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Do Clinicians Know Which of Their Patients Have Central Venous Catheters? A Multicenter Observational Study

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Abstract

Background—Complications associated with central venous catheters (CVCs) increase over time. Although early removal of unnecessary CVCs is important to prevent complications, the extent to which clinicians are aware that their patients have a CVC is unknown.

Objective—To assess how often clinicians were aware of the presence of triple-lumen or peripherally inserted central catheters (PICCs) in hospitalized patients.

Design—Multicenter, cross-sectional study.

Setting—Three academic medical centers in the United States.

Patients—Hospitalized medical patients in intensive care unit (ICU) and non-ICU settings.

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Measurements—To ascertain awareness of CVCs, we first determined whether a PICC or triple-lumen catheter was present; clinicians were then queried about device presence. Differences in device awareness among clinicians were assessed by chi-square tests.

Results—990 patients were evaluated, and 1881 clinician assessments were done. The overall prevalence of CVCs was 21.1% ($n = 209$), of which 60.3% (126 of 209) were PICCs. A total of 21.2% (90 of 425) of clinicians interviewed were unaware of the presence of a CVC. Unawareness was greatest among patients with PICCs, where 25.1% (60 of 239) of clinicians were unaware of PICC presence. Teaching attendings and hospitalists were more frequently unaware of the presence of CVCs than interns and residents (25.8% and 30.5%, respectively, vs. 16.4%). Critical care physicians were more likely to be aware of CVC presence than general medicine physicians (12.6% vs. 26.2%; $P = 0.003$).

Limitations—Awareness was determined at 1 point in time and not linked to outcomes. Patient length of stay and indication for CVC were not recorded.

Conclusion—Clinicians are frequently unaware of the presence of PICCs and triple-lumen catheters in hospitalized patients. Further study of mechanisms that ensure that clinicians are aware of these devices so that they may assess their necessity seems warranted.

Primary Funding Source—None.

Central venous catheters (CVCs) are instrumental for the safe and comprehensive care of many hospitalized patients. Often inserted in intensive care unit (ICU) and non-ICU settings, CVCs provide reliable venous access for tasks ranging from hemodynamic monitoring to delivery of irritants, vesicants, and intravenous antibiotics. In adults, 2 devices are most used in this context: nontunneled triple-lumen catheters placed in the subclavian, jugular, or femoral veins and peripherally inserted central catheters (PICCs) inserted into upper-extremity veins (1, 2).

Despite their many advantages, triple-lumen catheters and PICCs are associated with important risks, including central line–associated bloodstream infections (CLABSI) and venous thromboembolism (3, 4). In particular, PICC-related CLABSI and thromboembolism have recently garnered attention owing to their frequency, attributable cost, and potential for prevention (5, 6). Because the risk for these adverse outcomes increases with time, early removal of CVCs that are no longer clinically warranted is a key strategy for prevention (7, 8).

However, accumulating evidence suggests that clinicians often do not remove unnecessary CVCs. For example, a study done at a large academic medical center found many patients with PICCs that were idle and not clinically justifiable (3). In another study, 6.6% of CVCs in non-ICU settings were found to be inappropriate and clinically unnecessary at the time of review (4). These findings are not unique to the United States—concerns about inappropriately prolonged use of vascular access devices are well-documented worldwide (9–12).

In survey-based studies of inpatient providers, nearly one half of all hospitalists stated that they had, at least once, forgotten that their patient had a PICC in situ (13, 14). These findings

mirror trends noted with indwelling urinary catheters, in which 1 in 3 physicians was unaware that these devices were present (15). Given this background, we sought to determine how often interns, residents, general medicine attendings, hospitalists, and subspecialists know which of their hospitalized patients have a PICC or triple-lumen catheter. We hypothesized that clinicians who write orders for or those that are most “proximal” to patients (for example, interns and hospitalists) would be most likely to correctly identify which of their patients have CVCs. Further, we postulated that clinicians who insert CVCs (such as critical care specialists) or consciously deliberate on the choice of a vascular access device (such as hematologists or oncologists) would be more likely to be aware that a device was present.

Methods

Patients and Population

Between April 2012 and September 2013, we did face-to-face interviews of hospitalized patients and their responsible clinicians at 3 academic medical centers in the United States. A responsible clinician was defined as an intern, resident, physician extender (for example, nurse practitioner or physician assistant), or attending physician who had provided care to a patient for at least 24 hours. Housestaff were defined as interns (year 1 of training), residents (beyond year 1 of training), or physician extenders who cared for patients under the supervision of an attending physician. At each site, patients and providers were randomly selected from general medicine teaching, hospitalist-only, and subspecialty services that often use CVCs (such as cardiology, gastroenterology and hepatology, hematology and oncology, and critical care) and were primarily responsible for patient care (for example, not consultants). Thus, any “on-service” provider on duty provider or patient receiving care in a specialty or discipline of interest was eligible for study inclusion.

Eligible patients were identified using electronic patient lists for provider teams at each site. At 2 sites, patients were approached for participation and interviewed for the presence of a CVC. At 1 site, CVCs were identified through use of a validated electronic tool (98% accuracy at correctly identifying CVC presence); these patients were included but not directly examined for device presence. After patients were interviewed or electronically identified, providers were approached to ascertain awareness of device presence. Clinicians were blinded to which patients were participating in the study and were queried for all patients on their roster.

Survey Methods

Before morning team rounds, we approached patients to seek written informed consent for participation at 2 of our 3 sites. If patients could not provide consent and a family member was available, consent was obtained from next of kin. Requirement for informed consent was waived at our third site.

After consent was obtained, patients were interviewed and a focused examination was done to determine the presence of a PICC or triple-lumen catheter in the jugular, subclavian, or femoral veins at 2 study sites. Central venous catheters were defined as PICCs inserted in

any upper-extremity vein or triple-lumen catheters placed in the neck, chest, or groin. Patients with specialty catheters, including hemodialysis catheters, Pro-Line CTs (Medcomp), tunneled lines, and midlines were excluded. We surveyed patients in ICU and non-ICU settings; those on surgical services were excluded. Patients were surveyed only once during hospitalization; surveys were done weekly at all sites.

After team rounds, we interviewed medical providers for each patient and asked, “As of this morning, does your patient have a PICC or a triple-lumen catheter in the neck, chest, or groin?” All clinicians were interviewed after morning rounds to ensure that they had seen the patient the day that the survey was administered. Clinicians were interviewed separately and were not notified of our visit beforehand. We allowed clinicians to use such materials as written notes or sign-outs during the interview but they were not allowed access to electronic health records.

Because teaching attendings were responsible for all patients on the team, they were queried about CVC presence for all patients on their list. Subspecialists were similarly queried for all patients on their inpatient specialty teams. Interns, residents, and physician extenders were questioned only about patients for whom they were primarily responsible, irrespective of assignment to a general medicine or specialist team. All clinicians were surveyed the day that patients were examined.

Statistical Analysis

Descriptive statistics for patient, provider, device, and site characteristics were used to define the study samples. The primary outcome of interest was unawareness of PICC or triple-lumen catheter presence. Given the categorical nature of the data, differences among provider types and training levels were compared using chi-square tests, where appropriate. Stata MP, version 13.0 (StataCorp), was used for all statistical analyses; $P < 0.050$ was considered statistically significant. Institutional review boards at each site provided ethical and regulatory approval for the study.

Role of the Funding Source

The study was not funded by any agency.

Results

Of the 1082 patients whom we approached, 990 (91.5%) consented to participate in the study. For these 990 patients, we did 1881 clinician assessments across the 3 study sites (Table 1). Clinician responses from interns (454), residents and physician extenders (513), general medicine teaching attendings (245), subspecialty attendings (176), intensivists (95), and hospitalists (398) were included. An average of 1.9 clinician assessments were associated with each patient.

The overall prevalence of CVCs (triple-lumen catheter or PICC) was 21.1% (209 of 990). More than one half of the 209 devices were PICCs ($n = 126$ [60.3%]); the remaining 83 devices were triple-lumen catheters inserted in the neck ($n = 41$ [19.6%]), chest ($n = 24$ [11.5%]), or groin ($n = 18$ [8.6%]). A total of 47.0% (39 of 83) of triple-lumen catheters

were found in patients in ICU settings; conversely, 92.9% (117 of 126) of PICCs were found in non-ICU patients.

For the 209 patients with CVCs, 21.2% (90 of 425) of responsible clinicians were unaware of the presence of a triple-lumen catheter or PICC (Table 2). Unawareness of PICCs was greatest—more than 1 in 4 responsible clinicians (25.1% [60 of 239]) were not aware of their presence. Lack of awareness of a triple-lumen catheter or PICC varied from 16.3% to 31.1% across sites ($P = 0.038$) and was most pronounced in non-ICU settings, where PICCs are most common (24.8% vs. 12.6% in non-ICU and ICU settings, respectively; $P = 0.005$). Of note, a small but substantial number of clinicians (5.6% [82 of 1456]) stated that their patients had a CVC when no device was found on examination.

We tested whether proximity to patients was associated with awareness of device presence. Although interns were the clinicians most likely to write orders, almost 1 of every 5 surveyed was not aware that his or her patient had a triple-lumen catheter or PICC (19.1% [22 of 115]). Although medical residents were more frequently aware of device presence than interns, the difference did not reach statistical significance (13.8% vs. 19.1%, respectively; $P = 0.27$). However, teaching physicians and hospitalists were more often unaware of the presence of triple-lumen catheters and PICCs than interns, residents, and physician extenders (27.3% vs. 16.4%; $P = 0.006$).

Analyses to assess the association between provider training level and specialty on device awareness showed that general medicine teaching attendings were significantly more likely to be unaware of the presence of CVCs than housestaff (25.8% vs. 16.4%; $P = 0.031$). Hospitalists were also less likely to correctly identify the presence of CVCs than housestaff (30.5% vs. 16.4%; $P = 0.014$).

We hypothesized that “ownership” of CVCs may influence awareness, such that specialists who often place CVCs (for example, critical care providers) or consider the route and device for venous access (such as hematologists and oncologists) would be more aware of device presence. Our analyses showed that critical care providers were significantly more likely to be aware of CVC presence than general medicine or hospitalist providers (12.6% vs. 26.2%; $P = 0.003$). Specialty services providers were more frequently aware of device presence than members of general medicine teaching services, but this difference was not statistically significant (22.5% vs. 26.2%; $P = 0.48$).

Discussion

In this multicenter, cross-sectional study of patients in ICU and non-ICU settings, we found that clinicians at all training levels and specialties frequently did not know which of their patients had triple-lumen catheters or PICCs. In addition, we found that teaching attendings and hospitalists were least likely to be aware of CVC presence. Because early removal of CVCs requires knowledge of their presence, these findings have important patient safety and policy implications for providers and health systems worldwide.

Traditionally limited to critical care environments, CVCs provide reliable venous access for many tasks in the sickest patients. However, with the advent and expanding use of PICCs in

general medical and surgical patients, the epidemiology of CVCs has changed such that most are now found in non-ICU settings (1, 2, 4, 16). With these important shifts, accumulating evidence suggests the emergence of new and important problems associated with their use. For example, in a study done in Switzerland examining indications for device use, neither the nurse nor the treating physician could explain why a CVC was in place for almost 10% of non-ICU patients at a single hospital (4).

In another study done at an academic medical center in the United States, many CVCs and PICCs in non-ICU patients were found to be associated with multiple, nonjustifiable idle days of nonuse (3). One plausible explanation for this finding may be physician unawareness of CVC presence, as suggested by surveys of hospitalist providers (13, 14). Indeed, many electronic systems that track CVC use are often nurse-directed or accessible only to infection preventionists, thus being virtually siloed from treating clinicians. In addition, nursing staff and phlebotomists often request PICC placement in non-ICU patients, especially when delivery of the next antibiotic dose or blood draw may be challenging. In this context, clinicians may not pay appropriate attention to the rationale or necessity for a PICC, leading to lower recollection of device presence.

These observations and our findings raise concern because recent studies suggest that PICCs are not as innocuous as once believed. Rather, morbid complications, such as CLABSI and venous thromboembolism, are common, costly, and potentially lethal adverse events associated with these devices (17–19). For example, in a systematic review and meta-analysis, PICCs were associated with a 2.5-fold greater risk for deep venous thrombosis than nontunneled CVCs inserted in the neck, groin, or chest (18). In another systematic review (17) and more recent meta-analysis (19), PICCs were associated with rates of CLABSI that paralleled or exceeded those of traditional CVCs in hospitalized patients. As the use of PICCs expands to vulnerable populations, such as infants, children, and critically ill and immunocompromised patients (9, 11), our findings about lack of reliable device awareness highlight opportunities to improve clinical practice and patient safety.

In accordance with our hypothesis, we observed that housestaff was more likely to correctly identify the presence of a CVC than teaching attendings. However, we found that this hypothesis did not necessarily hold true for hospitalists. Our findings may relate to the fact that housestaff is more often charged with the minutiae of clinical care in contrast to teaching attendings or hospitalists, whose focus is more holistic or often concentrated on managerial aspects.

Similarly, because teaching attendings and hospitalists collectively care for more patients than individual housestaff, such data as CVC presence or ongoing necessity may be challenging for these providers to track on a daily basis. This theory might also explain greater observed awareness of CVCs among intensivists, because lower patient–provider ratios, coupled with standardization of process and a culture that is highly attuned to these devices, may make CVCs more “visible” in critical care settings (12). Conversely, the absence of such culture and the heterogeneous composition of care teams in non-ICU settings may inadvertently foster lack of CVC awareness (10, 20, 21).

We unexpectedly found that the directionality of this effect varied, because many clinicians in our study believed that a CVC was present when, in fact, it was not. Although we did not examine recent discontinuation of CVCs to corroborate these viewpoints, the absence of discrete processes to track CVCs seems likely to promote this type of bidirectional dissonance in clinical practice (10, 16, 22).

Our study has limitations. First, we determined awareness of the device at 1 point in time; providers may have been preoccupied or transiently forgot CVC presence during interviews, contributing to a false-negative response. Second, we did not link awareness of CVCs to adverse outcomes, a limitation related to the cross-sectional design of our study. Third, we constrained providers to only use materials available to them during interviews, an approach may have biased our findings. Fourth, we did not collect such patient and provider data as indication for CVC, duration of use, or patient load of each provider. Although these factors are pertinent because they may influence device awareness, we do not believe that they justify lack of CVC awareness in hospitalized patients. Fifth, housestaff was probably sampled more than once, a phenomenon related to rotation through different services during our study. Because we did not track providers over time, the influence of repeated sampling on our results is not known.

Limitations notwithstanding, our study has important strengths. First, to our knowledge this is the first study that examines how often clinicians in various locations, training levels, and specialties are unaware of the presence of CVCs. Our finding that awareness is particularly lower for PICCs in non-ICU settings is important, because these devices have become more common in these settings across the country. Second, the inclusion of geographically disparate academic hospitals lends a high degree of external validity to our findings. Third, we found that housestaff and critical care practitioners were most often aware of CVC presence. Incorporating practices and approaches from these subsets to improve awareness among other clinicians may thus prove valuable. Finally, our study suggests that relying on frontline clinicians who are responsible for CVC care to remove these devices may not be ideal. Rather, multidisciplinary approaches that incorporate bedside and vascular nursing, infection preventionist, and clinician review of the presence and necessity of CVCs seem necessary. Renewed focus to develop more transparent and advanced methods to track CVC days in ICU and non-ICU settings will help propel such efforts.

Our study also has important patient safety and policy implications. First, our findings suggest that removal of clinically unnecessary CVCs may be limited by lack of awareness of device presence, especially in non-ICU settings. Second, because clinicians at all levels were often incorrect about CVC presence, integrating and building on the concept of medical mindfulness (for example, taking the time to be more aware of one's surroundings), especially with regard to CVC management, may prove valuable (23). Our findings suggest that such training should be emphasized at all levels, including for practitioners most responsible for general patient care—teaching attendings and hospitalists. Finally, our study highlights the potential for improvement in the quality, safety, and delivery of care to hospitalized patients with CVCs. Because these devices frequently lead to hospital-acquired complications, safe, effective, and efficient patient care may be jeopardized without improved practice in this domain.

In conclusion, we found that providers are frequently unaware of the presence of CVCs in their patients. Further study of mechanisms that ensure that clinicians are aware of the presence and clinical necessity of CVCs is warranted. Policies and procedural oversight to increase visibility of these devices, especially in non-ICU settings, would be welcome.

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Context

Central venous catheters (CVCs) are commonly used to care for hospitalized patients; however, their continued presence creates substantial risks, including infection and thrombosis. Although indwelling CVCs should be removed as soon as they are no longer needed, clinicians may not be aware of their presence.

Contribution

This study found that many interns, residents, and attending physicians were unaware that their patients had indwelling catheters, including triple-lumen and peripherally inserted central catheters.

Implication

Increased efforts are needed to ensure that clinicians are mindful of the presence of their patients' CVCs.

—The Editors

Table 1**Patient, Provider, and Hospital Characteristics**

Variable	Site 1	Site 2	Site 3	Total
Patient and provider characteristics				
Study patients, <i>n</i> (%)	320 (32.3)	375 (37.9)	295 (29.8)	990 (100)
General medicine teaching attending	70 (25.1)	183 (65.6)	26 (9.3)	279 (100)
Hospitalist	89 (22.4)	91 (22.9)	218 (54.8)	398 (100)
Critical care	35 (36.8)	60 (63.2)	0 (0.0)	95 (100)
Other subspecialty	126 (57.8)	41 (18.8)	51 (23.4)	218 (100)
Mean age, <i>y</i> [*]	52.2	46.0	59.1	NA
Male, % [*]	51.0	49.8	49.5	NA
Provider assessments, <i>n</i> (%)	690 (36.7)	826 (43.9)	365 (19.4)	1881 (100)
General medicine teaching attending	181 (24.4)	502 (67.7)	59 (7.9)	742 (100)
Hospitalist	89 (22.4)	91 (22.9)	218 (54.8)	398 (100)
Critical care	101 (40.1)	151 (59.9)	0 (0.0)	252 (100)
Other subspecialty	319 (65.2)	82 (16.8)	88 (18.0)	489 (100)
CVC characteristics, <i>n</i> (%)				
PICC	64 (50.8)	24 (19.0)	38 (30.2)	126 (100)
ICU	7 (77.8)	2 (22.2)	0 (0.0)	9 (100)
Non-ICU setting	57 (48.7)	22 (18.8)	38 (32.5)	117 (100)
Triple lumen catheter	20 (24.1)	53 (63.9)	10 (12.0)	83 (100)
ICU	15 (38.5)	24 (61.5)	0 (0.0)	39 (100)
Non-ICU setting	5 (11.4)	29 (65.9)	10 (22.7)	44 (100)
Site characteristics[*]				
Hospital beds, <i>n</i>	604	413	867	1884
Inpatient discharges, <i>n</i>	45 429	17 361	45 897	108 687
Mean length of hospital stay, <i>d</i>	6.14	5.73	7.80	NA
Medical discharges, <i>n</i>	19 725	4684	3763	28 172
Medical interns, residents, and/or physician extenders, <i>n</i>	151	185	125	461
Clinician most responsible for PICC placement	Vascular nursing	Vascular nursing	Interventional radiology	NA

Variable	Site 1	Site 2	Site 3	Total
Clinician most responsible for triple lumen catheter placement	Medical physician	Medical physician	Medical physician	NA
Does the EMR remind clinicians of CVC presence?	No	No	No	NA
Written nursing protocol for assessing device necessity and removal?	No	No	No	NA

CVC = central venous catheter; EMR = electronic medical record; ICU = intensive care unit; NA = not applicable; PICC = peripherally inserted central catheter.

* Data were sourced for patients and providers specific to the departments of medicine at individual hospitals and facilities and reflect most recent fiscal year.

Table 2

Awareness of CVC Presence

Variable	Assessments/Total, n/N (%)			
	Unaware of CVC Presence [*]	Erroneously Believed CVC Was Present	Unaware of CVC Presence or Absence [†]	Correctly Assessed Presence or Absence of CVC
By provider				
House staff	39/238 (16.4)	42/729 (5.8)	81/967 (8.4)	886/967 (91.6)
Interns	22/115 (19.1)	16/339 (4.7)	38/454 (8.4)	416/454 (91.6)
Residents	17/123 (13.8)	26/390 (6.7)	43/513 (8.4)	470/513 (91.6)
General medicine teaching attending	33/128 (25.8)	25/388 (6.4)	58/516 (11.2)	458/516 (88.8)
Hospitalist	18/59 (30.5)	15/339 (4.4)	33/398 (8.3)	365/398 (91.7)
By service				
General medicine teaching attending or hospitalist	49/187 (26.2)	45/953 (4.7)	94/1140 (8.2)	1046/1140 (91.8)
Critical care	16/127 (12.6)	24/125 (19.2)	40/252 (15.9)	212/252 (84.1)
Other subspecialties	25/111 (22.5)	13/378 (3.4)	38/489 (7.8)	451/489 (92.2)
ICU	16/127 (12.6)	24/125 (19.2)	40/252 (15.9)	212/252 (84.1)
Non-ICU setting	74/298 (24.8)	58/1331 (4.4)	132/1629 (8.1)	1497/1629 (91.9)
PICC	60/239 (25.1)	— [‡]	— [‡]	— [‡]
Triple lumen catheter	30/192 (15.6)	— [‡]	— [‡]	— [‡]
Site 1	41/180 (22.8)	24/510 (4.7)	65/690 (9.4)	625/690 (90.6)
Site 2	30/184 (16.3)	48/642 (7.5)	78/826 (9.4)	748/826 (90.6)
Site 3	19/61 (31.1)	10/304 (3.3)	29/365 (7.9)	336/365 (92.1)
Total	90/425 (21.2)	82/1456 (5.6)	172/1881 (9.1)	1709/1881 (90.9)

CVC = central venous catheter; ICU = intensive care unit; PICC = peripherally inserted central catheter.

^{*} Physician believed CVC was absent when it was present.

[†] Incorrect assessment of presence or absence of CVC among patients with and without CVCs.

[‡] Not tracked because no CVCs were found in these patients.