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ORIGINAL ARTICLE

Investigation of the case numbers of catheter-related bloodstream infection overestimated by the central line-associated bloodstream infection surveillance definition

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Background/Purpose: Diagnosis of catheter-related bloodstream infection (CRBSI) requires specific laboratory evidence. A simpler definition, central line-associated bloodstream infection (CLABSI), is recommended for surveillance purposes. Because exclusion of all other infection sources is difficult, CRBSI cases may be overestimated by using the CLABSI definition.
Methods: A retrospective observational study was performed at a regional hospital in southern Taiwan from September 2012 to December 2013. All 106 reported CLABSI cases were assessed. Cases with catheter tip cultures were reviewed. CRBSI was defined as the identification of same organisms from the paired blood and catheter tip cultures ($\geq$15 colony-forming units) without evidence of secondary bacteremia from other infection sources.
Results: Overall, 64 cases were included and 31 (48.4%) were defined as CRBSI cases. In 30 (46.9%) cases, catheter tips were cultured after the corresponding blood cultures were performed. Later tip cultures were significantly more frequent in cases with other catheter types (18/22, 81.8%) than those with central lines (12/42, 28.6%; $p < 0.0001$). The same significant difference was also found among the CRBSI cases (central lines, 3/17, 17.6%; others, 13/14, 92.9%; $p < 0.00005$). Twelve bacterial species were identified from the CRBSI cases, with

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Staphylococcus aureus being the most frequent (13, 41.9%), followed by *Pseudomonas aeruginosa* (5, 16.1%).
Conclusion: The positive predictive value of the CLABSI definition for CRBSI cases was 48.4%. One should be aware of this discrepancy and should interpret the CLABSI surveillance definition with care.

Introduction

Catheter-related bloodstream infection (CRBSI) is an important healthcare-associated infection. It may increase medical expenses,[1] may lengthen hospitalization period by 7—21 days,[2] and is associated with a higher mortality of 12—25%.[3] Reports have indicated that CRBSI is preventable.[3—5] Therefore, BSI bundle intervention has been established widely to eliminate CRBSI,[6—8] with an ultimate goal of achieving a zero CRBSI rate in clinical settings.[5,9]

The fundamental diagnosis of a CRBSI is the documentation of bacteremia, followed by demonstrating that the central venous catheters (CVCs) are the source of the infection. Exclusion of other potential primary infection foci is required for defining a true CRBSI.[10] Generally, three methods are recommended for the diagnosis of CRBSI.[11] The first method is catheter tip culture (CTC) by a semi-quantitative method.[12] CTC with a growth ($\geq$15 colony-forming units, CFU) of the same microbial organisms as that from the peripheral blood culture is considered a definitive diagnosis for CRBSI.[13,14] The second one is estimation of the ratio of quantitative culture (RQC). It is estimated by comparing the bacterial growth of a pair of blood specimens that were drawn, respectively, from a catheter and from a peripheral vein at the same time. If both cultures grow the same organisms and the colony counts from the catheter-drawn blood is five (or at least 3) times greater than that drawn by venipuncture, then it is considered a confirmatory diagnosis for CRBSI.[11,14] The last method is to evaluate the differential time to positivity (DTP). The definition of DTP is similar to that of RQC, except that it compares the times required for a positive growth of the same organisms from the two blood cultures. If the time to positive growth is at least 2 hours earlier for the catheter-drawn blood compared to that for the blood drawn by venipuncture, then it is also considered a confirmatory diagnosis for CRBSI.[14,15] Among the three methods, CTC is used most commonly in clinical microbiology laboratories due to the simplicity of the method. However, it requires removal of the catheter. By contrast, RQC and DTP do not need to remove the catheter, but they are not performed routinely in laboratories due to their technical complexity.

According to the guideline from the Centers for Disease Control and Prevention (CDC) in the USA, CRBSI is a clinical definition used for the diagnosis and treatment of patients who develop bacteremia while using CVCs.[10] As described above, the precise diagnosis of CRBSI is not easy. For the purpose of surveillance or monitoring of such infections, another system, central line-associated bloodstream infection (CLABSI), was used by CDC's National Healthcare Safety Network (NHSN).[16] A CLABSI is defined as a primary BSI in a patient with central lines (CLs) within the 48-hour period prior to the onset of the BSI, and the BSI is not related to any infection at other foci. Since the identification and exclusion of all the associated infection sources, other than CVCs, that may predispose the patient to the BSI are difficult, true CRBSI cases may be overestimated by using the CLABSI surveillance definition.[3,10] However, reports to delineate the extent of this discrepancy remains sporadic.

Tainan Municipal Hospital is a 622-bed regional hospital in southern Taiwan. Since September 2012, the hospital has started to collect the number of CLABSI cases per month and report to the Centers for Disease Control in Taiwan (Taiwan CDC). The reporting criteria defined by the Taiwan CDC are based on the NHSN CLABSI surveillance definition defined in 2008.[16,17] Up to December 2013, 106 cases have been reported. However, prior to the use of the CLABSI definition, only about two CRBSI cases per month were noted. The present study was therefore conducted to elucidate whether the sudden increase to an average of 6.6 cases per month was due to the overestimation by using the CLABSI surveillance definition.

Methods

This is a retrospective observational study. For the diagnosis of CRBSI, the standard CTC method is routinely performed in the clinical microbiology laboratory of this hospital. Therefore, CTC results were used to define true CRBSI cases among the CLABSI cases. From September 2012 to December 2013, a total of 106 CLABSI cases were identified to fulfill the CLABSI definition[16,17] and reported to Taiwan CDC by the infection control personnel. From them, records of CTCs performed after or within 2 days prior to the specimen date of the positive blood cultures were examined. If a CTC grew $\geq$15 CFU of the same microbial organism as that identified from the corresponding blood culture, the case would be defined as a CRBSI.

Medical records of the CLABSI cases with CTCs were reviewed. Information regarding demographic data; types of CVCs, including CLs, double lumens, permanent catheters, Port-A-Caths, and peripherally inserted central catheters; and clinical presentations or diagnosis at the removal of the catheter tips was collected for comparison. The correctness of the designation of CLABSI cases was also checked. Results of bacterial cultures from other specimens and imaging examinations, such as sonograms, chest X-rays, etc., of these cases within 7 days prior to or after

the specimen dates of the corresponding positive blood cultures were examined to exclude the possibility of secondary bacteremia originating from other infection sources.

For statistical analysis, the Chi-square test was used. A difference was considered statistically significant when $p < 0.05$.

Results

Of the 106 reported CLABSI cases, 39 (36.8%) did not have corresponding CTCs. Whether or not they were also CRBSI cases could not be confirmed. Among the other 67 cases with CTCs, one was further excluded from the CLABSI category because, according to the medical records, the catheter tip was removed and sent for microbial cultures about 57 hours earlier than that of the blood culture. The case would otherwise be considered as a CRBSI because *Proteus mirabilis* was identified from both blood cultures and CTCs (≥15 CFU). Another two cases were also excluded from the CLABSI category because they had other infection foci, one with urinary tract infection caused by *Candida tropicalis* and the other with wound infection caused by *Acinetobacter baumannii* and *Stenotrophomonas maltophilia*. The same organisms were also identified from their corresponding paired blood cultures and CTCs (both ≥15 CFU), respectively.

Among the 64 cases included for study, 31 (48.4%; Y1−Y31) were found to have the same organisms identified from their paired blood cultures and CTCs (≥15 CFU) and thus were further categorized as CRBSI cases (Table 1). Therefore, the positive predictive value of the CLABSI definition for CRBSI cases was 48.4%. All of the 64 cases were adults, aged between 40 years and 90 years, and 38 were male patients. Fever was found in 58 cases, and six cases had septic shock at the time of catheter removal (Tables 1 and 2). These demographic and clinical characteristics were similar between the CRBSI and non-CRBSI cases.

The most common CTCs were from CLs ($n = 42$), followed by Port-A-Caths ($n = 10$), double lumens ($n = 8$), permanent catheters ($n = 3$), and peripherally inserted central catheters ($n = 1$). In 34 (53.1%) cases, the paired blood and catheter tip specimens were submitted for microbial cultures simultaneously, and 15 (44.1%) of them were defined as CRBSI subsequently. In the remaining 30 (46.9%) cases, the catheter tips were removed and submitted for cultures about 1−8 days after the corresponding blood cultures were performed. Sixteen (53.3%) of these cases were further categorized as CRBSI. Although the proportion of CRBSI cases was lower in the former group in which blood and tip specimens were submitted simultaneously, the difference was not statistically significant ($p = 0.4616$). Furthermore, among the 42 cases with CLs, 12 (28.6%) were found to have tip cultures later than the corresponding blood cultures. By contrast, the proportion (18 cases, 81.8%) was significantly larger in the remaining 22 cases with other catheter types ($p < 0.0001$). When only the 31 CRBSI cases were compared, later tip cultures were found in three (17.6%) of the 17 cases using CLs; the proportion (13 cases, 92.9%) was significantly larger among the 14 cases with other catheter types ($p < 0.00005$; Table 1). It is also noted that the proportion of CRBSI cases was relatively higher among patients who used other catheter types (14/22, 63.6%) than among those who used CLs (17/42, 40.5%), although the difference was not statistically significant ($p = 0.0783$).

As shown in Table 1, various bacterial species were associated with the 31 CRBSI cases, including 18 (58.1%) Gram-positive organisms (*Staphylococcus aureus*, 13, 41.9%; other *Staphylococcus* spp., 4, 12.9%; and *Enterococcus faecium*, 1), eight (25.8%) Gram-negative organisms (*Pseudomonas aeruginosa*, 5, 16.1%; *A. baumannii*, 1; *Klebsiella pneumoniae*, 1; and *Ralstonia pickettii*, 1), and five (16.1%) *Candida* spp. (*Candida albicans* and *C. tropicalis*, 2 each; and *Candida parapsilosis*, 1). Table 2 demonstrates microbial findings for the 33 non-CRBSI cases. Compared to that only 12 bacterial species were identified from the CRBSI cases, microbial spectra were more diverse in the non-CRBSI cases. A total of 26 bacterial species were identified from either the blood cultures or the CTCs, with 22 of them being found from the blood cultures.

Discussion

In the present study, only 31 (48.4%) of the CLABSI cases fulfilled the CRBSI criteria. The data showed an average of 1.9 CRBSI cases per month, which was similar to that reported prior to when the CLABSI definition was adapted at this hospital. The results suggested that, with the use of the CLABSI surveillance definition, the rate of CRBSI may be overestimated by approximately 50%. The finding is surprising but not impossible, as a recent study also demonstrated a low positive predictive value (27.7%) of the CLABSI surveillance definition.[18] Studies have shown that unexplained fever is common among critically ill patients.[19] Therefore, such a high overestimation rate implied that the causes of a half of the "suspected" CRBSI cases would be erroneously attributed to the in-used catheters. Similar arguments have also been raised by others.[20] Accordingly, the use of the CLABSI surveillance definition to monitor some infection control measures, e.g., BSI bundle care, may lead to unsatisfactory consequences, even though much effort has been made.

More than one-third of the CLABSI cases did not have corresponding CTCs and therefore were excluded from the study. This may somehow affect the accuracy of the findings in the present study. As this was a retrospective study, we were unable to confirm the proportion of CRBSI cases among the 39 non-catheter-tip-cultured CLABSI cases. However, even though the 39 cases were all true CRBSI cases, overestimation of the actual rate by the CLABSI surveillance definition would still be high at 32.0%. This high overestimation rate may not be a problem if the resulting CLABSI case numbers remained at a low and acceptable range. However, if the number of reported CLABSI cases increased unexpectedly, as we have encountered since the use of the CLABSI definition at this hospital, CTC or other methods, such as the RQC and DTP, may be necessary for the suspected CLABSI cases to explore some potential problems.[14]

It was noted that some CTCs were performed after positive results were reported from the corresponding

Table 1 Microbial culture results of the 31 CRBSI cases

Case	Cause for catheter removal	Blood isolate[a]	BC date	CTC date	Tip isolate[a]	CFU	CVC
Y1	Septic shock	*Staphylococcus aureus*[a]	Oct 2, 2012	Oct 2, 2012	*S. aureus*[a]	>15	CL
Y2	Fever	*Pseudomonas aeruginosa*	Oct 11, 2012	Oct 11, 2012	*P. aeruginosa*	>15	CL
Y3	Fever	*Klebsiella pneumoniae*[a]	Oct 19, 2012	Oct 19, 2012	*K. pneumoniae*[a]	>15	CL
Y4	Fever	*Candida albicans*	Oct 22, 2012	Oct 22, 2012	*C. albicans*	=15	CL
Y5	Fever	*S. aureus*	Nov 1, 2012	Nov 3, 2012	*S. aureus* *P. aeruginosa*	>15 >15	DL
Y6	Fever	*P. aeruginosa* *Acinetobacter baumannii* *Staphylococcus hominis*	Nov 8, 2012	Nov 8, 2012	*P. aeruginosa*	>15	CL
Y7	Fever	*Staphylococcus capitis*	Nov 15, 2012	Nov 15, 2012	*S. capitis*	>15	CL
Y8	Septic shock	*S. aureus*[a]	Nov 19, 2012	Nov 19, 2012	*S. aureus*[a] *P. aeruginosa*	>15 >15	CL
Y9	Fever	*S. aureus*	Nov 26, 2012	Nov 27, 2012	*S. aureus*	>15	DL
Y10	Fever	*S. aureus*	Dec 5, 2012	Dec 5, 2012	*S. aureus* *Enterobacter cloacae*	>15 >15	CL
Y11	Fever	*P. aeruginosa*	Jan 8, 2013	Jan 8, 2013	*P. aeruginosa*	>15	CL
Y12	Fever	*A. baumannii*[a]	Feb 7, 2013	Feb 7, 2013	*A. baumannii*[a]	>15	CL
Y13	Fever	*S. aureus*	Feb 8, 2013	Feb 9, 2013	*S. aureus*	>15	DL
Y14	Fever	*Ralstonia pickettii*	Feb 18, 2013	Feb 21, 2013	*R. pickettii*	>15	Pen cath
Y15	Fever	*S. aureus*[a]	Feb 27, 2013	Feb 27, 2013	*S. aureus*[a]	>15	PAC
Y16	Fever	*S. aureus*[a]	Apr 6, 2013	Apr 8, 2013	*S. aureus*[a]	>15	PAC
Y17	Fever	*P. aeruginosa* *S. aureus*	May 20, 2013	May 27, 2013	*P. aeruginosa*	>15 >15	PAC
Y18	Fever	*Staphylococcus epidermidis*	May 21, 2013	May 24, 2013	*S. epidermidis*	>15	CL
Y19	Fever	*Candida parapsilosis*	May 23, 2013	May 27, 2013	*C. parapsilosis*	>15	PAC
Y20	Fever	*Enterococcus faecium*[a]	May 26, 2013	May 27, 2013	*E. faecium*[a] *C. albicans*	>15 >15	CL
Y21	Fever	*S. aureus*[a]	Jun 3, 2013	Jun 3, 2013	*S. aureus*[a]	>15	CL
Y22	Fever	*S. epidermidis*	Jul 12, 2013	Jul 12, 2013	*S. epidermidis*	>15	CL
Y23	Fever	*S. aureus*	Jul 16, 2013	Jul 19, 2013	*S. aureus*	>15	Pen cath
Y24	Fever	*Candida tropicalis*	Aug 1, 2013	Aug 2, 2013	*C. tropicalis*	>15	PAC
Y25	Fever	*C. tropicalis* Coagulase (−) staphylococci	Aug 5, 2013	Aug 5, 2013	*C. tropicalis*	>15	CL
Y26	Fever	*S. aureus*[a]	Aug 21, 2013	Aug 22, 2013	*S. aureus*[a]	>15	DL
Y27	Fever	Coagulase (−) staphylococci	Sep 23, 2013	Sep 25, 2013	Coagulase (−) staphylococci	>15	PICC
Y28	Fever	*S. aureus*[a]	Oct 23, 2013	Oct 24, 2013	*S. aureus*[a]	>15	CL
Y29	Fever	*P. aeruginosa* *Serratia marcescens*	Nov 16, 2013	Nov 21, 2013	*P. aeruginosa*	>15	PAC
Y30	Fever	*S. aureus*	Nov 18, 2013	Nov 19, 2013	*S. aureus*	>15	PAC
Y31	Fever	*C. albicans*	Dec 14, 2013	Dec 14, 2013	*C. albicans*	>15	CL

[a] Antimicrobial resistance in the bacterium indicated: *S. aureus*, methicillin resistant; *K. pneumoniae*, extended-spectrum β-lactamase producing; *A. baumannii*, carbapenem resistant; and *E. faecium*, vancomycin resistant.
BC = blood culture; BSI = bloodstream infection; CFU = colony-forming unit; CL = central line; CRBSI = catheter-related bloodstream infection; CTC = catheter tip culture; CVC = central venous catheter; DL = double lumen; PAC = Port-A-Cath; Pen cath = permanent catheter; PICC = peripherally inserted central catheter.

blood cultures. A previous study indicated that the final diagnosis of CRBSI was not affected by either immediate catheter removal or postponement for a watchful waiting when a CRBSI is suspected.[21] Our data support their findings in demonstrating that CTCs performed later than the corresponding blood cultures did not lead to significant differences in the diagnosis of CRBSI. Previous reports revealed that cases with unnecessary catheter removal could range from 48% to 91%.[21] Thus, for the 51.6% non-CRBSI cases identified in the present study, removal of catheters may be mostly unnecessary. Therefore, it may be more practical that CTCs are performed, if necessary, after

Table 2 Microbial culture results of the 33 non-CRBSI cases

Case	Cause for catheter removal	Blood isolate[a]	BC date	CTC date	Tip isolate[a]	CFU	CVC
N1	Fever	*Candida albicans*	Sep 17, 2012	Sep 17, 2012	*Staphylococcus aureus*[a]	(Enriched)	CL
N2	Fever	*Acinetobacter* spp.	Oct 4, 2012	Oct 4, 2012	(No growth)		CL
N3	Fever	*C. albicans*	Oct 21, 2012	Oct 26, 2012	(No growth)		PAC
N4	Septic shock	*Enterococcus faecium*	Oct 27, 2012	Oct 27, 2012	*Enterococcus* spp.	>15	DL
N5	Fever	*Klebsiella pneumoniae*[a]	Nov 21, 2012	Nov 21, 2012	*K. pneumoniae*[a] *Candida glabrata*	(Enriched) >15	CL
N6	Fever	*Pseudomonas aeruginosa*	Nov 28, 2012	Nov 28, 2012	*P. aeruginosa*	(Enriched)	CL
N7	Fever	*Escherichia coli* *Klebsiella ozaenae*	Dec 3, 2012	Dec 3, 2012	*K. pneumoniae*	(Enriched)	CL
N8	Fever	*Burkholderia cepacia*	Dec 21, 2012	Dec 21, 2012	*Staphylococcus epidermidis*	>15	CL
N9	Septic shock	*K. pneumoniae*[a]	Jan 8, 2013	Jan 8, 2013	*Candida tropicalis*	>15	CL
N10	Fever	*Enterobacter cloacae*	Jan 22, 2013	Jan 24, 2013	*Enterococcus faecalis* *Klebsiella oxytoca*[a] *S. aureus*[a]	>15 >15 >15	CL
N11	Fever	*Serratia marcescens*	Jan 24, 2013	Feb 1, 2013	*S. marcescens*	(Enriched)	CL
N12	Fever	*Candida parapsilosis*	Jan 25, 2013	Jan 25, 2013	*C. glabrata*	>15	CL
N13	Fever	*P. aeruginosa*	Jan 28, 2013	Jan 30, 2013	*C. albicans*	(Enriched)	CL
N14	Fever	*S. epidermidis*	Feb 10, 2013	Feb 10, 2013	*Staphylococcus saprophyticus*	>15	CL
N15	Fever	*Enterococcus faecium*[a]	Feb 21, 2013	Feb 27, 2013	*Acinetobacter baumannii*[a]	(Enriched)	CL
N16	Fever	*Klebsiella oxytoca*[a]	Feb 22, 2013	Feb 22, 2013	*K. pneumoniae*[a]	>15	CL
N17	Fever	*E. faecium*	Mar 20, 2013	Mar 20, 2013	*Enterococcus* spp.	>15	DL
N18	Fever	*Staphylococcus haemolyticus*	Mar 31, 2013	Apr 1, 2013	*C. albicans*	>15	CL
N19	Fever	*Streptococcus mutans*	May 4, 2013	May 4, 2013	*S. epidermidis*	>15	DL
N20	Fever	*Alcaligenes faecalis*	May 27, 2013	May 27, 2013	(No growth)		CL
N21	Fever	*Brevundimonas* spp.	Jul 4, 2013	Jul 4, 2013	*Enterococcus* spp.	>15	CL
N22	Fever	*S. aureus*	Jul 12, 2013	Jul 16, 2013	(No growth)		CL
N23	Fever	*Citrobacter kerosi*	Sep 24, 2013	Sep 25, 2013	(No growth)		CL
N24	Fever	*A. baumannii*	Oct 11, 2013	Oct 15, 2013	*A. baumannii*	1	DL
N25	Fever	*P. aeruginosa*	Oct 20, 2013	Oct 21, 2013	(No growth)		CL
N26	Fever	*S. aureus*[a]	Oct 22, 2012	Oct 29, 2012	*S. aureus*[a]	1	Pen cath
N27	Fever	*E. cloacae*	Oct 30, 2013	Nov 1, 2013	(No growth)		CL
N28	Septic shock	*A. baumannii*[a]	Nov 17, 2013	Nov 17, 2013	*A. baumannii*[a]	3	CL
N29	Fever	*K. pneumoniae*[a]	Nov 18, 2013	Nov 18, 2013	*K. pneumoniae*[a] *A. baumannii*[a]	(Enriched) (Enriched)	CL
N30	Fever	*Porphyromonas endodontalis*	Nov 18, 2013	Nov 18, 2013	(No growth)		CL
N31	Fever	*A. baumannii*	Nov 18, 2013	Nov 22, 2013	(No growth)		PAC
N32	Fever	*P. aeruginosa*	Nov 23, 2013	Nov 28, 2013	*C. albicans*	>15	PAC
N33	Septic shock	*Enterococcus* spp.	Dec 27, 2013	Dec 27, 2013	(No growth)		CL

[a] Antimicrobial resistance in the bacterium indicated: *S. aureus*, methicillin resistant; *K. pneumoniae* and *K. oxytoca*, extended-spectrum β-lactamase producing; *A. baumannii*, carbapenem resistant; and *E. faecium*, vancomycin resistant.
BC = blood culture; BSI = bloodstream infection; CFU = colony-forming unit; CL = central line; CRBSI = catheter-related bloodstream infection; CTC = catheter tip culture; CVC = central venous catheter; DL = double lumen; PAC = Port-A-Cath; Pen cath = permanent catheter.

positive growth is reported for the corresponding blood cultures, to prevent unnecessary catheter removals.[21]

Compared to CLs, the other catheters were more likely to be cultured later than the corresponding blood cultures, especially among the CRBSI cases. The techniques required for the placement of these catheters are relatively more complicated than that for CLs. Therefore, when a CLABSI is suspected in patients using such

catheters, physicians may be more hesitant in deciding whether to remove the catheters. However, both the difficulty in placement of such catheters and the tendency toward their longer usage may add to their risk of causing CRBSI.[22] Therefore, when a suspected CLABSI is related to the use of such catheters, it is very likely that a true CRBSI is encountered. Data in the present study also demonstrated that the proportion of CRBSI cases was relatively higher in cases using other catheter types than those using CLs. In order to initiate an appropriate treatment promptly, the use of methods such as RQC and DTP has been suggested for a differential diagnosis.[14] In hospitals where these two techniques are not available, catheters are suggested to be removed and cultured for timely diagnosis and treatment.

One of the major criteria for defining either CLABSI or CRBSI is the exclusion of other associated infection sources.[16] In the present study, two CLABSI cases, which would otherwise be categorized as CRBSI cases, were excluded due to the existence of other concurrent infection sources. However, whether the infections at other foci were due to bacterial seeding from the bloodstreams or translocation of bacteria from the distal infection foci into bloodstreams and their subsequent colonization of the catheter tips could not be confirmed.[23] Reports also indicated that bloodstream infections occurring in patients with postchemotherapy neutropenia are frequently due to the translocation of intestinal organisms; however, these infections would still be categorized as CLABSI if they meet the NHSN CLABSI definition.[24] Accordingly, the CLABSI surveillance definition has been revised in 2013 to reduce the inappropriate inclusion of CLABSI cases associated with bacterial translocation.[25] Still, suggestions regarding the exclusion of other subgroups of patients, e.g., intra-abdominal surgery patients, or some specific microorganisms, e.g., *Escherichia coli*, were subsequently reported.[26] By contrast, accumulating studies also demonstrated that substantial variability could exist among infectious-diseases physicians and infection control personnel in the interpretation and application of the CLABSI surveillance definition.[27–29] To apply the CLABSI definition accurately and effectively, as well as to include only the infections relevant to infection control practices, further refinement of the CLABSI definition appears inevitable.

In conclusion, minimization of the possibility of CRBSI occurrence is important for patient safety, and many efforts have been made to achieve this goal. To reflect the effectiveness of such efforts, an accurate evaluation or consistent monitoring system is also vital. The CLABSI surveillance definition has been used in this hospital for just over 1 year. Our study may be limited by the small case number and its retrospective nature, but the gap between CLABSI and CRBSI has been clearly demonstrated. With a longer observation period or a larger prospective study to include data from multiple medical institutions, a more precise conclusion may be obtained. Prior to suggesting a better resolution, the infection control personnel and the associated authority should be aware of this discrepancy, and the CLABSI surveillance definition should be interpreted and applied with care.

Conflicts of interest

All contributing authors declare no conflicts of interest.

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