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Major article

Electronic health record solutions to reduce central line-associated bloodstream infections by enhancing documentation of central line insertion practices, line days, and daily line necessity

Kathleen A. Quan MSN, RN, CIC, CPHQ [a], Sarah M. Cousins BS [b,*], Darlene D. Porter BSN, RN, PHN [c], Margaret O'Brien BSN, RN [d], Scott Rudkin MD [c], Brian Lambertson BSN, RN [c], Dennis Hoang PharmD [c], Amish A. Dangodara MD [e], Susan S. Huang MD, MPH [a,b]

[a] Epidemiology and Infection Prevention, University of California Irvine Health, Orange, CA
[b] Division of Infectious Diseases and Health Policy Research Institute, University of California Irvine School of Medicine, Irvine, CA
[c] Health Affairs Information Services, University of California Irvine Health, Orange, CA
[d] Nursing Informatics, University of California Irvine Health, Orange, CA
[e] University of California Irvine Hospitalist Program Informatics, Orange, CA

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Background: Central line-associated bloodstream infections (CLABSIs) continue to cause preventable morbidity and mortality, but methods for tracking and ensuring consistency of CLABSI-prevention activities remain underdeveloped.

Methods: We created an integrated electronic health record solution to prompt sterile central venous catheter (CVC) insertion, CVC tracking, and timely line removal. The system embedded central line insertion practices (CLIP) elements in inserter procedure notes, captured line days and new lines, matching each with its CLIP form and feeding back compliance, and enforced daily documentation of line necessity in physician progress notes. We examined changes in CLIP compliance and form submission, number of new line insertions captured, and necessary documentation.

Results: Standard reporting of CLIP compliance, which measures compliance per CLIP form received, artificially inflated CLIP compliance relative to compliance measured using CVC placements as the denominator; for example, 99% per CLIP form versus 55% per CVC placement. This system established a higher threshold for CLIP compliance using this denominator. Identification of CVCs increased 35%, resulting in a decrease in CLABSI rates. The system also facilitated full compliance with daily documentation of line necessity.

Conclusions: Integrated electronic health records systems can help realize the full benefit of CLABSI prevention strategies by promoting, tracking, and raising the standard for best practices behavior.

Major national efforts have resulted in a large reduction in central line-associated bloodstream infections (CLABSI). Nevertheless, CLABSI continue to cause preventable morbidity and mortality[1] in 15,600 inpatients annually in acute care hospitals.[2] Successful strategies to reduce CLABSI have included ensuring sterile processes for central venous catheter (CVC) insertion, establishing maintenance and access protocols, and promoting line removal. These activities are considered gold standard care for CVCs.[3,4] However, methods for tracking and ensuring consistency of these activities are not well developed.

One method to ensure appropriate insertion processes to prevent CLABSI is the use of checklists.[5] The central line insertion practices (CLIP) checklist form was developed by the Centers for Diseases Control and Prevention to confirm appropriate hand hygiene, skin preparation with a chlorhexidine product, and maximal sterile barrier precautions.[6] The states of California[7] and New Hampshire[8] have

* Address correspondence to Sarah M. Cousins, BS, c/o Susan Huang, Health Policy Research Institute, 100 Theory, Suite 110, Irvine, CA 92617.
E-mail address: scousins@uci.edu (S.M. Cousins).

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mandated public reporting of compliance with this form. Despite the benefits of the CLIP form, inserters (or an observer) often fail to submit it, making comprehensive assessment of insertion techniques difficult.

Another method of preventing CLABSI is to monitor and feedback CLABSI rates at the unit or hospital level to highlight good performance and encourage poor performers to improve.[9] Monitoring requires the accurate capture of the number of central line days as the denominator for rates. Often a manual or periodic sampling technique is used in place of a true count of central line days, which may contribute to inaccuracy in reported rates.

A third way to reduce CLABSI is to ensure prompt line removal. To this end, California law[10] requires that physicians document the necessity for continuing a CVC each day. As with the CLIP form, daily documentation of line necessity requires initiative on the part of the attending physician to complete the form. Given the intensity of medical care frequently required in patients needing central lines, this documentation is often not prioritized and adherence with daily documentation of necessity is poor.

Techniques that rely on clinician initiative to complete CVC-related infection prevention documentation have limited success. When good intentions fail, electronic tools can be very helpful in prompting best practice behaviors. We describe the successful use of electronic health record (EHR) solutions to improve CLIP documentation, capture CVC line days, and ensure documentation of daily necessity assessment.

METHODS

CLIP documentation

In response to the California mandate to ensure CLIP form documentation, we created a progression of documentation tools leading up to our ultimate EHR solution. For rapid deployment, we initially created a paper-based form that had to be printed, completed, and faxed by the submitter (eg, inserter or observer) to the hospital's Epidemiology and Infection Prevention (EIP) program, and then manually entered into a database by EIP staff. To improve compliance, we temporarily placed an electronic version of the CLIP form within the nursing electronic documentation system to be completed online by nurses after witnessing or assisting with a CVC insertion. During this second phase of electronic nursing documentation we no longer accepted paper CLIP forms.

Our permanent EHR solution created an electronic procedure note with embedded CLIP form elements for documenting CVC insertion. The form provided a series of check boxes (Fig 1A) that generate a narrative procedure note using templated language that could be edited by the physician before being finalized (Fig 1B). This allowed physicians to complete the note rapidly and, if necessary, remotely. To finalize the note, inserters were required to report adherence with CLIP elements using additional check boxes. Inserters could select a single check box to confirm that all elements of maximal sterile precautions were employed or select from a series of individual elements.

To evaluate the fraction of CVC insertions for which CLIP forms were completed, we identified the total number of CLIP forms received divided by the number of CVC insertions based on electronic nursing documentation indicating the new presence of a line. Adherence with CLIP elements within the form was calculated 2 ways: by assessing the fraction of forms with adherence to all CLIP components among forms submitted and by assessing the fraction of forms with adherence to all CLIP components among lines placed.

Capture of line days and identification of new lines

Comprehensive capture of CVC line days is essential for calculation of CLABSI rates, defined as the number of CLABSI events divided by the number of device days. We calculated both the total number of line days (eg, 2 lines in 1 patient for 1 day counts as 2 line days) and the National Healthcare Safety Network (NHSN) device patient days (eg, 2 lines in 1 patient for 1 day counts as 1 line day). When not otherwise specified, the NHSN definition of 1 device day as 1 day per patient who has 1 or more lines was used.

Before the development of our EHR solution, we captured line days by requiring each unit to maintain daily paper records of all patients who had CVCs. We then moved to an interim electronic system in which nurses documented the number of patients with any CVCs for every shift. This system did not track each CVC individually, so device-specific dwell times could not be calculated.

In our permanent EHR solution, we developed comprehensive electronic nursing documentation for individual CVCs. Daily e-flowsheets were modified to collect CVC insertion site (eg, internal jugular, subclavian, antecubital, and femoral), left or right side, type of CVC (eg, peripherally inserted central catheter, tunneled/nontunneled single or multilumen catheter, tunneled/nontunneled hemodialysis line, and vascular access port), and assessment of skin integrity as part of the nursing assessment conducted during each shift.

For newly placed CVCs, inserter name and unit of insertion were also collected, facilitating clinician-specific follow-up for missing CLIP forms. An automated report matched nursing CVC documentation of new lines and electronically submitted CLIP forms. CVC insertions without associated electronic CLIP forms were reported to the inserting unit medical director, nurse manager, and inserting clinician, as well as the EIP program.

CVC data were linked between shifts, allowing for device-specific CVC information and calculation of dwell times. This allowed us to calculate device days based on the total number of lines or based on the NHSN patient days definition. A CVC's device days were counted from the first to last calendar day that had nursing documentation for a specific CVC and attributed to the first documenting unit of the day. We then calculated unit-specific or patient-specific total monthly NHSN patient device days (maximum 1 device day per patient per day) and device use ratio (number of device days divided by number of patient days) as required for mandated reporting. In addition to use for mandated reporting, the dwell time for each line was cascaded from nursing e-flowsheets to the physician e-progress note to ensure physician attention was drawn to long dwell times.

Daily documentation of line necessity

Before our EHR solution, physicians were expected to self-initiate documentation of CVC necessity each day in accordance with California law. To facilitate this, intensive care units used a variety of mechanisms. In certain units, the unit clerk stamped a template for documenting CVC necessity on the patient chart for the primary team physicians to complete each day. Others incorporated documentation of daily necessity into templated paper progress notes in patient charts. No facilitating interventions were implemented for non-intensive care units.

In our EHR solution, electronic physician progress notes (e-progress note) replaced paper progress notes. Within the e-progress note for a given patient, each existing CVC from the electronic nursing flowsheet documentation was automatically cascaded into the e-progress note with an indication of the CVC type, side, and site, and device-specific dwell time. Next to each listed CVC were