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Ultrasound-guided placement of midline catheters in the surgical intensive care unit: a cost-effective proposal for timely central line removal

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ABSTRACT

Background: The early removal of central intravenous (IV) catheters, as a means of reducing the incidence of central line–associated blood stream infections (CLABSI), remains a major health care initiative. However, attaining IV access in the surgical intensive care unit (SICU) can be quite difficult. We report the success of a novel, resident-driven program for the placement of ultrasound-guided midline catheters in critically ill patients.

Materials and methods: A prospective pilot study of 31 subjects admitted to the SICU from June to December 2011 was performed. Intermediate-length (20 cm) midline catheters were placed by trained housestaff, under ultrasound guidance, into the basilic or cephalic veins. Procedural details including time to cannulation, complications, and costs were recorded.

Results: Successful placement was achieved in 96.8% ($n = 30$), with a mean follow-up of 9.8 ± 5.6 (range 2–21) days. An average of 1.3 ± 0.7 (range 1–4) attempts with a median of 13.0 ± 14.5 (range 0.5–68) minutes was required for successful venous cannulation. The most common site was the basilic vein ($n = 23$). Only minor complications were encountered; three catheters leaked at the insertion site and one patient developed phlebitis. No CLABSI occurred. The total procedure cost was $87 per catheter for the SICU team compared with $1500 per catheter when performed by an interventional radiologist. During the study period, a total of 283 central line days were avoided with an estimated cost savings of $13,614.

Conclusions: Ultrasound-guided midline catheters placed by the housestaff are a cost-effective alternative for patients in the SICU with difficult IV access. Successful placement can help facilitate early central line removal and thus may reduce CLABSI rates.

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1. Introduction

Reducing the incidence of central line–associated blood stream infections (CLABSI) continues to be a major national initiative. Early removal of central intravenous (IV) catheters is a means of accomplishing this. According to the Centers for Disease Control and Prevention (CDC) an estimated 18,000 CLABSI (1.65 infections per 1000 central-line days) occurred in intensive care units in the United States in 2009 [1]. The estimated costs of approximately 92,000 CLABSI in 2010 was in excess of 2.5 billion dollars [2]. The mandate for decreasing CLABSI from both the patient safety and cost-benefit perspective is clear.

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Strategies to decrease CLABSI involve avoidance of non-essential central line placement and earliest removal when no longer indicated. Attaining IV access in the surgical intensive care unit (SICU) can be quite difficult secondary to patient factors (i.e., critically ill patients may be edematous, obese, or have a prolonged hospital stay with few remaining superficial veins after repeated venipuncture). In our institution, the nurses and the IV team make several attempts at cannulation without success and often, intervention radiologists have been consulted to place a peripherally inserted central catheter (PICC). This, in some cases, delays removal of central venous catheter removal by several days. The purpose of our study was to evaluate a novel, housestaff-driven program for the placement of ultrasound-guided (USG) midline catheters in SICU patients by analyzing the procedural details, associated costs, and ease of implementation. The existing literature for USG peripheral IV and midline catheter placement is based mostly on experiences by emergency room physicians, radiologists, IV nurses, or anesthesiologists. This is the first study in the SICU population, specifically involving midline procedures performed by the surgical housestaff.

2. Materials and methods

Our study is an institutional review board–approved, prospective pilot study (protocol #10-147B) conducted in an 18-bed SICU at a quaternary care teaching hospital between June and December 2011. All data from 31 patients were entered into a secure procedure log maintained on the hospital network. The following data was collected:

- Patient demographics (including age, sex, body mass index, American Society of Anesthesiologists (ASA) score)
- Primary diagnosis
- Indications for IV placement
- Central line location and duration (in days)
- Intensive care unit length of stay before midline catheter placement
- Number of attempts
- Time to successful cannulation (in minutes)
- Midline catheter location and duration (in days)
- Complications or indication for removal

An attempt was defined as venous cannulation accompanied by blood return, and time to successful cannulation was recorded from the start of attempted cannulation to the time the midline catheter was advanced completely. Intermediate-length (20 cm) midline catheter kits (Arrow International, Inc.; Reading, PA CDC-02031-MK1A—Figs. 1 and 2) were placed by trained housestaff, under ultrasound guidance, into the basilic or cephalic veins. Patients were included in the study if they were consentable adults >18 y of age and failed at least one attempt at peripheral IV placement by a member of the nursing staff or specialized IV team. All patients were admitted to the SICU at the time of procedure. Exclusion criteria were met if patients had an ongoing need for central line access or an absolute indication for a PICC (i.e., Total parenteral nutrition, long-term IV antibiotics) after discharge.

Fig. 1 – Arrow Midline Kit (CDC-020410MK1A). (Color version of figure is available online.)

All procedures were monitored by the critical care nursing staff. Although the patients were in the SICU, the lines were monitored by the critical care attending. On transfer of the patient to the floor, midline catheters were followed by surgical residents and physician assistants. None of these health care practitioners were directly involved in the study.

2.1. *Statistical and cost analysis*

The successful placement of a midline catheter eliminates the need for central venous access for the remainder of hospitalization in patients with difficult IV access. With this in mind, we calculated the savings expected by avoiding central lines, their complications, and associated costs. Based on available institutional data, costs were calculated for midline catheters placed in the SICU and PICC lines performed by interventional radiologists. The total cost to place a midline was $87 per catheter. There were no associated incremental labor costs, as housestaff were not compensated specifically for the procedures performed. The total cost of a PICC line was $1500 per catheter, including both the supply and labor costs

Fig. 2 – Opened Arrow Midline Kit (CDC-020410MK1A). (Color version of figure is available online.)

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