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Major Article

Human factors related to time-dependent infection control measures: “Scrub the hub” for venous catheters and feeding tubes

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Background: The use of catheter hub decontamination protocols is a common practice to reduce central line-associated bloodstream infections. However, few data exist on the most effective disinfection procedure prior to hub access accounting for human factors and time-dependent practices in real time in the clinical setting.

Methods: An observational design with a multimodal intervention was used in this study in a neonatal intensive care unit. Direct observations on nurse compliance of scrub times with decontamination when accessing of venous catheter and feeding tube hubs were conducted during 3 phases: (1) baseline period prior to any interventions; (2) during an educational intervention phase; and (3) during a timer intervention period when using a timing device, either an actual timer or music button.

Results: Overall, both education and the timing device interventions increased the mean scrub time \pm SD of venous catheter hubs. Mean baseline scrub times of 10 ± 5 seconds were lower compared with 23 ± 12 seconds after educational intervention ($P < .002$) and 31 ± 8 seconds with timer or music button use ($P < .001$). Timer intervention scrub time was also more effective than education alone ($P < .05$). Similar findings were observed with scrub times of feeding tubes.

Conclusions: Time-based infection control measures, such as scrubbing the hub, must be implemented with aids that qualify specific times to account for human factors, to ensure adherence to time-dependent measures aimed at decreasing nosocomial infections.

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BACKGROUND

Scrubbing the catheter hubs is one key part of the maintenance component of central line bundle protocols.^{1,2} Because the hub can be a portal for microbes into the catheter and

bloodstream, decreasing venous access and decontaminating the hub prior to access are critical to preventing central line-associated bloodstream infections (CLABSIs).^{3,4} Recent laboratory (nonclinical) studies of antiseptic scrub times for catheter hubs found that 3- to 5-second alcohol scrubs were not sufficient to decontaminate hubs⁵ and that a minimum of a 15-second alcohol scrub with friction is needed to effectively sterilize needless access ports.^{6,7}

Neonatal enteral feeding tubes also act as loci for bacterial attachment and multiplication. There is growing evidence that bacteria colonize most feeding tubes and can enter the stomach as a bolus with tube feeding, leading to complications such as gastrointestinal infection (necrotizing enterocolitis), feeding intolerance, or bacterial translocation with sepsis.⁸⁻¹¹ Bloodstream infections occur in 15%-20% of preterm infants <1,500 g at birth, with possibly up to 66% originating from the gastrointestinal tract.¹² Interventions such as scrubbing the entry port of the feeding tube may help decrease colonization, contamination, and bacterial load of enteral catheters.

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There is a significant gap in knowledge of key human factors in infection control and the degree of accuracy of adherence to recommended time-based measures, such as hand hygiene and scrubbing central line catheter hubs. This is an important aspect of practice because, in many units, wristwatches are prohibited to reduce the risk of infection. Further, wall clocks are not always easily visible from the bedside and also place the focus on the clock and remembering what time one started and needs to stop rather than scrubbing the hub with friction. Therefore, providers are left to estimate scrub times. To our knowledge, no studies have assessed health care providers' knowledge of and adherence to recommended scrub times for catheter disinfection in the clinical setting accounting for human factors such as estimating time, distractions, multitasking, or using the second hand of a clock. In the psychology literature, there appears to be significant variation in accurately estimating time periods, either overestimating¹³ or underestimating,¹⁴ especially when distractions are present.

The purpose of this study was to evaluate nurses' knowledge of and adherence to one unit's protocol for hub disinfection, followed by 2 interventions directed at scrubbing the hub for a specified time as part of efforts to reduce central venous catheter and feeding tube contamination. Nurses were the target group of this study because of their key role and responsibility for hub decontamination.

MATERIALS AND METHODS

This single-center, multimodal interventional study was one component of a larger trial to determine the incidence and correlation of microbial colonization with invasive infections related to central venous catheters and enteral feeding tubes with infection control practices in the neonatal intensive care unit (NICU). This study was conducted in the NICU at the University of Virginia Health System, a 45-bed regional neonatal referral center with 20 intensive care and 25 intermediate care beds. This study was approved by the University of Virginia Institutional Review Board.

The NICU adopted a venous and arterial hub decontamination protocol in 2008, in response to studies indicating ≥ 15 -second scrub with friction using 70% ethanol to be effective.⁶ In 2010, a similar protocol was adopted for feeding tube hubs, as part of larger study in our NICU of feeding tube contamination and gastrointestinal infection. Both protocols involve two 15-second scrubs with friction with two 70% alcohol swabs using clean gloves (15 seconds with each pad and 30 seconds' total time) and allowing for drying time. Ethanol dries rapidly (within seconds), and for this study we defined adequate dry time as ≥ 5 seconds.⁷ These protocols were purposefully created to be >15 -second scrub time in hopes of providing a safety net for inaccuracies in adherence to the protocols. The venous hubs used in this study were the BD Q-Syte Luer Access Split-Septum needleless device (BD Medical, Franklin Lakes, NJ).

Throughout the 3-phase study, data were collected on the day shift through direct observation and nurse surveys. Observations of nursing adherence to the venous hub and feeding tube protocols were conducted through covert audits at random by 4 researchers. Observation tools for each protocol were designed and tested by the primary author (L.C.) (available on request). Swab times were measured by the researchers using stopwatches or watch second hands. Failure to disinfect the hub was recorded as 0. Nurse surveys were created by the authors (L.C. and A.B.) and were distributed to the entire NICU nursing staff via Survey Monkey (San Mateo, CA).

The 3-phase study was conducted as follows: The baseline phase (July 2010–November 2010) involved observation and nurse survey prior to any intervention. The survey was designed to assess the level of awareness of the unit's hub decontamination protocols for venous catheters and feeding tubes. The education phase (February 2011) included an educational intervention conducted daily for 1 week

during change of shift report. The 5-minute intervention included a brief description of the consequences of nosocomial infections in the NICU, an overview of the scrub the hub protocols, survey results from phase 1, and a demonstration of proper decontamination procedures. Additionally, this information was posted on the NICU staff bulletin board and was included in the weekly staff newsletter (available on request). Observation audits were conducted during the week of the educational intervention. After a break for 1 week, the timer phase was implemented. This phase involved surveying nurses as to how they estimated scrub times, and implementation of bedside timers to improve scrub time accuracy for both venous catheters and feeding tubes. Two types of timers were trialed: actual timers and music buttons. Music buttons played 15 seconds of "Twinkle Little Star." For standardization, the timers were set for 15 seconds. For both devices, the nurse was required to press the device twice—once for each alcohol swab—to achieve the total 30-second scrub time. The timers and music buttons were mounted on laminated index cards with instructions on their use, and were placed randomly at the bedsides of the 20 intensive care beds (available on request). The timing devices were introduced in the same manner as the educational intervention in phase 2—demonstration during shift report, display on the NICU staff bulletin board, and inclusion in the NICU staff newsletter. Audits were collected during this week of the demonstrations and the week following. Two weeks after the audits were completed, the nursing staff was surveyed again for their feedback about the bedside timing devices.

Survey and observation data were analyzed using descriptive methods, Fisher exact test and Student *t* test. Additionally, 1-way analysis of variance was used to examine the differences between phases. A *P* value $< .05$ was considered statistically significant.

RESULTS

Prior to any interventions, a survey of the NICU staff nurses ($N = 78$) found that 77% and 67% of nurses identified the correct total scrub time (30 seconds) when accessing a catheter (central or venous) and feeding tubes, respectively. Further, 68% of nurses responded that their practice is to scrub the hub for 30 seconds. When asked how the length of time was measured, 49% reported "counting in my head", and 37% reported looking at the clock.

Venous scrub the hub data

Baseline data

Observation audits were conducted to collect baseline data ($n = 9$). The mean scrub time for venous access was 10 ± 5 seconds. Nearly half (55%) of the nurses did not use a second alcohol swab for venous access compared with 100% for the first alcohol swab ($P = .03$). Mean scrub time for the first alcohol pad was 8 ± 5 seconds compared with an average time of 4 ± 2 seconds when the second alcohol pad was used in only 4 of the patients ($P = .06$). These data suggest that the actual amount of time spent scrubbing the hubs was much lower than estimated times. Using these findings, an educational intervention for phase 2, including review of the protocols and demonstration of scrub times, was designed.

Education period (phase 2)

During the week of the educational intervention, observational audits (17 venous hubs) were conducted. Education significantly increased scrub time to 23 ± 12 seconds compared with baseline (Fig 1). This resulted in 35% (6/17) of the venous hubs being scrubbed for ≥ 30 seconds and 71% (12/17) for ≥ 15 seconds. About one-third (35%) of the nurses did not use a second alcohol swab for venous access compared with 100% for the first alcohol swab ($P = .03$). Mean scrub time for the first alcohol pad was 14 ± 6 seconds com-

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