% CI, 0.60–1.24; $P = .41$). The CLABSI standardized infection ratio (SIR) decreased by 18% during the implementation period from 1.1 to 0.9, but without statistical significance (95% CI, 0.7–1.2; $P = .50$). During the implementation period, the monthly CLABSI rate varied more above and below our center line, but the process never met criteria for being out of control. During the 11-month sustainability period, 50 CLABSIs were reported, and 8 of the final 9 monthly rates were below the center line, which indicates improvement in the process (Supplemental Fig. 2 online).

Monthly CVC utilization remained similar throughout the baseline and implementation period at 0.4 CVC days per patient day.

Qualitative results

During in-person conversations, nurses raised important practice and patient safety questions. We identified 4 themes from nurses' comments at the bedside: product issues, best practice review, parent education, and staff education (Table 3). As a result of these findings, new products were tried, evidence-based reviews were conducted, and re-education of parents and staff occurred in real time.

Discussion

In our QI initiative, implementation of a standardized tool to monitor maintenance CVC care for pediatric patients increased overall reliability from 43% to 78%, and the hospital CLABSI rate trended lower after implementation. Hospitals have challenges achieving adherence to recommended maintenance care.[12] Edwards et al[30] found that among pediatric intensive care units (PICUs) with CVC insertion and maintenance bundles, only 35% achieved ≥95% adherence over a 2-year period. Our intervention demonstrates that K-cards are a novel way to address this gap by reducing variability in audits and facilitating real-time education and dialogue with nurses about CVC maintenance in a nonthreatening environment. Hospital and unit-based leadership support enabled us to promote a culture of high reliability.

Identified opportunities for improvement included the daily discussion of need for a CVC and daily patient bathing. Barriers to daily discussion of CVC necessity included lack of provider engagement and lack of a clear guideline for this discussion. The intended goal was daily verbal acknowledgment of the CVC during rounds and a description of the need for central access. Providers argued that this discussion was unnecessary for patients who were on parenteral nutrition or who were long-term oncology patients undergoing chemotherapy through implanted ports. These patients were expected to have CVCs in place for a prolonged period, and daily discussion would extend rounds without offering a meaningful opportunity for intervention. In response to this feedback, exclusion criteria for the daily discussion were implemented in February 2018. Reliability for this element increased after this change, but it can be improved further.

Daily bathing for patients with a CVC remains another opportunity. Reported barriers to daily bathing included absence of review of bathing at hand-off or report, inconsistent bathing products across units, patient or parent preference not to bathe, and lack of knowledge regarding potential benefits of bathing for high-risk patient populations. Infection preventionists educated nurses during K-card rounding by sharing literature, by using role play to review how to address patient or parent preferences, and by obtaining alternative bathing products for particular patient populations. Our experience is consistent with the

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Table 3. Qualitative Themes From Kamishibai Card (K-Card) Rounding and Associated Practices Changes

Theme	Illustrative Quotes	Change
Product issues	"Patient has special accommodation of coiled IV tubing that allows for more movement." "Will ask . . . to bring the coiled tubing that adds some 'play' to the line to products. Use depends on many factors, but might represent an option for a certain population."	Coiled tubing option was brought to the products committee to reduce tension on the CVC with patients that move a lot for developmental reasons.
Best-practice review	"Cap gas is more accurate and we are teaching doctors how to do cap gases instead of entering the line for a venous gas." "Per NP bathing criteria for NICU needs to be refined . . . not best practice for some babies to be bathed daily as it is very age dependent."	This unit had implemented an alternate way to obtain blood instead of entering the CVC, leading other units to also consider cap gases as a way to avoid central access. Bathing practices and current evidence regarding bathing in the NICU were reviewed and new guidelines developed.
Parent education	"RNs commented on mom's long gel nails—a concern since mom very involved in care."	Infection preventionist followed up with the mother and did education regarding gel nails and risk of infection.
Staff education	"Redundant securement outside of dressing." "Filter clogged this morning, there is nowhere to document a filter change." "Radiology confirmation pending." "Alteplase use in the previous 24 hours."	Unit staff and the IV team were reminded that 1 securement device is adequate. This nurse was educated about different filter sizes, the filter policy, and completing a safety event report. In addition, a workgroup was assembled to discuss CVC lines, filters and disconnections. RNs and physicians were reminded that they must have the radiology confirmation before using the CVC. Alteplase education was provided to encourage its use for sluggish CVCs. If alteplase previously had been used, during subsequent K-card audits nurses were asked to confirm the CVC was no longer sluggish. As an adjunct, the manager of IV team has held in-services on alteplase.[31,32]

Note. CVC, central venous catheter; NICU, neonatal intensive care unit; RN, registered nurse; NP, nurse practitioner; IV, intravenous;

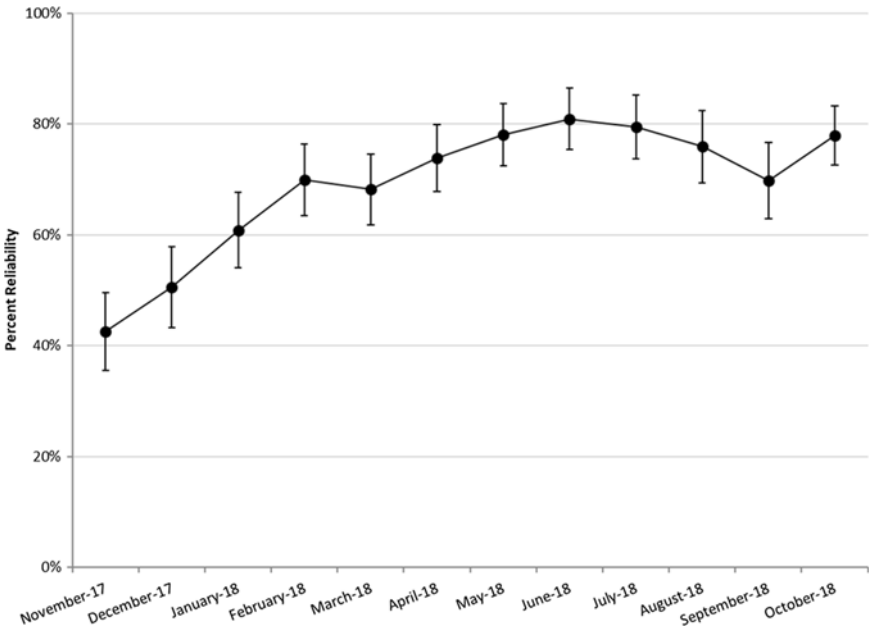

Fig. 1. Kamishibai card (K-card) central venous catheter (CVC) maintenance bundle overall reliability during implementation period.

findings of Duffy et al,[6] who demonstrated that the proportion of patients with documentation of a daily bath or shower increased from 30% to 70% after implementing a CVC bundle.

Our project has several limitations. We implemented a QI initiative at a large, freestanding, children's hospital, and our experience may not be generalizable to other organizations with different patient populations. We did not attempt to account for the influence of other factors (eg, patient diagnoses, age, hospital census or staffing levels) that might affect adherence to the CVC maintenance bundle. Some bundle elements were not documented in the EHR, so adherence could not be validated by data review. Because this project was a QI initiative, it may have been

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underpowered to detect small differences in CLABSI rates after the intervention. The strengths of our study include prospective data collection, a long study period with many observations, and inclusion of qualitative data to describe providers' experiences with the new process.

In summary, our QI initiative provides the first data assessing the impact of K-card rounding on outcome measures related to CLABSI prevention. We demonstrated that K-card rounding was feasible to implement and sustain in an academic pediatric hospital and was acceptable to providers. After implementation, our CVC maintenance bundle reliability increased significantly, accompanied by a trend towards a lower CLABSI rate.

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References

1. Goudie A, Dynan L, Brady PW, Rettiganti M. Attributable cost and length of stay for central line-associated bloodstream infections. *Pediatrics* 2014;133:1525–1532.
2. Wilson MZ, Rafferty C, Deeter D, Comito MA, Hollenbeak CS. Attributable costs of central line-associated bloodstream infections in a pediatric hematology/oncology population. *Am J Infect Control* 2014;42:1157–1160.
3. Dudeck MA, Weiner LM, Allen-Bridson K, *et al.* National Healthcare Safety Network (NHSN) report, data summary for 2012, Device-associated module. *Am J Infect Control* 2013;41:1148–1166.
4. How-to guide: prevent central line-associated bloodstream infections. Institute for Healthcare Improvement website. http://www.ihi.org/resources/Pages/Tools/HowtoGuidePreventCentralLineAssociatedBloodstreamInfection.aspx. Updated March 2012. Accessed May 17, 2020.
5. Choi SW, Chang L, Hanauer DA, *et al.* Rapid reduction of central line infections in hospitalized pediatric oncology patients through simple quality improvement methods. *Pediatr Blood Cancer* 2013;60:262–269.
6. Duffy EA, Rodgers CC, Shever LL, Hockenberry MJ. Implementing a daily maintenance care bundle to prevent central line–associated bloodstream infections in pediatric oncology patients. *J Pediatr Oncol Nurs* 2015;32:394–400.
7. Miller MR, Griswold M, Harris JM, *et al.* Decreasing PICU catheter-associated bloodstream infections: NACHRI's quality transformation efforts. *Pediatrics* 2010;125:206–213.
8. Ormsby JA, Bukoye B, Lajoie D, *et al.* Enhanced central venous catheter bundle for pediatric parenteral-dependent intestinal failure. *Am J Infect Control* 2018;46:1284–1289.
9. Schulman J, Stricof R, Stevens TP, *et al.* Statewide NICU central-line–associated bloodstream infection rates decline after bundles and checklists. *Pediatrics* 2011;127:436–444.
10. Smulders CA, Van Gestel JPJ, Bos AP. Are central-line bundles and ventilator bundles effective in critically ill neonates and children? *Intensive Care Med* 2013;39:1352–1358.
11. Wheeler DS, Giaccone MJ, Hutchinson N, *et al.* A hospital-wide quality-improvement collaborative to reduce catheter-associated bloodstream infections. *Pediatrics* 2011;128:e995–e1004.
12. Rinke ML, Chen AR, Bundy DG, *et al.* Implementation of a central-line maintenance care bundle in hospitalized pediatric oncology patients. *Pediatrics* 2012;130:e996–e1004.
13. Costello JM, Morrow DF, Graham DA, Potter-Bynoe G, Sandora TJ, Laussen PC. Systematic intervention to reduce central-line–associated bloodstream infection rates in a pediatric cardiac intensive care unit. *Pediatrics* 2008;121:915–923.
14. Marschall J, Mermel LA, Fakih M, *et al.* Strategies to prevent central-line–associated bloodstream infections in acute-care hospitals: 2014 update. *Infect Control Hosp Epidemiol* 2014;35:753–771.
15. Sacks GD, Diggs BS, Hadjizacharia P, Green D, Salim A, Malinoski DJ. Reducing the rate of catheter-associated bloodstream infections in a surgical intensive care unit using the Institute for Healthcare Improvement central-line bundle. *Am J Surg* 2014;207:817–823.
16. SPS Prevention Bundles December 2019. Children's Hospitals' Solutions for Patient Safety website. https://www.solutionsforpatientsafety.org/wp-content/uploads/SPS-Prevention-Bundles_DECEMBER-2019.pdf. Accessed May 27, 2020.
17. Furuya EY, Dick A, Perencevich EN, Pogorzelska M, Goldmann D, Stone PW. Central line bundle implementation in US intensive care units and impact on bloodstream infections. *PLoS One* 2011;6:1–6.
18. Affolter JT, Huskins WC, Moss M, Kuhn EM, Gedeit R, Rice TB. The association of central-line-associated bloodstream infections with central-line utilization rate and maintenance bundle compliance among types of PICUs. *Pediatr Crit Care Med* 2016;17:591–597.
19. Fisher D, Cochran KM, Provost LP, *et al.* Reducing central-line–associated bloodstream infections in North Carolina NICUs. *Pediatrics* 2013;132:e1664–e1671.
20. Iwao S. Revisiting the existing notion of continuous improvement (Kaizen): literature review and field research of Toyota from a perspective of innovation. *Evol Institutional Econ Rev* 2017;14:29–59.
21. Jurecko L. Kamishibai card rounding helps prevent hospital-acquired infections. Children's Hospital Association website. https://www.childrenshospitals.org/newsroom/childrens-hospitals-today/issue-archive/issues/summer-2015/articles/lean-tools-help-prevent-hospital-acquired-infections. Published March 13, 2017. Accessed October 10, 2019.
22. Shea G, Smith W, Koffarnus K, Knobloch MJ, Safdar N. Kamishibai cards to sustain evidence-based practices to reduce healthcare-associated infections. *Am J Infect Control* 2019;47:358–365.
23. Ogrinc G, Davies L, Goodman D, Batalden P, Davidoff F, Stevens D. Standards for QUality Improvement Reporting Excellence 2.0: revised publication guidelines from a detailed consensus process. *J Surg Res* 2016;200:676–682.
24. Mermel LA, Allon M, Bouza E, *et al.* Clinical practice guidelines for the diagnosis and management of intravascular catheter-related infection: 2009 update by the Infectious Diseases Society of America. *Clin Infect Dis* 2009;49:1–45.
25. Bell T, O'Grady NP. Prevention of central line–associated bloodstream infections. *Infect Dis Clin North Am* 2017;31:551–559.
26. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009;42:377–381.
27. IHI White Paper. Using care bundles to improve health care quality. Institute for Healthcare Improvement website. http://www.ihi.org/resources/Pages/IHIWhitePapers/UsingCareBundles.aspx. Published 2012. Accessed May 18, 2020.
28. Bloodstream infection event (central line-associated bloodstream infection and non–central-line–associated bloodstream infection). Centers for Disease Control and Prevention website. https://www.cdc.gov/nhsn/pdfs/pscmanual/4psc_clabscurrent.pdf. Published January 2020. Accessed May 18, 2020.
29. Pope C, Van Royen P, Baker R. Qualitative methods in research on healthcare quality. *Qual Saf Heal Care* 2002;11:148–152.
30. Edwards JD, Herzig CTA, Liu H, *et al.* Central-line–associated bloodstream infections in pediatric ICUs: longitudinal trends and compliance with bundle strategies. *Am J Infect Control* 2016;43:489–493.
31. Rowan CM, Miller KE, Beardsley AL, *et al.* Alteplase use for malfunctioning central venous catheters correlates with catheter-associated bloodstream infections. *Pediatr Crit Care Med* 2013;14:306–309.
32. Thakarar K, Collins M, Kwong L, Sulis C, Korn C, Bhadelia N. The role of tissue plasminogen activator use and systemic hypercoagulability in central-line–associated bloodstream infections. *Am J Infect Control* 2014;42:417–420.