Insertion and Use of Arterial Catheters: A Survey of Clinician Antiseptic Technique

DAVID M. COHEN, MD; ANDREW LEVINSON, MD, MPH; JEFFREY MAZER, MD; STEPHANIE LUECKEL, MD; GERARDO CARINO, MD, PhD; LEONARD MERMEL DO, ScM

ABSTRACT

RATIONALE: Recent studies have shown that the incidence of bloodstream infections (BSIs) associated with arterial catheters (ACs) is comparable to that of central venous catheters (CVCs). In 2011, the CDC published guidelines recommending the use of limited barrier precautions during AC insertion. The goal of this study was to assess the attitudes and current antiseptic techniques employed by physicians who place arterial catheters in intensive care units.

METHODS: An anonymous, web-based survey was sent to critical care physicians from multiple specialties at six teaching hospitals in Rhode Island.

RESULTS: Survey response rate was 33% (27/83). Only 44% of participants reported using CDC-recommended barrier precautions during AC insertion, and only 15% reported using full barrier precautions.

CONCLUSIONS: Use of barrier precautions for arterial catheter insertion was inconsistent in the cohort surveyed. Less than half of physicians surveyed were in compliance with CDC guidelines. Further studies are warranted to determine the optimal preventive strategies for reducing BSIs associated with ACs.

KEYWORDS: arterial catheters, bloodstream infections, sepsis, ICU, critical care

INTRODUCTION

Peripheral arterial catheters (ACs) are commonly used in the ICU setting for accurate measurement of blood pressure and serial arterial blood gas sampling. It is estimated that six million ACs are placed in the US each year.[1] Arterial catheters represent a potential source of blood stream infection (BSI), as they provide a direct, indwelling pathway between the skin and blood stream. Infection of intravascular devices is associated with significant increases in morbidity, length-of-stay and hospital costs.[2] Infection control efforts have focused predominately on preventing infections associated with central venous catheters (CVCs, or "central lines"). The results of the *5 Million Lives Campaign* showed a significant (66-74%) reduction in the rate of central venous catheter-related BSIs through the use of a five-part program which includes hand hygiene, full barrier precautions (sterile gloves, sterile gown, surgical cap, surgical mask and full body sterile drape), chlorhexidine skin anti-sepsis, optimal site selection and daily review of catheter necessity with prompt removal.[3] Due to the success of this campaign, it is now considered standard of care to implement these precautions for the insertion of all CVCs.

Previously assumed to be benign compared to CVCs, arterial catheters also pose a significant infectious risk to patients. Recent studies have shown that the incidence density of BSIs (new infections per 1,000 catheter-days) associated with ACs is 40-90% of the incidence density associated with CVCs.[1,4-6] However, antiseptic guidelines for arterial catheters have lagged behind those for CVCs. Prior to 2011, there were no guidelines regarding which barrier precautions should be used for AC insertion.[7] In 2011, the CDC updated their infection- prevention guidelines for ACs, recommending that a cap, mask, sterile gloves and a small sterile fenestrated drape be used during all peripheral arterial catheter insertions.[8] To date, there are no published studies evaluating which antiseptic techniques are actually employed by physicians during AC insertion in clinical practice; it is unknown whether critical care physicians are aware of, or in compliance with CDC guidelines for AC insertion.

We hypothesized that considerable inter- and intra-institutional practice variability exists among physicians who place arterial catheters in Rhode Island. Furthermore, based on personal experience and anecdotal accounts, we speculated that, in general, clinicians underestimate the infectious risks posed by arterial catheters. The objective of this study was to formally assess the attitudes and current practice patterns of clinicians who place peripheral arterial catheters in the intensive care setting of hospitals in Rhode Island.

METHODS

Study Design and Instrument Development

An anonymous, web-based survey was used to assess the aseptic technique of physicians in Rhode Island practicing in critical care settings. The survey was developed by a focus group consisting of one infectious diseases specialist, three medical intensive care specialists, one surgical intensive care specialist, a medical resident, and a biostatistician. Prior to dissemination the survey was reviewed and approved by the Institutional Review Board (IRB) at Rhode Island Hospital.

Participants

Survey participants consisted of attending physicians who practice medical, surgical, or pediatric critical care at six teaching hospitals in Rhode Island. Adult pulmonary/critical care fellows, adult cardiology fellows, and senior surgical residents (PGY3-PGY5) from three teaching hospitals (Rhode Island Hospital, Miriam Hospital, Providence VA Medical Center) and one attending neurointensivist were also included in the study. All attending physicians included in the survey had fellowship training and board certification in critical care within their specialty. An initial email list was generated from the Brown University Pulmonary and Critical Care grand rounds mailing list, which was then reconciled and augmented with published department listings at hospitals in Rhode Island to create the final distribution list. All together, survey participants spanned six teaching hospitals (Hasbro Children's Hospital, Miriam Hospital, Memorial Hospital of Rhode Island, Providence VA Medical Center, Rhode Island Hospital, Roger Williams Medical Center), covering a total of 160 ICU beds.

Survey Instrument and Administration

The survey consisted of 13 questions. Twelve multiple choice questions assessed demographic information, frequency of arterial catheter use, antiseptic techniques employed during arterial catheter insertion, and attitudes regarding mandatory use of full barrier precautions for AC insertion. In one question, participants were asked to provide a numerical estimate (percentage) for the relative risk of BSIs associated with ACs as compared to CVCs, in terms of incidence density. All data were non-identifiable. The survey was conducted via REDCap™, an online survey and data capture tool.[9] Each participant received the research invitation and survey link via email. Implied consent was obtained by the informational letter and taking part in the survey. Participants were sent a total of three invitation emails over a period of 10 days in October of 2013.

Analysis

Data were analyzed using Excel (Redmond, Washington: Microsoft, 2003). Data are reported as percentages. Pearson chi-squared test and independent samples t-tests were used to compare categorical and continuous variables (respectively) between different specialties.

RESULTS

The survey was sent to 83 doctors (43 attending critical care physicians, 24 adult cardiology and pulmonary/critical care fellows and 16 senior surgical residents). The response rate was 33% (14 attending critical care physicians, 9 fellows and 4 senior surgical residents). Over 60% of responses were from critical care physicians specializing in internal medicine, with the remainder of participants from surgery, pediatrics and neurology. The participant response rates and demographics are summarized in **Table 1** and **Table 2**, respectively.

Twelve respondents (44%) were in compliance with CDC-recommended antiseptic precautions for arterial catheter insertion, consisting of hand hygiene, sterile gloves, a surgical cap, surgical mask, and a small sterile fenestrated drape. Four respondents (15%) reported use of full barrier precautions, consisting of hand hygiene, skin prep with alcoholic chlorhexidine solution, sterile glove, sterile gown, surgical cap, surgical mask, and a full body sterile drape. Survey responses are summarized in **Table 3**.

The mean estimation of relative risk of bloodstream infections associated with arterial catheters as compared to central venous catheters was 46%, indicating that clinicians in this study had a realistic conception of the infectious risk posed by arterial catheters. There were large variations observed between surgical and non-surgical specialties in terms of both perceived risk of infection from arterial catheters, as well as attitudes regarding the use of full barrier precautions for arterial catheter insertion. However, these differences did not achieve statistical significance (**Table 4**).

Table 1. Survey Response Rates

Variable	Responses (%)
Level of Training	
Attending	14 (33)
Fellow	9 (38)
Senior surgical resident	4 (25)
Specialty	
Medicine	17 (30)
Surgery	6 (27)
Pediatrics	3 (75)
Neurology	1 (100)
Anesthesiology	0 (0)
Overall	27 (33)

Table 2. Characteristics of Respondents

Variable	N (%)
Level of Training	
Attending	14 (52)
Fellow	9 (33)
Senior surgical resident	4 (15)
Specialty	
Medicine	17 (63)
Surgery	6 (22)
Pediatrics	3 (11)
Neurology	1 (4)
Anesthesiology	0 (0)
Critical Care Training	
Yes	22 (82)
No	5 (18)
Frequency of Arterial Catheter Insertion	
once per Day	8 (30)
once per Week	13 (48)
once per Month	5 (18)
once per 3 Months	1 (4)
once per Year	0 (0)

DISCUSSION

In this study, there was significant variability in which barrier precautions were employed by different physicians during arterial catheter insertion. The most significant finding was that less than half of physicians surveyed reported using CDC-recommended barrier precautions during arterial catheter insertion. If the results of this study are representative of clinical practice on a large scale, then our current level of compliance with CDC guidelines for AC insertion represents a "missed opportunity" to prevent BSIs in the intensive care setting. Efforts to increase compliance with the new guidelines should be escalated accordingly.

Compared to the infection prevention guidelines for CVCs, the new CDC guidelines for ACs are both less evidence-based and less stringent. In light of the multiple recent studies suggesting that the risk of BSIs associated with ACs is comparable to CVCs, one could make a compelling argument that insertion of arterial catheters should require the same barrier precautions as CVCs. To date, only one small randomized, controlled trial has examined implementing full barrier precautions for the insertion of ACs.[10] Although this trial showed no difference in colonization and a non-significant decrease in AC-related infections in the full barrier precaution group (RR=0.4, p=0.11), with only 272 randomized participants the study was underpowered.

Participants in our survey provided, on average, accurate estimates for the relative risk of infection associated with ACs, as compared to CVCs. Despite this, only 56% of participants reported that they believed full barrier precautions should be mandatory for AC insertion, as they are for insertion of CVCs. Only 15% of those surveyed reported that they routinely use full barrier precautions during AC insertion. The major limiting factor in adoption of full barrier precautions by physicians in this study was use of the full body sterile drape, which was employed by only 19% of respondents. No randomized controlled trials have compared the effectiveness of different drape sizes in decreasing BSIs associated with ACs. However, it seems unlikely that a small area drape can ensure equivalent sterility of both the proceduralist and procedural field, especially when ultrasound guidance is used for arterial catheter insertion. In summary, although the new CDC guidelines for AC insertion published in 2011 are clearly a step in the right direction, large prospective studies are now warranted to develop an evidence-based infection-prevention guideline for arterial catheter insertion.

One important aspect of this study is that, to our knowledge, it is the first detailed survey about AC insertion practice by critical care specialists. Another is that it documents significant practice variation in Rhode Island with regards to a very commonly performed procedure in critically-ill patients. Potential limitations of this study were the small sample size (27 respondents), the use of only teaching hospitals in the greater Providence area and the low overall response rate (33 %). There is a high likelihood that a selection bias exists among those who elected to participate in the

Table 3. Insertion and Use of Arterial Catheters: A Survey of Clinician Practice Patterns

Variable	%
Barrier and Antiseptic Techniques Employed	
Hand hygiene	89%
Skin prep using alcohol	4%
Skin prep using alcoholic chlorhexidine solution	96%
Allow alcohol and/or chlorhexidine to dry before proceeding	81%
Non-sterile gloves	0%
Sterile gloves	100%
Sterile gown	74%
Surgical mask	89%
Surgical cap	78%
Shaving the area prior to insertion	7%
Small sterile drape (only covering area around insertion site)	78%
Full body sterile drape (including head, feet and hands)	19%
None of the above	0%
Routinely discuss appropriateness of arterial catheter removal every day on rounds for each patient	78%
Employ an "absolute removal" policy of all arterial catheters after a pre-determined number of days	4%
Compliant with CDC-recommended antiseptic techniques (hand hygiene, skin prep with alcoholic chlorhexidine solution, sterile gloves, surgical cap, surgical mask, small sterile drape)	44%
Use full barrier precautions (hand hygiene, skin prep with alcoholic chlorhexidine solution, sterile gloves, sterile gown, surgical cap, surgical mask, full body sterile drape)	15%
Would support mandatory use of full barrier precautions during arterial catheter insertion	56%

Table 4. Variation between surgical and non-surgical specialties

Variable	Non-surgeons	Surgeons	p-value
Estimation of relative risk of bloodstream infections associated with arterial catheters as compared to central venous catheters	50%	32%	0.33
Would support mandatory use of surgical cap, surgical mask, sterile gown, sterile gloves and a full body sterile drape during arterial catheter insertion	62%	33%	0.21

survey as well as in the selection of the hospitals. It is possible that the statistics cited above may overestimate the prevalence of barrier-precaution usage during AC insertion. Critical care physicians from specialties other than internal medicine were underrepresented in this study. Finally, these results were based on provider self reports and may not accurately reflect true clinical practice.

CONCLUSIONS

This pilot survey of critical care physicians in Rhode Island suggests that barrier precautions are employed inconsistently during arterial catheter insertion in clinical practice. Less than half of physicians surveyed were in compliance with the new CDC guidelines for arterial catheter insertion. Further studies are warranted to estimate practice patterns on a larger scale, and to determine the optimal preventive strategies for reducing bloodstream infections associated with arterial catheters.

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Authors

David Cohen, MD, is an Internal Medicine Resident at The Warren Alpert Medical School of Brown University (Rhode Island Hospital).

Andrew Levinson, MD, MPH, is an Assistant Professor of Medicine at The Warren Alpert Medical School of Brown University and is affiliated with Rhode Island Hospital and Miriam Hospital.

Jeffrey Mazer, MD, is an Assistant Professor of Medicine at The Warren Alpert Medical School of Brown University and is affiliated with Rhode Island Hospital and Miriam Hospital.

Stephanie Lueckel, MD, is an Assistant Professor of Surgery at The Warren Alpert Medical School of Brown University and is affiliated with Rhode Island Hospital and Miriam Hospital.

Gerardo Carino, MD, PhD, is an Assistant Professor of Medicine at The Warren Alpert Medical School of Brown University and is affiliated with Rhode Island Hospital and Miriam Hospital.

Leonard Mermel, DO, ScM, is a Professor of Medicine at The Warren Alpert Medical School of Brown University and is affiliated with Rhode Island Hospital.

Disclosures

The authors have no financial disclosures to report.

Correspondence

David M. Cohen, MD
Rhode Island Hospital
Department of Medicine
593 Eddy Street
Providence, RI 02903
401-996-1661 (cell phone)
David_Cohen@brown.edu