ORIGINAL RESEARCH

Hospital-Wide Survey of the Adequacy in the Number of Vascular Catheters and Catheter Lumens

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BACKGROUND: Removal of unnecessary catheters has been proposed as an important measure to reduce catheter-related morbidity. Nevertheless, there is scarce information about the potential magnitude of such intervention.

OBJECTIVE: The present study was aimed at analyzing the appropriateness of use of vascular catheters and catheter lumens in the inpatient setting.

DESIGN: Cross-sectional survey.

SETTING: The entire population of adult inpatients admitted to a 1368-bed tertiary-care hospital in a single day.

MEASUREMENTS: We used a set of preestablished criteria to evaluate the appropriateness of use of vascular catheters and catheter lumens according to the number and administration regimen of intravenous drugs.

RESULTS: Out of 834 patients, 575 (68.9%) had ≥ 1 vascular catheters in place on the day of the survey.

The type and distribution of the 703 surveyed catheters were peripheral venous catheter, 80.6%; central venous catheter, 15.8%; and arterial catheter, 3.6%. We found an overall mean of 2.06 ± 0.82 lumens per catheter, with significant differences between intensive care units and conventional wards ($P < 0.0001$). Based on our criteria, 126 out of 575 patients (21.9%) had an inappropriate number of catheters (medical wards, 20.0%; surgical wards, 23.9%; intensive care units, 26.3%), and 631 out of 14248 nonarterial catheter lumens (43.6%) were considered unnecessary.

CONCLUSIONS: Significant room exists for improving the adequacy of the number of vascular catheters and catheter lumens as a potentially useful tool for decreasing the incidence of catheter-related bloodstream infection. *Journal of Hospital Medicine* 2014;9:35–41. © 2013 Society of Hospital Medicine

Catheter-related bloodstream infections (CRBSIs) are among the most common forms of hospital-acquired infection and increase both length of stay and cost of hospitalization.[1,2] Notable efforts are being devoted to reduce the rate of CRBSI, usually by implementing a bundle of measures.[3–5] One measure focuses on reducing to a minimum the exposure to vascular catheters.[3] In addition, various studies have shown that multilumen central venous catheters (CVCs) are associated with a higher risk of CRBSI than are single-lumen catheters.[6–10] Accordingly, the Healthcare Infection Control Practices Advisory Committee (HIC-PAC) guideline recommends that clinicians "use a CVC with the minimum number of ports or lumens essential for the management of the patient."[3]

Despite the fact that most CRBSIs occur in conventional wards,[1,11] only a few studies have been focused on the potential magnitude of reducing the number of

unnecessary vascular catheters and catheter lumens in the non–critical-care setting.[12–16] The adequacy of vascular-catheter use has been predominantly assessed for nontunneled CVCs.[14,16–18] An institutional program aimed at reducing the overall rate of CRBSI should also include other sources, such as conventional peripheral venous catheters (PVCs), peripherally inserted central catheters (PICCs), and arterial catheters (ACs).[3] The need to extend surveillance to other types of catheters has been identified by the Infectious Diseases Society of America (IDSA) as an unresolved issue.[19]

We sought to investigate the rate and appropriateness of use of vascular catheters in the entire population of inpatients at a tertiary-care center on a single day, as well as the adequacy of the number of catheter lumens harbored by each patient, by using a set of preestablished objective criteria.

METHODS

Setting and Study Population

We performed a 1-day cross-sectional study in March 2012 at the University Hospital "12 de Octubre" in Madrid, Spain, a 1368-bed tertiary-care institution with a catchment area of 412,930 inhabitants in 2011 and 5 different adult intensive care units (ICUs; medical, trauma, coronary, general surgery, and cardiac surgery). In 2009, our center joined a national

program aimed at implementing a catheter-care bundle in adult ICUs with the intention of achieving zero incidence of CVC-related bloodstream infections. This bundle consisted of a number of evidence-based practices[4] (eg, avoiding the femoral site if possible and removing unnecessary CVCs).[20]

Study Design and Data Collection

All inpatient beds were reviewed, even if they were unoccupied on the day of the survey. The only exclusions were pediatric wards and the hospital facility for imprisoned patients. All inpatients with ≥1 vascular catheters in place on the day of survey were subsequently included. We analyzed ACs, PVCs, and the following types of CVCs: nontunneled (temporary) catheters, skin-tunneled catheters (Hickman type), totally implantable catheters (Port-A-Cath), Swan-Ganz thermodilution catheters, dialysis catheters (Shaldon type), and PICCs.

The following data were abstracted using a standardized sheet from each patient's medical and nursing records and by direct inspection: basic patient demographics; type of ward (medical/surgical [hereinafter, "conventional" wards] or ICU); type of vascular catheter; anatomic site of catheter insertion; medical or nursing team responsible for catheter placement; catheter insertion-site dressing regimen; overall number of vascular catheters per patient; and overall number of venous or arterial catheter lumens per patient (resulting from adding up all the lumens present in each patient, including 3-way stopcocks and noncoring needles in Port-A-Cath devices; each of the inflow ports in 3-way stopcocks attached to a vascular catheter was counted as a separate lumen). Those patients who were not in their wards on the day of survey for any reason (eg, an ongoing surgical procedure) were excluded.

The current indication to maintain ongoing catheterization was recorded by means of the following variables: overall number of intravenous (IV) medications administered during the previous 24 hours; type of medication (antimicrobial therapy, fluid therapy, vasoactive and inotropic drugs, chemotherapy, blood products, or others [eg, analgesics or diuretics]); type of IV administration regimen; and other indications for catheter use (need for monitoring hemodynamic status, renal replacement therapy, or need for preemptive vascular access in patients expected to be at risk of hemodynamic deterioration potentially requiring fluid resuscitation or inotropic support over the next days [eg, septic shock, acute decompensation of heart failure, or gastrointestinal bleeding within the previous week]).[21] After thorough scrutiny of prescription orders, we assigned each medication to one of 3 different IV administration regimens: (1) rapid infusion (over <1 hour); (2) infusion over 1 to 24 hours; and (3) continuous infusion over a 24-hour period. In doubtful cases, nursing staff was directly asked about the regimen of infusion.

No formal informed consent was obtained from the participants, as the present study was strictly observational and part of the institutional quality initiatives. The local Clinical Research Ethics Committee approved the study protocol.

Assessment Criteria

The adequacy of use of vascular catheters and catheter lumens was assessed by one of 4 researchers not associated with day-to-day patient care by using a set of a priori determined criteria. To determine appropriateness, a maximum theoretical number of vascular lumens was assigned to each specific indication for catheterization (Table 1). We considered that all IV medications administered by rapid infusion could be delivered consecutively through 1 single catheter lumen. Those medications administered by infusion over 1 to 24 hours, or by continuous infusion over a 24-hour period, would require an exclusive lumen. The nature of the infusate, the potential incompatibility between infused drugs, and the method of infusion (gravity drip or pump) were not taken into account in this assignment process. Hemodynamic monitoring and renal replacement therapy also required an exclusive catheter lumen. When the vascular catheterization was retained only for preemptive reasons, we considered as justified the use of a maximum of 2 single-lumen catheters.

Appropriateness of the Use of Vascular Catheters

The presence of a conventional PVC or a nontunneled (temporary) CVC was considered justifiable if ≥1 of its lumens was indicated according to the abovementioned criteria. We applied the principle that the requirements of catheter lumens should be met by keeping the number of catheters as low as possible. For instance, if a given patient had 2 catheters with an overall number of 3 lumens (ie, 1 single-lumen catheter and 1 double-lumen catheter), and only 2 catheter lumens were actually deemed necessary, we considered that the overall number of catheters was

TABLE 1. Criteria Used for the Assessment of Appropriateness of Catheter Use

Indication	No. of Catheter Lumens Deemed Necessary
Administration of IV medications	
Rapid infusion over <1 hour	1 common lumen (for all medications)
Infusion over 1–24 hours	1 exclusive lumen (for each medication)
Continuous infusion over a 24-hour period	1 exclusive lumen (for each medication)
Hemodynamic monitoring	1 exclusive lumen
Renal replacement therapy	1 exclusive lumen
Preemptive catheterization (ie, patients at risk of hemodynamic deterioration over the next days)	Maximum of 2 single-lumen catheters

NOTE: Abbreviations: IV, intravenous.

inappropriate. In view of their particular characteristics, the following types of catheters were by definition deemed to be appropriate: Swan-Ganz catheters and ACs (as nearly exclusively used for hemodynamic monitoring in critically ill patients), dialysis catheters (as solely used for this specific purpose), and PICCs and nontemporary CVCs (as most of them had been placed prior to the current hospitalization episode for the periodic administration of chemotherapy or domiciliary parenteral nutrition). Because no IV medications are delivered through Swan-Ganz catheters, ACs, and dialysis catheters, we did not take into account the presence of these devices when assessing the appropriateness of other vascular catheters present in a given patient.

Appropriateness of the Use of Catheter Lumens
First, we added up all the catheter lumens present in each patient (regardless of the type of device), and then we established the theoretical number of catheter lumens that the patient would have actually required, according to the above-mentioned criteria. The difference between both figures gave the number of unnecessary catheter lumens. Only the potentially removable lumens were included in this analysis (those of PVCs and nontunneled CVCs, as well as each of the noncoring needles inserted in Port-A-Cath catheters). The lumens of skin-tunneled CVCs, Swan-Ganz catheters, and PICCs were considered nonremovable and, therefore, always justified. We excluded ACs from this specific analysis.

Statistical Analysis
Quantitative data were shown as the mean ± standard deviation, whereas qualitative variables were expressed as absolute and relative frequencies with 95% confidence intervals (CIs). Categorical and continuous variables were compared using χ^2 and unpaired Student t tests, respectively. We calculated 3 different ratios: patients with ≥1 inappropriate catheter to overall number of inpatients; patients with ≥1 inappropriate catheter to patients with ≥1 vascular catheter in place on the day of survey; and overall number of unnecessary catheter lumens to overall number of catheter lumens. All the significance tests were 2-tailed. Statistics were performed using SPSS version 15.0 (SPSS Inc, Chicago, IL).

RESULTS
Out of 1134 reviewed inpatient beds, 834 (73.5%) were occupied on the day of the survey. The mean age of the included patients was 64.5 ± 18.8 years, and 415 (49.8%) were male. Of these patients, 575 (68.9%) had ≥1 vascular catheter in place. The proportion of patients with a vascular catheter was significantly higher in ICUs compared with conventional wards (100% vs 66.7%, $P < 0.0001$; Table 2). The overall numbers of vascular catheters and catheter lumens analyzed were 703 and 1448, respectively.

Regarding the type of device, 567 (80.6%) were PVCs, 111 (15.8%) were CVCs (including 65 nontunneled CVCs, 16 dialysis catheters, 15 PICCs, 7 skin-tunneled CVCs, 5 totally implantable CVCs, and 3 Swan-Ganz catheters), and 25 (3.5%) were ACs. The distribution according to hospital ward and anatomic site of insertion is detailed in Table 2. The use of CVCs and ACs was higher in ICUs (42.0% and 28.4% of all catheters in place, respectively) compared with conventional wards (12.0% and 0.0%, $P < 0.0001$). The use of the subclavian vein insertion site was more common in medical wards (65.7% of all CVCs, excluding PICCs) than in surgical wards or ICUs (26.9%, $P = 0.0002$). Most of the catheters had been inserted by nursing staff members (75.2%), followed by anesthesia physicians (13.4%) and critical-care medicine physicians (4.8%). An opaque gauze or transparent polyurethane insertion-site dressing was present in 378 (53.8%) and 319 (45.3%) catheters, respectively, with no significant differences according to the type of device or hospital ward.

After excluding ACs, we found an overall mean number of 2.06 ± 0.82 lumens per catheter (1.86 ± 0.45 per PVC and 3.09 ± 1.39 per CVC), with significant differences between ICUs and conventional wards ($P < 0.0001$; Table 2). There was a mean of 0.86 ± 0.57 3-way stopcocks per catheter. The mean number of concurrent IV medications per patient was 2.8 ± 2.7 (ranging from 2.3 ± 2.1 in those with a single catheter to 10.5 ± 2.6 in those with 4 catheters). The most commonly administered medications were antimicrobials (46.6% of patients with a vascular catheter), fluid therapy (33.4%), chemotherapy (2.3%), and vasoactive and inotropic drugs (1.0%). According to the administration regimen, 455 (79.1%), 30 (5.2%), and 182 (31.6%) patients were receiving medications by rapid infusion, infusion over 1–24 hours, or continuous infusion over a 24-hour period, respectively. In 57 patients (9.9%), the catheter was used only as preemptive vascular access. No apparent indication for the use of a vascular catheter was found in 63 patients (10.9%).

Based on our criteria, 126 out of 834 inpatients (15.1%, 95% CI: 12.8–17.7) had ≥1 inappropriate catheter, with significant differences between conventional wards and ICUs (13.2% vs 26.3%, $P = 0.014$). This prevalence rate increases to 21.9% (95% CI: 18.7–25.5) when only patients with ≥1 vascular catheter in place were analyzed.

Focusing on the number of catheter lumens, 631 out of 1448 (43.6%, 95% CI: 41.0–46.1) were considered unnecessary. There was a nonsignificant trend toward a higher rate of unnecessary lumens in conventional wards compared with ICUs (44.8% vs 39.4%, $P = 0.086$; Table 3). Because some centers have policies requiring all inpatients to harbor ≥1 PVC in place throughout the entire hospitalization period, we performed a first sensitivity analysis in which we assumed

TABLE 2. Number of Catheters Per Patient and Characteristics of Vascular Catheters Analyzed

	No. of Patients			
	Overall, N = 834	Medical Wards, n = 498	Surgical Wards, n = 279	ICUs, n = 57
No. of catheters in place, n (%)	259 (31.1)	168 (33.7)	91 (32.6)	0 (0.0)
≥1	575 (68.9)	330 (66.3)	188 (67.4)	57 (100.0)*
1	477 (57.2)	299 (60.0)	158 (56.6)	20 (35.1)
2	72 (8.6)	26 (5.2)	24 (8.6)	22 (38.6)
3	22 (2.6)	5 (1.0)	6 (2.2)	11 (19.3)
4	4 (0.5)	0 (0.0)	0 (0.0)	4 (7.0)

	No. of Catheters			
	Overall, N = 703	Medical Wards, n = 391	Surgical Wards, n = 224	ICUs, n = 88
Type of catheter, n (%)				
PVC	567 (80.6)	345 (88.2)	196 (87.5)	26 (29.6)*
CVC	111 (15.8)	46 (11.8)	28 (12.5)	37 (42.0)*
AC	25 (3.6)	0 (0.0)	0 (0.0)	25 (28.4)*
Insertion site, n (%)[†]				
PVCs				
Hand and forearm	425 (74.9)	245 (71.0)	156 (79.6)	24 (92.3)
Antecubital fossa	105 (18.5)	73 (21.2)	31 (15.8)	1 (3.8)
Arm	36 (6.3)	26 (7.5)	9 (4.6)	1 (3.8)
Lower extremity	1 (0.2)	1 (0.3)	0 (0.0)	0 (0.0)
CVCs				
Arm (PICC)	13 (11.7)	11 (23.9)	2 (7.1)	0 (0.0)
Subclavian vein	40 (36.0)	23 (50.0)	7 (25.0)	10 (27.0)
IJ vein	47 (42.3)	9 (19.6)	18 (64.3)	20 (54.1)
Femoral vein	11 (9.9)	3 (6.5)	1 (3.6)	7 (18.9)
ACs				
Upper extremity	19 (76.0)	0 (0.0)	0 (0.0)	19 (76.0)
Lower extremity	6 (24.0)	0 (0.0)	0 (0.0)	6 (24.0)
No. of lumens per catheter, mean ± SD				
All nonarterial catheters	2.06 ± 0.82	1.88 ± 0.57	1.98 ± 0.56	2.98 ± 1.42[‡]
PVCs	1.86 ± 0.45	1.81 ± 0.44	1.88 ± 0.39	2.12 ± 0.66[‡]
CVCs	3.09 ± 1.39	2.45 ± 0.99	2.68 ± 0.98	4.02 ± 1.40[‡]

NOTE: **Abbreviations:** AC, arterial catheter; CVC, central venous catheter; ICU, intensive care unit; IJ, internal jugular; PICC, peripherally inserted central catheters; PVC, peripheral venous catheter; SD, standard deviation.

*$P < 0.0001$ for comparison between ICUs and conventional wards.

[†]Relative frequencies refer to the no. of catheters of each type.

[‡]$P < 0.001$ for comparisons between ICUs and conventional wards.

that having a single functional vascular lumen was appropriate in all cases, regardless of any other criteria. Under this assumption, only 248 lumens (17.1%, 95% CI: 15.3–19.2) could be regarded as unnecessary. We conducted a second sensitivity analysis by including in the rate denominator only those catheter lumens potentially removable (eg, PVCs, nontunneled CVCs, and noncoring needles inserted in Port-A-Cath catheters). By applying this method, 48.6% of lumens

(631 out of 1298, 95% CI: 45.9–51.3) could be considered inappropriate.

DISCUSSION

In this cross-sectional survey, we found that 1 out of every 5 (20%) adult inpatients with a vascular catheter in place in our tertiary-care center had an inappropriate number of catheters. This figure increased to 43.6% when the number of catheter lumens was

TABLE 3. Appropriateness of the Use of Vascular Catheters and Catheter Lumens

Rate	Overall	Medical Wards	Surgical Wards	ICUs
Patients with ≥1 inappropriate catheter/overall no. of inpatients, n (%)	126/834 (15.1)	66/498 (13.2)	45/279 (16.1)	15/57 (26.3)*
Patients with ≥1 inappropriate catheter/patients with ≥1 vascular catheter, n (%)	126/575 (21.9)	66/330 (20.0)	45/188 (23.9)	15/57 (26.3)
No. of unnecessary vascular catheter lumens/overall no. of vascular catheter lumens, n (%)	631/1448 (43.6)	298/684 (43.6)	207/444 (46.6)	126/320 (39.4)[†]

NOTE: **Abbreviations:** ICU, intensive care unit.

*$P = 0.014$ for comparison between ICUs and conventional wards.

[†]$P = 0.086$ for comparison between ICUs and conventional wards.

analyzed (or 17.1% if we assumed that all patients should have at least 1 vascular access during their hospitalization period solely on the basis of preemptive reasons). Such rates of unnecessary catheter use throughout an entire institution offer an opportunity for improvement in clinical practice and, eventually, for reducing catheter-related morbidity.

Other authors have also assessed the adequacy of CVC use in either ICU[16,17] or non-ICU settings.[14–16,18,21] A recent hospital-wide survey found that 4.8% of catheter-days were unnecessary, with a higher proportion in conventional wards than in the ICU,[16] mirroring the results from previous studies.[14] Another prospective study, limited to conventional wards, reported that almost half of the patients had ≥1 day with inappropriate vascular-device use; age, total number of catheters used, and duration of catheterization were significantly associated with this event.[21] On the contrary, compliance with the criteria drawn up by the HICPAC and the Infusion Nurses Society for PICC use was found to be high overall in a medium-sized community hospital.[22] Interestingly, we found a differential pattern in the adequacy of catheter use between hospital areas in function of the variable analyzed: number of inappropriate vascular catheters (higher rate in ICUs) or number of unnecessary vascular lumens (higher rate in conventional wards). Although our assessment criteria may partially account for such differences (ie, drug infusions for >1 hour justified the use of an exclusive catheter lumen), this finding raises the question of whether future interventions should be aimed at modifying specific catheter practices according to the type of hospital ward.

In contrast to the amount of literature on CVC, there is a scarcity of studies evaluating the appropriateness of PVC use in clinical practice. Lederle et al. reported that 17% of patients admitted in conventional wards of a university hospital had an "idle" PVC, with 20% of patient-days of catheter exposure considered unnecessary.[12] The same authors subsequently demonstrated a significant decrease in these figures by implementing a multidisciplinary quality-improvement intervention.[13] A previous cross-sectional survey in our center revealed a PVC use rate as high as 46.2% among non-critically ill adult inpatients.[23] Phlebitis is a common complication of PVC use, occurring in about 7% of inpatients and usually leading to catheter removal and replacement.[24] Although at a much lower incidence, peripheral catheterization also represents a non-negligible source of CRBSI.[25] In our institution, in which a recently implemented specific bundle has resulted in a clear improvement in CVC care,[4,20] about 60% of CRBSI occurring during the first 3 months of 2013 were due to PVCs (unpublished data). Therefore, this type of device should be routinely included in future surveys seeking to investigate the local epidemiology of catheter use at each institution. In that sense, it should be noted that a recent clinical trial showed no benefit of routine third-day replacement vs clinically indicated replacement for phlebitis or CRBSI.[24]

Our study suggests that the daily review of the need for maintaining the vascular catheter should take into account the number of vascular lumens, as >40% of them were deemed unnecessary. To our knowledge, this area for potential intervention has not been addressed in previous surveys. Numerous studies have long demonstrated that the use of double-lumen or triple-lumen CVCs is associated with a higher rate of CRBSI than single-lumen devices.[6–8] Even though a meta-analysis concluded that this relationship diminishes when only high-quality studies were included,[9] a more recent prospective study reported a hazard ratio for infection of 4.4 for each additional lumen.[10] However, it might be argued against our decision to count each inflow port in multiway stopcocks as a separate vascular lumen. Because the present survey was ultimately aimed at identifying opportunities to reduce the risk of CRBSI by decreasing catheter exposure, such an approach was chosen to properly capture and quantify every single potential source of infection in catheterized patients. We hypothesize that the use of 3-lumen stopcocks could involve an increased number of manipulations, thus jeopardizing the integrity of the insertion-site dressing and subsequently favoring the intraluminal bacterial colonization of the common catheter. Although the current guidelines do not provide specific recommendations regarding the number of lumens in devices other than CVCs,[3,19] the potential benefit of reducing this figure to the minimum in PVCs and ACs should also be assumed. In our opinion, specific efforts have to be focused on improving the use of 3-way stopcocks, as we found a mean of 1.86 lumens per PVC and >3 lumens per CVC in our study. Maybe the need for 3-way stopcocks should be reassessed on a daily basis in a similar way as that recommended for temporary CVCs.[3,19] By eliminating unnecessary vascular lumens, the risk of CRBSI could be diminished without compromising the availability of vascular access for preemptive purposes.

The present surveillance also provides an accurate insight into the "real-life" vascular catheter practices in a hospital-wide setting, in contrast with most of the previous studies, which have been conducted in specific wards or units.[13,15,17] One relevant finding was the relatively low use of the subclavian vein site for central venous access (only 40.8% of all CVCs inserted), with significant differences between medical wards and the remaining hospital areas. Various studies have shown that the subclavian site is associated with a lower risk of infectious and thrombotic complications.[4,26–28] Therefore, the HICPAC and IDSA guidelines strongly recommend using a subclavian site, rather than a jugular or a femoral site, to minimize infection risk for nontunneled CVCs.[3,19] Nevertheless, recent studies have suggested that internal jugular and

femoral sites could be acceptable when a subclavian approach is not feasible, particularly if chlorhexidine-impregnated dressings are used and catheters are left in place for <4 days.[29]

The current study has a number of inherent limitations; the most significant is its cross-sectional design, which precludes direct comparison of the rates of catheter use with other prospective cohort surveys.[14,16,21] In addition, we were not able to assess the changing dynamics of catheter use over time. In other words, the lack of use of a given device on the day of the survey does not necessarily imply inappropriateness. The criteria used to determine appropriateness of vascular catheterization were consensus opinion and not evidence-based, a weakness shared by previous studies,[21] as current guidelines only address the indications for certain devices (ie, HICPAC and Infusion Nurses Society recommendations for PICC use).[3,30] Although we have attempted to be liberal in accepting indications for catheter use (ie, preemptive access in patients deemed at risk of hemodynamic instability), some misclassification bias cannot be ruled out. In evaluating the adequacy of catheter lumens, we did not take into account the simultaneous delivery of incompatible infusates—which must be infused through separate lines—or other relevant variables (eg, nursing availability). Because the aim of our study was simply to determine whether a patient had an appropriate number of vascular catheters and vascular lumens in overall terms, all vascular lumens in each subject were individually counted and added regardless of the nature of the device, and therefore we were not able to disaggregate the adequacy rate by specific catheter types. Finally, the generalizability of the results may be hampered by their single-center nature, and this limitation applies particularly to institutions with different policies than ours regarding preemptive vascular catheterization (ie, those requiring that all inpatients have at least 1 vascular lumen at any time during hospitalization).

On the other hand, some strengths of this survey merit consideration, namely its comprehensive design, capturing the entire population of adult inpatients in different hospital areas and every type of vascular catheter. Moreover, we addressed the adequacy of maintaining catheterization not only in terms of "idle" catheters in place, but also in terms of unnecessary lumens. In conclusion, there remains room for improvement in daily practice regarding the prompt removal of vascular catheters and vascular lumens that are no longer medically necessary. Further educational efforts among physicians and nursing staff should be targeted toward achieving this simple but effective measure to reduce the incidence of CRBSI.

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