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Incidence of central venous catheter hub contamination

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ABSTRACT

Purpose: To investigate microorganisms causing central venous catheter contamination and how this contamination differs across different catheter metrics.
Materials and methods: After obtaining IRB approval and informed consent, 830 cultures were prospectively obtained from 45 ICU patients with central venous catheter or peripherally inserted central catheter. Bacterial colonies were identified by mass spectrometry.
Results: Bacterial contamination of central catheter hubs occurred 44% of the time in this study in the ICU setting. Coagulase-positive staphylococci cultures had higher median (± interquartile range) CFUs (12 ± 232) versus coagulase-negative (3 ± 10) and other bacteria (1 ± 3; $P < 0.001$). Bacterial contamination was associated with various metrics. Higher incidence ($P < 0.05$) of coagulase-positive staphylococci cultures was associated with hub-only connections (a "hub" being a female connection; 10.9% vs. 7.9% male connections), connections without a manifold (1 lumen device that mixes multiple infusions together; 9.7% vs. 0% with manifold); and central venous pressure monitoring connections (25.8% vs. 7.1% without). Internal jugular sites (10.0% vs. 2.7% femoral, 6.2% PICC, $P = 0.031$) and medial lumens of triple lumen catheters (11.9% vs. 5.6% distal, 7.0% proximal, $P = 0.049$) had increased incidence of higher bacteria loads (>15 CFUs).
Conclusions: This study found a high incidence of central access catheter hub bacterial contamination, which correlated with positive blood cultures in 2 of 3 total bacteremia cases identified in the 45 patients.

1. Introduction

Despite diligent healthcare worker efforts and Centers for Disease Control checklist protocols [1] designed to prevent central line-associated blood stream infections (CLABSI), CLABSI remain a problem for hospitals causing patient harm. CLABSI are estimated to cost more than $45,000 per occurrence, and consequences include an average of 10.4 days increase in hospital length of stay [2].

One of the most common causes of CLABSI is colonization of central venous catheters (CVCs) [3] with sources for this catheter colonization including the catheter hub or the skin surrounding the catheter insertion site [4,5]. Cultures obtained from short and long-term CVCs either obtained by swabbing the inside of the lumen of catheter hubs (i.e. intraluminal) or by withdrawing fluid from the catheter hub, reveal that central venous catheter colonization is unlikely if cultures obtained from the catheter hubs fail to grow microorganisms [6-9]. However, the procedure for intraluminal catheter hub culturing in vivo requires entering the hub of the catheter and thus carries the risk for migration of microorganisms into the bloodstream during the process [10,11]. A recent investigation of short-term CVCs in cardiac surgery intensive care unit ICU patients demonstrated that if CVC needleless hub connector cultures obtained from the external surface of the hub were negative for bacterial growth, CVC colonization was unlikely; external hub culture results were also superior to intraluminal hub cultures to rule out short-term CVC colonization [12].

Because contamination of CVCs is a common cause of CLABSI, the aim of this study was to determine the extent of external contamination of needleless connectors from CVCs located in various vascular access sites in the ICU setting and how this contamination was related to different catheter metrics. The metrics included use of central venous pressure monitoring, propofol infusion, connector type, the anatomical location of the CVC and for multiple lumen catheters, the location of the lumen from which the sample was obtained. The primary outcome for this study was bacterial contamination, as measured by the number of overall positive cultures, bacterial load (colony forming units, CFUs), and incidence of coagulase positive (COPS) versus coagulase negative

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(CONS) species within positive cultures. Our hypothesis was that factors associated with more frequent accessing of the CVC needleless connector and the infusion of propofol would be related to an increased incidence of bacterial contamination.

2. Materials and methods

2.1. Study design

After obtaining IRB approval (University of Florida IRB #201200067), 45 patients in the Neuro ICU (NICU) and Burn ICU (BICU) at UF Health Shands Hospital, Gainesville, FL, were enrolled in our prospective cohort study over a period of 4 months from April 2013 to August 2013. Written informed consent was obtained from all subjects or a legal surrogate if the patient was not able to provide consent. This study did not involve the assignment of patients to treatment groups.

2.2. Inclusion criteria and patient population

Patients were eligible for enrollment if they had at least one CVC or peripherally inserted central catheter (PICC). The catheter hubs of these CVCs and PICCs were sampled every 24 h for 7 days or until the CVC or PICC was removed or the patient was discharged, whichever occurred first. Of the 45 patients, 29 successfully completed the full 7 days of culturing; the remaining patients had fewer than 7 days of culturing due to CVC or PICC removal. Research personnel were neither involved in decisions for removal of central access nor patient discharge.

2.3. Patient catheter culturing technique

Sterile, cotton-tipped applicators (Medline Industries, Inc., Mundelein, IL) moistened with 0.9% NaCl sterile saline solution (Baxter Healthcare Corporation, Deerfield, IL) were used to lightly brush the external surface of the catheter hub; this sampling did not involve entering the hub catheter or any connections to the CVC or PICC (e.g. propofol infusion) (Fig. 1). For consistency, the hub proximal to the patient was chosen to obtain cultures if there were multiple needleless connectors. After sampling, the hubs were scrubbed with 70% isopropyl alcohol.

Although sterilizing before access is standard of care, it is unclear if this process is followed every time the CVC or PICC is accessed, so for this study, the needleless hubs were not scrubbed before sampling. Sampling was done by two of the authors (Brenda Fahy, MD and Julie Holroyd, BS). Kenneth Rand, MD Professor and Clinical Pathology and Medicine Director Virology and Bacteriology Director UF Health Shands Hospital trained the investigators on sampling technique. Negative controls were not performed for this study because hubs and stopcocks taken directly from sterile packaging have been shown not to be contaminated with microorganisms [13].

The type of connector, if present on the central catheter, was recorded. These included a needleless connector with a male connector used to access the female hub of the catheter (Fig. 2), a manifold, which is a single lumen device with multiple ports that allow several infusions to be mixed together (Fig. 3), or a stopcock serving as an intravenous connector to join two or more infusions into one with the ability to stop the flow of one of the infusions by turning a handle. Other data recorded included the anatomical location of the CVC and, for multiple lumen CVCs, the location of the lumen from which the sample was obtained was noted. For a CVC with 3 lumens, each proximal, medial (between the proximal and distal), and distal location was recorded as the culture site. During hub culturing, the fluid(s) and/or medication(s) being administered through the hub was recorded. If there was more than one needleless connector attached to the hub, the connector with a medication that had the potential to provide a medium for bacterial growth (e.g., propofol) was preferentially sampled. Central venous catheter lumens utilized for central venous pressure (CVP) monitoring were also sampled and recorded. CVP can be used as a proxy for frequency of catheter access because, at our institution, CVP access is often utilized for intermittent administration of intravenous medications, whereas the other lumens were used for continuous infusions. Insertion data for the CVC was collected including date, anatomic site, (internal jugular, subclavian, femoral, or basilic vein), and hospital location of the patient at the time of insertion.

Throughout the study, clinical staff adhered to the UF protocol for routine care of CVCs and PICCs. During the study period, CVC placement was performed adhering to Centers for Disease Control recommendations [1], including hand sanitization before insertion, patient skin preparation with 2% chlorhexidine solution, and maximum barrier precautions, including the individual responsible for placement of the CVC wearing a hat and mask, sterile gown and gloves and covering the patient with a sterile full body drape during insertion. In addition, alcohol was used for scrubbing before accessing the needleless catheter hub, and infusion tubing was changed every 72 h, except for propofol, whose medication and infusion tubing was changed every 24 h. No patient during this study received total parenteral nutrition. Clinical practice remained the same during the study period including the techniques for accessing CVCs or PICCs, required timing of intravenous administration set changes, and nurse-to-patient ratio. The BICU policy requires all CVCs and PICCs to be changed every 7 days.

2.4. Microbiological techniques

The cotton-tipped applicator swab samples obtained from the external surface of the catheter hubs were streaked across standard 5% sheep

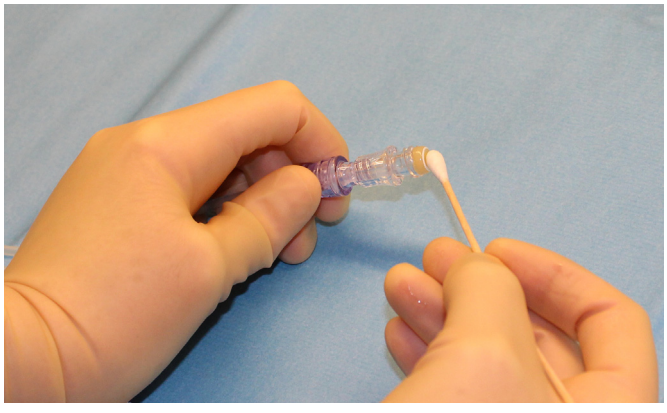

Fig. 1. Culturing of outside surface of needleless connector hub with cotton-tipped applicator.

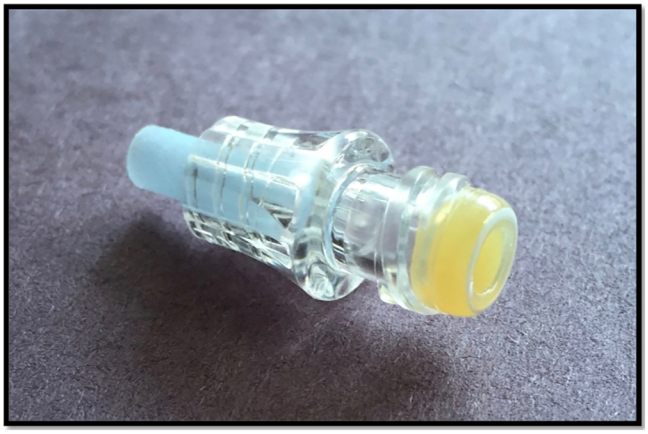

Fig. 2. Female hub connector.