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SCIENTIFIC ARTICLE

The unnecessary application of central venous catheterization in surgical patients



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KEYWORDS

Central venous catheter;
Catheter placement;
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Abstract

Background and objectives: Perioperative physicians occasionally encounter situations where central venous catheters placed preoperatively turn out to be unnecessary. The purpose of this retrospective study is to identify the unnecessary application of central venous catheter placement and determine the factors associated with the unnecessary application of central venous catheter placement.

Methods: Using data from institutional perioperative central venous catheter surveillance, we analysed data from 1,141 patients who underwent central venous catheter placement. We reviewed the central venous catheter registry and medical charts and allocated registered patients into those with the proper or with unnecessary application of central venous catheter according to standard indications. Multivariate analysis was used to identify factors associated with the unnecessary application of central venous catheter placement.

Results: In 107 patients, representing 9.38% of the overall population, we identified the unnecessary application of central venous catheter placement. Multivariate analysis identified emergencies at night or on holidays (odds ratio [OR] 2.109, 95% confidence interval [95% CI] 1.021–4.359), low surgical risk (OR = 1.729, 95% CI 1.038–2.881), short duration of anesthesia (OR = 0.961/10 min increase, 95% CI 0.945–0.979), and postoperative care outside of the intensive care unit (OR = 2.197, 95% CI 1.402–3.441) all to be independently associated with the unnecessary application of catheterization. Complications related to central venous catheter placement when the procedure consequently turned out to be unnecessary were frequently observed (9/107) compared with when the procedure was necessary (40/1034) ($p=0.032$, OR = 2.282, 95% CI 1.076–4.842). However, the subsequent multivariate logistic model did not hold this significant difference ($p=0.0536$, OR = 2.115, 95% CI 0.988–4.526).

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PALAVRAS-CHAVE

Cateter venoso central;
Colocação de cateter;
Aplicação desnecessária de cateter

Conclusions: More careful consideration for the application of central venous catheter is required in cases of emergency surgery at night or on holidays, during low risk surgery, with a short duration of anesthesia, or in cases that do not require postoperative intensive care.

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A aplicação desnecessária de cateterização venosa central em pacientes cirúrgicos**Resumo**

Justificativa e objetivos: No perioperatório, os médicos ocasionalmente encontram situações nas quais um cateter venoso central colocado pré-operativamente se revela desnecessário. O objetivo deste estudo retrospectivo foi identificar a colocação desnecessária de um cateter venoso central e determinar os fatores associados à colocação desnecessária de cateter venoso central.

Métodos: Com os dados da vigilância institucional de cateter venoso central no período perioperatório, analisamos 1.141 pacientes submetidos à colocação de cateter venoso central. Revisamos o registro de cateter venoso central e os prontuários médicos e alocamos os pacientes registrados entre aqueles com colocação adequada ou desnecessária de cateter venoso central, de acordo com as indicações padronizadas. Uma análise multivariada foi usada para identificar os fatores associados à colocação desnecessária de cateter venoso central.

Resultados: Em 107 pacientes, que representaram 9,38% da população global, identificamos a colocação desnecessária de cateter venoso central. A análise multivariada identificou emergências à noite ou em feriados (razão de chances [OR] 2,109; 95% de intervalo de confiança [IC 95%] 1,021–4,359), baixo risco cirúrgico (OR = 1,729; IC 95%: 1,038–2,881), curta duração da anestesia (OR = 0,961/10 min de aumento; IC 95%: 0,945–0,979) e assistência pós-operatória fora da unidade de terapia intensiva (OR = 2,197; IC 95%: 1,402–3,441), todos independentemente associados à aplicação desnecessária de cateterização. Complicações relacionadas à colocação de cateter venoso central, quando esse procedimento revelou-se desnecessário, foram frequentemente observadas (9/107), em comparação com a necessidade da execução desse procedimento (40/1.034) ($p=0,032$, OR = 2,282; IC 95%: 1,076–4,842). Porém, o modelo logístico multivariável subsequente não manteve essa diferença significativa ($p=0,0536$, OR = 2,1515; IC 95%: 0,988–4,526).

Conclusões: É preciso que uma análise mais cuidadosa seja feita sobre a colocação de cateter venoso central em casos de cirurgia de emergência à noite ou em feriados, durante cirurgia de baixo risco, em anestesia de curta duração ou em casos que não requeiram terapia intensiva no pós-operatório.

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Introduction

Central venous catheters (CVCs) provide reliable venous access for a variety of medical needs. Standard indications for insertion include need for venous access (including need for frequent blood sample collection), monitoring, cardiac pacing, hemodialysis, and centrally administered intravenous therapies (for example, inotropes, vasopressors, total parenteral nutrition, chemotherapy, and long term antibiotics).¹ However, insertion of CVCs is associated with important risks, including catheter-related bloodstream infections, mechanical injuries, and venous thromboembolism.¹ Nevertheless, we think that it is preferred to perform CVC placement with expanded indications during the perioperative periods in case of unforeseen

circumstances. Expanding the indications for CVCs during restricted periods may be feasible from the point of view of risk management; however, we may need to reconsider the indications for CVCs during the perioperative period, and take into consideration the CVC-related complications, as situations in which CVCs placed preoperatively turned out to be unnecessary throughout the hospital stay occur with some frequency.

Because the risk for CVC-related adverse outcomes increases with time, the early removal of CVCs that are no longer clinically warranted is a key strategy for prevention of adverse events.^{2,3} We propose that a more promising strategy is the prevention of the unnecessary application of CVC placement in advance. For that purpose, it is important to ascertain factors that distinguish the unnecessary

application of CVC placement from the proper application of CVC placement during the perioperative period. We can identify factors associated with the unnecessary application of CVC placement by investigating the situations where physicians applied CVCs that were not used throughout the intra- and post-operative process.

Our institute has conducted perioperative CVC surveillance as a part of our medical quality improvement. Registration with this surveillance service is required in our institute, with a registration form to be filled out and submitted whenever CVC placement is performed perioperatively. Using this surveillance system and review of each patient's medical charts, we investigated whether CVCs placed preoperatively were used properly according to the initial reasons for CVC placement. Based on this investigation, we attempted to determine the factors associated with these unnecessary applications of CVC placements.

Patients and methods

Approval for the review of clinical charts of patients who underwent CVC placement during the perioperative period in the operating room was obtained from the Nara Medical University Institutional Review Board (No. 696 approved on 6/17/2013), and written informed consent for this retrospective observational study was waived.

Perioperative patient treatment and CVC surveillance

Methods of anesthetic induction, maintenance, and tracheal intubation were at the operator's discretion. Typically, general anesthesia was induced with intravenous propofol (1–2.5 mg.kg⁻¹) plus fentanyl (0.1–0.2 µg.kg⁻¹) and/or remifentanyl (0.2–0.3 µg.kg⁻¹.min⁻¹). Tracheal intubation was performed under laryngoscopy and facilitated by rocuronium (0.6–0.9 mg.kg⁻¹). After induction of anesthesia, CVC placement was performed when deemed necessary. Preoperative patient evaluation was made by a consultant anesthesiologist in charge at the preoperative anesthesia consultation clinic. Application of CVCs was discussed and roughly determined at that time. However, the final determination of CVC application was usually concluded through discussion between the attending physicians including anesthesiologists and surgeons. In case of a resident anesthesiologist, the final determination of CVC application was made after consulting a senior anesthesiologist. Usually, anesthesiologists had a priority to judge the indication for CVC placement in most cases because most of the reasons for acceptable indication of CVC placement were directly related with intraoperative management. The approach site for CVC placement depended on the operator's preference or type of surgery; however, the most common site was the right jugular vein. Occasionally, the femoral or cubital vein was used. According to the institutional CVC protocol, CVC placement was performed with a surface landmark-guided technique coupled with pre-scan vessel imaging using ultrasonography (US); however, real-time US-guided CVC placement was also performed according to the operator's preference. After completion of anesthesia, the operator in charge filled out the registration for perioperative CVC surveillance service, which was

designed to help improve CVC practice and prevent further complications. This form includes the operator's name, the name of the physician who performed the CVC placement, the reason for CVC placement (central venous pressure monitoring, parenteral nutrition, drug administration, rapid infusion against massive bleeding, alternatives for difficulty of peripheral catheterization, routes for cardiac devices), the site of approach, number of catheter lumens, use of US, number of attempts of insertion, the patient's demographic variables, information on final diagnosis and surgical procedures (later categorized into three classes based on the modified surgical risk stratification),⁴ background illnesses (hypertension, diabetes mellitus, coronary artery disease, history of heart failure, lung disease), duration of anesthesia and surgery, ASA physical status, urgency of surgery (emergency or elective), intraoperative patient positioning, requirement of transfusion, requirement of postoperative intensive care, and adverse events related to CVC placement (arterial puncture, hematoma formation, arrhythmia, etc.).

Determination of the unnecessary application of CVC

The reasons considered justifiable for CVC are in Table 1.^{5,6} Even in cases for which the initial criteria were satisfied, CVC placement was considered to be unjustified if eventually the catheter was not used properly. However, CVC placement was considered to be justified if eventually the catheter was used properly even for another reason. CVC procedures were divided into the proper and unnecessary application following review of the CVC registry and medical charts. One of the authors (KU) initially judged each CVC placement, and each judgment was reviewed by SI or MK.

Data handling

Data were collected between January 2009 and December 2013, during which time there were 21,606 anesthesia cases. There were 1731 CVC surveillance service registrations during this period. However, cases that included cardiovascular surgery were excluded from data analysis because CVCs were invariably placed and used according to the institutional anesthesia protocol and not depending on the operator's preference. Patients <15 years old were also

Table 1 Acceptable indication of CVC placement and determination of unnecessary application of CVC.

Acceptable CVC placement

No peripheral access and need for intravenous medication
Hemodynamic monitoring
Receipt of total parenteral nutrition
Administration of vasopressors or inotropes
Two intravenous medications simultaneously administered due to necessity rather than convenience
Hemodynamic instability due to intraoperative blood loss of more than 1500 mL^{5,6}

CVC, central venous catheter.

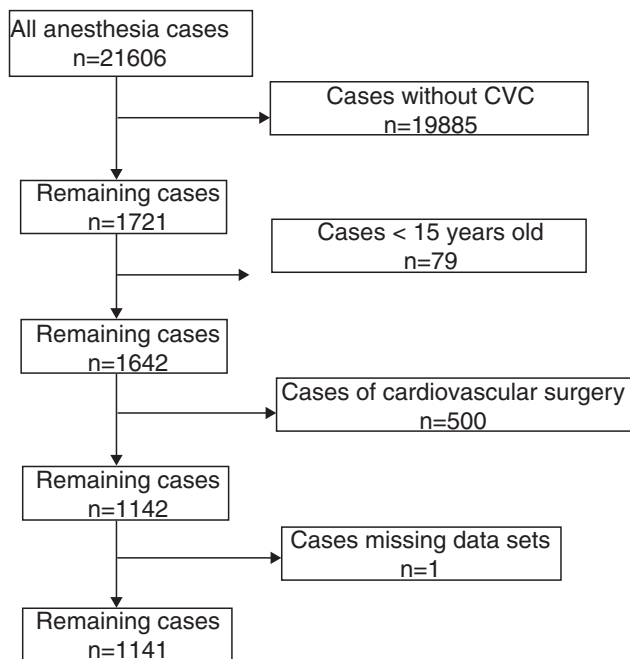


Figure 1 Flow diagram for patient inclusion and exclusion.

excluded because no CVC protocol for pediatrics had been established in our institute. Finally, exclusion criteria for the current study and consequent reductions in eligible patients are presented in Fig. 1.

Statistical analysis

Univariate analysis was used to identify candidate factors associated with the unnecessary application of CVC placement. Candidate variables (patient's demographics, preoperative comorbid conditions, who performed CVC catheterization (trainee or anesthetist; a trainee was defined as a medical school graduate, who had a medical qualification, in a 2 yr mandatory clinical training programme currently on rotation in the anesthesia department (for a couple of months) or a trainee anesthetist in a 2 yr training programme after the mandatory training.), duration of anesthesia and surgery, patient positioning, surgical risk categorized into low (low risk) or high (intermediate and high risk) risk based on the modified surgical risk stratification, surgical site, emergency at night or on holiday, postoperative Intensive Care Unit (ICU) admission, and transfusion requirement) were selected. Explanatory factors with significant univariate association ($p < 0.20$) with the unnecessary application of CVC placement were used to construct a forced-entry multivariable logistic regression model, presented as adjusted odds ratios with 95% confidence intervals (CI). Interactions between the variables were systematically searched, and collinearity was considered when r or $\rho > 0.8$ by Pearson or Spearman coefficient matrix correlation. Discrimination of the final model for the unnecessary application of CVC placement was assessed by the likelihood ratio test. Calibration of the model was tested using the Hosmer–Lemeshow statistical method. The area under the receiver operating characteristic curve was computed for use as a descriptive tool for measuring the bias of the model. Lastly, the complica-

tion rate related to CVC placement was compared between the unnecessary and proper application of CVC placement. Regarding this analysis, more confounders should be related with the complication related to CVC placement. Therefore, a forced-entry multivariable logistic regression model was applied to this analysis. Construction of the model was performed in the same manner. Data are expressed as mean and SD for the normal distribution or medians and IQR for the non-Gaussian distribution. Comparison of two means was performed using Student's t -test, comparison of two medians was performed using the Mann–Whitney's U test, and comparison of two proportions was performed using the Fisher exact method. We used the MedCalc statistical package (Version 14.12.0, MedCalc Software bvba, Ostend, Belgium) to perform all analyses in this study.

Results

We analyzed data from 1141 patients; 107 patients, representing 9.38% of the overall population, were judged to have received the unnecessary application of CVC placement. Any initial judgment for the unnecessary application of CVC placement was not rejected. Thus, eventually the judged catheters had not been used properly even for another justified reason. Table 2 shows the initial reasons for CVC placement on both unnecessary and proper application of catheterizations. The reasons for CVC placement were similar ($p = 0.13$); however, 107 catheters were not used properly after insertion as per CVC placement based on the reason for the placement.

Patient data and perioperative characteristics were compared between patients in both categories (Table 3). Univariate analysis indicated short stature, low weight, female gender, high grade ASA physical status, presence of co-existing disease, emergency at night or on holiday, degree of surgical risk, small amount of intraoperative bleeding, bloodless surgery, short duration of anesthesia and surgery, and cases without postoperative ICU admission were all extracted as candidates associated with the unnecessary application of catheterization for the next multivariate analysis. Collinearity between duration of anesthesia and surgery ($r > 0.99$) and between ASA physical status and presence of co-existing disease ($\rho = 0.831$) was found. Therefore, duration of surgery and ASA physical status were removed from candidate variables. Collinearity between duration of surgery and surgical risk ($\rho = 0.422$) and between duration of anesthesia and surgical risk ($\rho = 0.412$) was not observed. Multivariate analysis identified emergency at night or on holiday (odds ratio [OR] 2.109, 95% confidence interval (95% CI) 1.021–4.357), low surgical risk (OR = 1.729, 95% CI 1.038–2.881), short duration of anesthesia (OR = 0.961 per 10 min increase, 95% CI 0.945–0.979), and cases without postoperative ICU admission (OR = 2.197, 95% CI 1.402–3.441) to be independently associated with the unnecessary application of catheterization (Table 4). Discrimination of the final models assessed by the likelihood ratio test was significant for these variables ($p < 0.001$). The Hosmer–Lemeshow analysis suggested an acceptable calibration ($p = 0.592$). The explanatory model based on these variables had an area under the receiver operating characteristic curve of 0.730 (95% CI 0.703–0.755).

Table 2 Initial reasons for CVC placements for CVCs on both unnecessary and proper application of catheterizations.

	Unnecessary application of CVC placement (<i>n</i> = 107)	Proper application of CVC placement (<i>n</i> = 1034)	All patients (<i>n</i> = 1141)
Use of catecholamines	28 (26.2%)	278 (26.9%)	306 (26.8%)
Use of vasodilators	11 (10.2%)	198 (19.1%)	209 (18.3%)
Postoperative parental nutrition	19 (17.8%)	191 (18.5%)	210 (18.4%)
CVP monitoring	4 (3.7%)	33 (3.2%)	37 (3.2%)
Other (no peripheral line, against massive bleeding, use of hypertonic irritant solution)	45 (42.1%)	334 (32.3%)	379 (33.2%)
			<i>p</i> = 0.13

CVC, central venous catheter.
CVCs based on the unnecessary application were not used properly according to any justifiable reasons for CVC placement. Therefore, the listed reasons regarding the unnecessary application of CVC placement were the initial intended reasons for CVC placement.

Table 3 Results of univariate analysis.

	Unnecessary application of CVC placement (<i>n</i> = 107)	Proper application of CVC placement (<i>n</i> = 1034)	<i>p</i> -Value
Gender (M/F)	53/54	673/361	0.002
Age (year)	65.6 (13.8)	65.2 (12.8)	0.713
Height (cm)	157.8 (9.8)	161.2 (8.9)	<0.001
Weight (kg)	55.6 (12.4)	58.7 (11.8)	0.011
BMI (kg.m ⁻²)	22.2 (4.0)	22.5 (3.9)	0.480
ASA physical status (median IQR)	2 (2–2)	2 (2–2)	0.042
CVC placement by trainee (Y/N)	51/56	475/559	0.2225
Coexisting disease (Y/N)	43/84	164/870	0.133
Emergency at night or holiday (Y/N)	13/94	46/988	0.002
Surgical risk (high/low)	27/80	440/594	<0.001
Surgical site (thoracic or abdominal) (Y/N)	88/19	864/170	0.684
Supine position (Y/N)	74/33	669/365	0.395
Duration of anesthesia (min)	278 (137)	417 (228)	<0.001
Duration of surgery (min)	200 (131)	337 (218)	<0.001
Bleeding (mL)	328 (429)	791 (2276)	0.036
Transfusion (Y/N)	21/86	336/698	0.006
ICU admission (Y/N)	43/64	540/494	0.019

CVC, central venous catheter.
Values are mean (SD), median IQR (range), or number.

Table 4 Results of multivariate analysis.

	Odds ratio	95% CI	<i>p</i> -Value
Height (per 10 cm)	0.784	0.556–1.105	0.164
Weight (per 10 kg)	0.954	0.773–1.178	0.661
Female gender	1.217	0.687–2.156	0.502
Coexisting disease	1.071	0.621–1.848	0.805
Low surgical risk	1.729	1.038–2.881	0.036
Emergency at night or on holiday	2.109	1.021–4.359	0.044
Duration of anesthesia (per 10 min)	0.961	0.945–0.979	<0.001
Bleeding (per 100 mL)	0.998	0.965–1.032	0.891
Transfusion	0.922	0.483–1.762	0.806
Non ICU admission	2.197	1.402–3.441	<0.001

min, minutes; ICU, Intensive Care Unit.

A post hoc power calculation for this forced-entry multivariable logistic regression model using ten variables was conducted. We followed standard methods to estimate

sample size for multivariable logistic regression, with at least ten outcomes needed for each included independent variable.⁷ With the incidence of the unnecessary

Table 5 Complications related to CVC placement and items of complications.

	Unnecessary application of CVC placement (n = 107)	Proper application of CVC placement (n = 1034)	Odds ratio (95% CI)	p-Value
<i>Complication (Y/N)</i>	9/98	40/994	2.282 (1.076–4.842)	0.032
<i>Items of complications</i>				
Arterial puncture, n (%)	6 (1.7)	14 (1.4)		
Hematoma formation, n (%)	1 (0.9)	9 (0.9)		
Arrhythmia, n (%)	0 (0)	6 (0.6)		
Others, n (%)	2 (1.9)	13 (1.3)		
Total, n (%)	9 (8.4)	42 (4.1)		

CVC, central venous catheter.

The value is presented as the odds ratio on incidence of complication for unnecessary CVC placement against necessary CVC placement. Two cases in unnecessary application of CVC placement simultaneously developed two complications, which were arterial puncture + hematoma or hematoma + arrhythmia. That is why the total items of complications were more than the total number of cases. Regarding "others" in this table, a reporter for CVC registration form selected and marked an answer from a list of adverse events, which was consist of "arterial puncture", "hematoma formation", "arrhythmia", and "other". Therefore, any details in others are not known beyond that. Probably, they were not severe complications. For example, they were catheter tip malposition, in which the catheter was retrogradely placed to the innominate or subclavian vein through the right jugular vein or accidental removal of a guide wire during the procedure.

Table 6 Results of multivariate analysis for CVC complication.

	Odds ratio	95% CI	p-Value
Age (per 10 years)	0.846	0.695–1.029	0.0946
Female gender	1.760	0.987–3.141	0.0556
Unnecessary catheter	2.115	0.988–4.526	0.0536

CVC, central venous catheter.

application of central catheterization of 107/1141 (9.38%) in this population, we required 1066 operations of central catheterization to appropriately perform multivariable logistic regression with ten variables, which demonstrates that our sample size was sufficient to build the model.

Complications related to CVC placement when it was performed unnecessarily were frequently observed compared to when CVC placement was necessary ($p=0.032$, OR = 2.282, 95% CI 1.076–4.842) (Table 5). The most common complication was arterial puncture (39.2%) followed by hematoma formation (19.6%) and arrhythmia (11.8%) (Table 5). However, the multivariate analysis including age, gender, and the unnecessary application of catheterization as candidate variables showed that any variable was not independently associated with complications related to CVC placement (Table 6). CVC placement by trainee or with use of US was not extracted as a candidate for this model from the univariate analysis for CVC complications. Discrimination of the final model assessed by the likelihood ratio test was significant ($p < 0.0159$). Furthermore, the Hosmer–Lemeshow statistic did not reject a logistic regression model fit ($p = 0.2325$). Post hoc power calculations were performed for this forced entry multivariate logistic regression model using 3 variables in the model. We followed standard methods to estimate the sample size for multivariate logistic regression, with at least ten outcomes needed for each included independent variable.⁷ With a 4.29% (49/1141) incidence of complication in the study population, we required 699 patients to appropriately perform

multivariate logistic regression. This demonstrates that our sample sizes were sufficient to build the models.

Discussion

This study found that cases where emergency surgeries during the night or on holidays, cases of low risk surgeries, cases with short durations of anesthesia, and cases without post-operative intensive care were all prone to the unnecessary application of placement of CVCs, which means that placed CVCs were not properly used during the hospital stay. We additionally found that these unnecessary applications of CVC procedures tended to have a higher rate of CVC related complications although any obvious association with CVC related complications was not founded from the subsequent multivariate analysis.

It was previously found that weekend admission to the surgical ICU was associated with an increased hospital mortality rate.⁸ It has been suggested that deaths often occur out of regular hours, at night, when staffing levels are low or when staff are more tired.⁹ Therefore, attending medical staff tend to apply excessive preventive measures in advance, including preoperative ordering of blood products, multiple intravenous line placements, arterial line placement, and CVC placement, in order to make up for the manpower shortage during nights and holidays. While these excessive preparations may provide staff with a sense of security while managing patients when staffing levels are low, we note that excessive preventive measures result in wasting medical resources and spoil risk management strategies, potentially resulting in increases in CVC related complications such as those noted in this study.

In this study, CVCs were not used with higher frequency in patients who received postoperative care outside of the ICU. It has previously been reported that patients receiving care outside of the ICU were much more likely to have a CVC that was not clinically justified.⁵ In this report, the authors suggested that after patient transfer from the ICU to the regular unit, CVCs may unnecessarily remain in place. However,

we found that some attending staff performed CVC placement for borderline cases that may need care in the ICU; however, when the patients were not admitted to the ICU, most CVCs remained in place but were not used. It has been reported that clinicians on the general medicine floor are frequently unaware of the presence of CVCs in hospitalized patients, while critical care physicians were more likely to be aware of CVCs.¹⁰ However, it seems to be a logistic problem in our institution that CVCs of patients being transferred to the ward remain in place without being used and without the staff of the wards even to be aware of the presence of the CVCs. Considering that one important mainstay of safety in medical care is to anticipate situations and it may be preferred to place a CVC in a borderline or unclear case, even if it is not used, than to not place it and suddenly have to manage an acute instable case without the catheter. Therefore, the solution to this should be better documentation and communication and not to withhold CVCs intraoperatively from patients who will probably need them. Similarly, this might be applicable to emergency surgeries during the night or on holidays.

It has been proposed that optimal fluid management is crucial for patients who undergo major and prolonged surgery. However, the optimal perioperative fluid regimen for major noncardiac surgery is unclear.¹¹ Recently, it has been advocated that fluid management should be performed according to goal-directed intraoperative therapy, although this is still a matter of debate.^{11–13} To provide goal-directed intraoperative therapy, most protocols use central venous pressure monitoring, central venous oxygen saturation monitoring, and vasoactive or inotropic supports, all of which require CVCs. In our institute, the institutional standard protocol recommends anesthesia management according to goal-directed intraoperative therapy for major and prolonged surgery. Besides, an anesthesiology textbook clearly says that CVC placement and direct measurement of central venous pressure are frequently performed in patients undergoing major surgery.¹⁴ Conversely, minor and short surgery does not always require CVCs. Therefore, it is reasonable that we found unnecessary applications of CVC procedures more frequently performed in cases of low risk and short duration of anesthesia. To put it another way, unnecessary application of CVC placement may be the result of overestimation of the duration or risk of cases. To evaluate this assumption, it might be important to see the differences between actual and preoperative estimated duration of surgery and bleeding. Unfortunately, however, records regarding preoperative estimated duration of surgery and bleeding are not available.

Causes for the greater tendency of CVC related complications in the unnecessary application of CVC placement are unknown. This result could be a coincidence. However, we would like to emphasize that CVC related complications can occur with a certain probability regardless whether CVC placement is necessary or not. CVC related complications in the unnecessary application of CVC placement implies that we resulted in providing patients only with exposure to the risk of complications. Registration form submission only reported short-term complications such as arterial puncture, hematoma formation, catheterization induced arrhythmia, etc. Catheter Related Blood Stream Infection (CRBSI) is one of major complications of

CVC related complications. Unfortunately, in this study, we did not investigate the incidence of this complication. However, it is not unreasonable to think that the unnecessary application of CVC placement can increase the incidence of CRBSI because medical staff tends to pay less attention to unused catheters.¹⁰

There are a couple of limitations to this study. Because of the observational cohort nature of the study design, there is the possibility that we may have missed important confounding factors related to the unnecessary application of CVC placement. First, we performed a medical record based follow-up study to investigate whether CVCs placed preoperatively were used properly. Because of this, our determination of unnecessary or proper application of CVC placement depended on the accuracy of the medical documentation. In addition, the CVC registry used in this study is a self-reporting system in regards to CVC related complications; report of complications required the attending physician to consider the incident to be related to CVC placement. However, we note that the complications used for data analysis in this study are very clear, and thus there is little concern about the self-reporting system. Lastly, our study represents an audit of clinical practice at an individual institution and our findings might not be generalizable to the practice of anesthesiology as a whole.

In conclusion, we found that approximately 10% of CVC practices performed in the operating room were consequently unnecessary. Emergency surgery during the night or on holiday shifts and cases that did not receive care in the ICU postoperatively appears to have more frequently unnecessary application of CVCs. In addition, cases of low risk surgery or cases with short anesthesia duration may not require placement of CVCs placed in the operating room. Therefore, we suggest careful consideration before application of CVC placement in the above situations.

Conflicts of interest

The authors declare no conflicts of interest.

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