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ORIGINAL ARTICLE

Follow-up blood cultures add little value in the management of bacteremic urinary tract infections

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Abstract

The need for mandatory confirmation of negative conversion in bacteremic urinary tract infection (UTI) has not been adequately addressed, even though follow-up blood cultures (FUBCs) are still prescribed liberally. The purpose of this study was to identify possible risk factors associated with positive FUBCs. We retrospectively collected data on adult cases of bacteremic UTI with at least one FUBC. Patients were divided into the negative FUBCs and the positive FUBC group, and data of both groups were compared. Of 306 cases of bacteremic UTI, 251 had a negative result from an FUBC and 55 had a positive result. Diabetes mellitus, malignancy, complicated UTI, and initial intensive care unit (ICU) admission were significantly more common in the positive FUBC group than in the negative group (all-$P < 0.05$). Time to defervescence was significantly longer in the positive FUBC group than in the negative group (52.2 h vs. 25.3 h, $P < 0.05$). A multivariate analysis showed that malignancy, initial ICU admission, CRP > 16 (mg/dL), and a time to defervescence of more than 48 h were significant factors associated with a positive FUBC. No subsequent cases of bacteremia developed in patients without risk factors associated with a positive FUBC. In bacteremic UTIs, patients with positive FUBCs usually present with higher initial inflammatory markers, longer time to defervescence, more frequent ICU admission rates, and an elevated chance of having cancer. More careful clinical assessment before drawing FUBCs would reduce costs and inconvenience to patients.

Keywords Urinary tract infection · Bacteremia · Follow-up blood culture · Risk factor

Introduction

Urinary tract infection (UTI) is one of the most common and important infectious diseases worldwide and may be accompanied by bacteremia. The prevalence of UTIs was reported as 0.7% in an ambulatory care setting, with an overall annual incidence of 17.5 per 1000 persons per year [1, 2]. Although it is considered standard of care that follow-up blood cultures (FUBCs) be drawn from patients with bacteremia until negative conversion is seen, several previous studies have suggested that the usefulness of routine blood cultures should be reconsidered in patients with acute pyelonephritis and gram-negative bacteremia [3–5]. Indiscreet prescriptions of blood cultures may be due to anxiety about undertreatment and fear of using inappropriate antimicrobial agents, leading to limited culture positivity of 4 to 7% [6–8]. Although it is widely appreciated that the requirement for FUBCs in bacteremic patients is questionable, cultures are still prescribed too liberally [6, 9]. Routine FUBCs are strongly recommended in *Staphylococcus aureus* bacteremia and in infective endocarditis [10]. However, the need for mandatory confirmation of negative conversion in bacteremic UTI has not been adequately addressed.

Routine FUBCs often cause longer hospital stays, more frequent outpatient clinic visits, and excessively healthcare costs increase [6, 11, 12]. Drawing blood cultures is a time- and resource-consuming procedure and may have a questionable impact on therapeutic decision-making in gram-negative bacteremia [13]. Given the high incidence of bacteremic UTI and the overall low yield of blood cultures, the use of FUBCs

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should be scrutinized. The objective of the present study was to reevaluate the need for routine FUBCs in bacteremic UTIs and, if possible, to identify the patient groups that have bacteremia but do not need routine FUBCs.

Materials and methods

Study design and patient population

We retrospectively collected data on cases of bacteremic UTI at Samsung Medical Center, a university-affiliated 1950-bed, tertiary-care hospital in Seoul, Republic of Korea, from April 2013 through May 2017. Patients who were older than 18 years were included in the study. We searched EMR record by using ICD-10 code [14] for eligible patients, who had a UTI with a positive result in the initial blood culture and at least one FUBC. Exclusion criteria were patients without bacteremia, other obvious source of bacteremia (e.g., surgical site infection, pneumonia, liver abscess, and catheter-related blood-stream infection), and those without FUBCs for various reasons (e.g., transfer-out or follow-up loss). This study was performed and described in accordance with Strengthening the Reporting of Observational studies in Epidemiology guidelines for cohort studies.

Data collection and analysis

Medical records based on Electronic Medical Record systems for clinical and microbiological data were reviewed and collected. Patients were divided into two groups—those with negative FUBCs and those with positive FUBCs. The following data were collected: demographic data, microorganisms isolated from blood and urine cultures, antibiotic susceptibility, comorbidities (e.g., hypertension, diabetes mellitus [7], AIDS, chronic kidney disease, urinary catheters and malignancies), need for intensive care, presence of complicated UTI, time to defervescence, duration of antimicrobial therapy, invasive procedures, and treatment outcomes. We also collected the first laboratory data at the time of UTI diagnosis, with respect to white blood cell (WBC) counts, segmented neutrophil percentage, absolute neutrophil count, hemoglobin, platelet count, erythrocyte sedimentation rate (ESR), international normalized ratio, protein, albumin, total bilirubin, aspartate aminotransferase, alanine aminotransferase, C-reactive protein (CRP), procalcitonin, lactic acid, blood urea nitrogen, and creatinine. Microbiological data were obtained from the database at our clinical microbiology laboratory.

The duration of bacteremia (in days) among patients with FUBCs was calculated by subtracting the initial date of a positive culture from the latest date of a positive culture growing the same bacteria, as long as the last set of positive cultures was drawn at least 24 h after the initial culture. The number of FUBCs for each episode was recorded until negative conversion. The time to defervescence (in hours) after administration of antibiotics was calculated by subtracting the timing of initial administration of antibiotics (regardless of susceptibility) from the last febrile time (recorded temperature ≥ 38 °C).

Definitions

• Urinary tract infection: high-grade fever of more than 38 °C with pyuria, as more than 10 white blood cells (WBCs)/high-power field in a centrifuged urinary specimen, an isolated bacterial count of more than 10^5 colony-forming units (CFU)/mL in the urine specimen, and related characteristic symptoms such as polyuria, dysuria, and urinary urgency, accompanied by hematuria, urinary incontinence, flank, or lumbar pain. For patients who cannot complain about their urinary symptoms, characteristic symptoms may not be included in diagnosis [15, 16].

• Initial blood culture: the first positive blood culture at timing of UTI episode.

• Follow-up blood cultures (FUBCs): more than one separate blood culture taken more than 24 h after an initial blood culture.

• True bacteremia: at least one positive blood culture, not otherwise considered a contaminant.

• Contaminant: a positive blood culture in which the isolate was a common skin organism (such as diphtheroids, micrococci, or coagulase-negative staphylococci) isolated in one bottle, or when the medical records reported positive cultures as contaminants.

• Persistent bacteremia: positive blood cultures more than the 7 days after the initial culture.

• Febrile: patients were considered febrile if their recorded temperature was ≥ 100.4 °F (38 °C).

• Complicated urinary tract infection: if any of the following conditions were met: (1) renal abscess; (2) hydronephrosis and percutaneous nephrostomy (PCN) insertion after diagnosis of UTI; (3) presence of any metastatic infections (psoas muscle abscess, brain abscess, infective endocarditis, etc.); (4) presence of urinary stones, urethral strictures, congenital abnormalities; or (5) presence of prostatitis in men [15–17].

• Antimicrobial susceptibility: identified with a Microscan WalkAway 96 (Siemens Healthcare Diagnostics, Deerfield, IL) and VITEK 2 (bioMérieux, Marcy-l'Étoile, France), using Clinical and Laboratory Standards Institute (CLSI) criteria and guidelines [18]. When an isolate was resistant to both cefotaxime and ceftazidime, it was suspected of producing extended-spectrum β-lactamase (ESBL), production of which was confirmed by an automated system with a standard identification card and the modified broth microdilution method.

Statistical analyses

Results are expressed as means ± standard deviation or median (IQR) and as incidences in the study population. The Student's *t* test and Mann–Whitney test were used to compare continuous variables, and a chi-squared test and Fisher's exact test were used for categorical variables. To identify risk factors for positive FUBCs, a logistic regression model was used to control for confounding variables. All *P* values were two-tailed, and *P* values < 0.05 were considered statistically significant. Variables that were statistically significant in the univariate analyses were candidates for multivariate analysis in addition to the main variables of clinical importance. To evaluate the appropriate cutoff values for laboratory data such as CRP levels, a receiver-operating characteristic (ROC) analysis was carried out. IBM SPSS statistics software for Windows (version 24; SPSS Inc., Chicago, IL, USA) was used in the analyses.

Results

During the study period, 791 patients with a UTI and a positive result in the initial blood culture were identified. Of those, 458 had obvious other sources of bacteremia (e.g., surgical site infection, catheter-related blood-stream infection, pneumonia, intra-abdominal infection) and were excluded. Of the remaining 333 patients with bacteremic UTIs, 27 cases without an FUBC were excluded, 251 had a negative result from an FUBC (the negative FUBC group), and 55 (18.0%) had a positive result (the positive FUBC group) (Fig. 1). Baseline characteristics of patients are presented in Table 1. The median age of the study

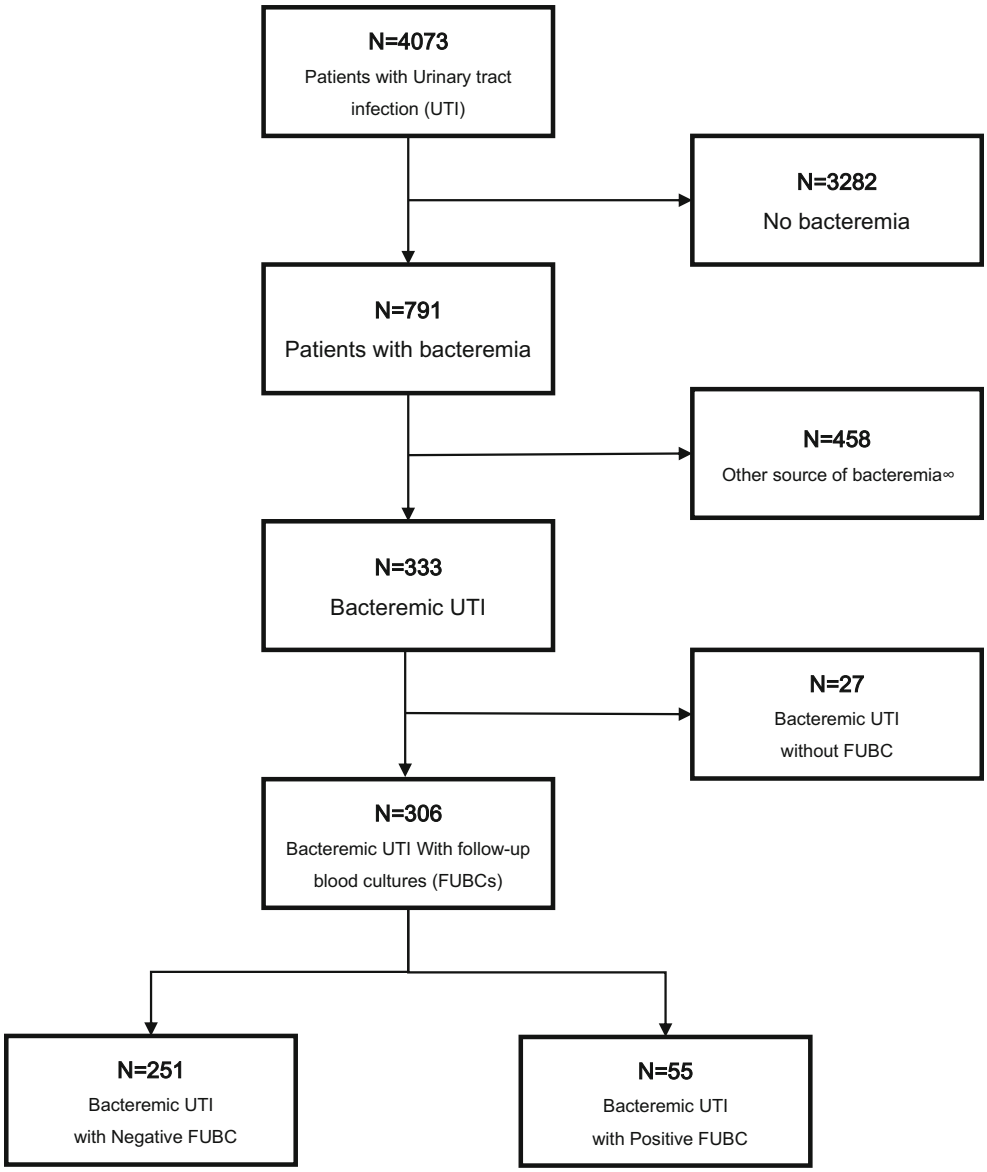

Fig. 1 Study populations. FUBC follow-up blood cultures. ∞Pneumonia, surgical site infection, catheter-related blood-stream infection, intra-abdominal infection, liver abscess, etc.

population was 70 (interquartile range (IQR) = 20) years and 71.9% were female. The most common underlying diseases were hypertension, diabetes mellitus, and malignancy (Table 1).

In the positive FUBC group, the mean additional blood cultures to negative conversion was 1.7 (range 1 to 6), and the mean duration of bacteremia was 3.7 days (range 1 to 18 days). Persistent bacteremia (more than 7 days of positive blood cultures) occurred in 10 of the 306 patients.

Variables related to the clinical presentation of the positive FUBC group were analyzed and are presented in Tables 1 and 2. DM, malignancy, presence of a PCN, complicated UTIs such as abscess and hydronephrosis, and an initial intensive care unit (ICU) admission were significantly more common in the positive FUBC group than in the negative group. The median WBC count of the negative FUBC group was significantly lower than that of the positive group (12,160/μL vs. 15.020/μL, $P = 0.015$). Other significantly different test results included ESR (56.00 mm/h vs. 68.50 mm/h, $P = 0.026$), CRP (11.31 mg/dL vs. 17.70 mg/dL, $P = 0.001$), procalcitonin (2.40 mg/dL vs. 12.98 mg/dL, $P = 0.023$), lactic acid (1.82 mmol/L vs. 2.55 mmol/L, $P = 0.013$), BUN (20.50 vs. 29.50, $P = 0.001$), and creatinine (1.00 mg/dL vs. 1.54 mg/dL, $P = 0.002$). The median time to defervescence in the negative FUBC group was significantly shorter than in the positive group (20 vs. 47.5 h, $P = 0.005$).

In the microbiologic analyses on causative pathogens, *Escherichia coli* ($n = 213$, 69.6%) was the most common pathogen, followed by *Klebsiella pneumoniae* ($n = 35$, 11.4%), *Enterococcus faecalis* ($n = 9$, 2.9%), *Pseudomonas aeruginosa* ($n = 7$, 2.3%), *Staphylococcus aureus* ($n = 6$, 2.0%), *Candida* spp. ($n = 4$, 1.3%), more than two pathogens ($n = 3$, 1.0%), *coagulase-negative Staphylococcus* ($n = 3$, 1.0%), and *Enterococcus faecium* ($n = 1$, 0.3%). As with causative microorganisms, *E. coli* was more common in the negative FUBC group than in the positive group (72.5% vs. 56.4%, 0.018), while *S. aureus* was more frequent in the positive FUBC group (0.8% vs. 7.3%, $P = 0.011$) (Table 3).

For the purpose of statistical analyses, continuous variables were changed to categorical variables (using normal cutoff

Table 1 Demographic data and comparison between the negative and positive FUBC group

Characteristic	Total	($N = 306$) (%)	Negative ($N = 251$) (%)		Positive ($N = 55$) (%)		P value
Patient							
Female sex	220	(71.9)	183	(72.9%)	37	(67.3%)	0.400
Age, median (IQR), (years)	70	(20)	71	(20)	64	(21)	0.768
Underlying disease							
Diabetes mellitus	**102**	**(33.7*) 3[a]**	**78**	**(31.2%*) 1[a]**	**24**	**(45.3%*) 2[a]**	**0.049**
Hypertension	133	(43.9*) 3[a]	115	(46.0%*) 1[a]	18	(34.0%*) 2[a]	0.109
HIV-positive	2	(0.7*) 3[a]	2	(0.8%*) 1[a]	0	(0%) 2[a]	1.000
Malignancy	99	(32.7*) 3[a]	**72**	**(28.8%*) 1[a]**	**27**	**(50.9%*) 2[a]**	**0.002**
Chronic kidney disease	25	(8.4*) 9[a]	21	(8.6%*) 6[a]	4	(7.7%*) 3[a]	1.000
Initial catheterization							
Foley catheter	23	(7.5*) 1[a]	20	(8.0%*) 1[a]	3	(5.5%) 0[a]	0.778
Percutaneous nephrostomy	17	(5.6)	**8**	**(3.2%)**	**9**	**(16.4%)**	**< 0.001**
Complicated UTI	93	(30%)	**68**	**(27.1%)**	**25**	**(45.5%)**	**0.007**
Prostatitis	24	(7.8)	22	(8.8%)	2	(3.6%)	0.273
Abscess	20	(6.5)	**13**	**(5.2%)**	**7**	**(12.7%)**	**0.040**
Hydronephrosis	47	(15.4)	**32**	**(12.7%)**	**15**	**(27.3%)**	**0.007**
Urinary stone	20	(7.4*) 35[a]	16	(7.3%) 33[a]	4	(7.5%) 2[a]	1.000
Severity							
Initial shock	58	(19.0)	**39**	**(15.5%)**	**19**	**(34.5%)**	**0.001**
Initial ICU admission	55	(18.0)	**35**	**(13.9%)**	**20**	**(36.4%)**	**< 0.001**
Treatment outcome	Median	(IQR)	Median	(IQR)	Median	(IQR)	P value
Duration of antibiotics (days)	14	(4)	14	(4)	15	(7)	0.163
Time to defervescence (after antibiotics) (h)	22.9	(39.2)	**20**	**(35.2)**	47.5	**(57.7)**	**0.005**
In-hospital death	8	(2.6%)	7	(2.8%)	1	(1.8%)	1.000

Bolded values are significantly different between two groups ($p < 0.05$)

FUBC follow-up blood culture, IQR interquartile range, HIV human immunodeficiency virus, UTI urinary tract infection, ICU = intensive care unit

*Effective percent excluding missing values

[a] Missing values

Table 2 Initial laboratory data and univariate analysis between the negative vs. positive FUBC group

Laboratory data (units)	Total (median (IQR))	Cutoff (by normal value)	negative ($N = 251$) (%)	Positive ($N = 55$) (%)	P value
White blood cells ($\times 10^3/\mu L$)	12.480 (8.125)	> 10.580	**156 (62.2%)**	**38 (69.1)**	**0.333**
Hemoglobin (g/dL)	11.6 (2.7)	< 13.6	48 (19.1%)	6 (10.9%)	0.148
Platelet count	175 (113.5)	**< 141.000**	**71 (28.3%)**	**26 (47.3%)**	**0.006**
Segmented neutrophil (%)	87 (10.3)	> 73.5%	230 (92.0%)	53 (96.4%)	0.257
Absolute neutrophil count ($\times 10^3/\mu L$)	10.770 (7.510)	> 8.300	171 (68.4%)	43 (78.2%)	0.151
Prothrombin time (INR)	1.14 (0.22)	**> 1.10**	**132 (56.9%)**	**42 (80.8%)**	**0.001**
ESR (mm/h)	57.50 (45.75)	> 22	194 (84.3)	41 (89.1)	0.405
CRP (mg/dL)	11.95 (12.74)	**≥ 16[a]**	**76 (30.3%)**	**33 (60.0%)**	**< 0.001**
Procalcitonin (mg/dL)	3.30 (16.67)	**> 0.5**	**137 (75.3%)**	**38 (95.0%)**	**0.006**
Lactic acid (U/L)	1.93 (1.49)	**> 2.2**	**87 (38.7%)**	**28 (54.9%)**	**0.034**
Protein (g/dL)	6.03 ± 0.92[b]	< 6.4	155 (64.9%)	38 (70.4%)	0.440
Albumin (g/dL)	3.6 (0.9)	**< 3.5**	**107 (44.4%)**	**39 (70.9%)**	**< 0.001**
Total bilirubin (mg/dL)	0.9 (0.7)	> 1.2	60 (24.7%)	17 (31.5%)	0.303
Aspartate aminotransferase (U/L)	31 (28)	> 40	75 (30.5%)	22 (40.7%)	0.145
Alanine aminotransferase (U/L)	21 (25)	> 41	56 (22.8%)	15 (27.8%)	0.433
BUN (mg/dL)	22.1 (17.7)	**> 23**	**102 (40.6%)**	**41 (74.5%)**	**< 0.001**
Creatinine (mg/dL)	1.09 (0.77)	**> 1.2**	**102 (40.6%)**	**39 (70.9%)**	**< 0.001**

Bolded values are significantly different between two groups ($p < 0.05$)

FUBC follow-up blood culture, IQR interquartile range, HIV human immunodeficiency virus, UTI urinary tract infection, ESR erythrocyte sediment rate, INR international normalized ratio, CRP C-reactive protein, BUN blood urea nitrogen

[a] CRP uses ROC curve cutoff value[16] as there is no case < 0.5 in PFUBC group

[b] Protein was described as mean + standard deviation because normally distributed

Table 3 Microbiologic differences between negative FUBC group vs. positive FUBC group

Characteristic	Negative ($N = 251$) (%)	Positive ($N = 55$) (%)	P value
Initial blood culture			
Escherichia coli	**182 (72.5)**	**31 (56.4)**	**0.018**
Klebsiella pneumoniae	28 (11.2)	7 (12.7)	0.740
Enterococcus faecalis	8 (3.2)	1 (1.8)	1.000
Pseudomonas aeruginosa	6 (2.4)	1 (1.8)	1.000
Staphylococcus aureus	**2 (0.8)**	**4 (7.3)**	**0.011**
Candida spp.	3 (1.2)	1 (1.8)	0.549
Coagulase-negative staphylococci	2 (0.8)	1 (1.8)	0.449
Enterococcus faecium	1 (0.4)	0 (0.0)	1.000
More than two pathogens	**0 (0.0)**	**3 (5.5)**	**0.006**
Others	19 (7.6)	6 (10.9)	0.413
Initial urine culture			
Escherichia coli	147 (57.0)	25 (45.5)	0.120
Klebsiella pneumoniae	22 (8.8)	5 (9.1)	1.000
Enterococcus faecalis	7 (2.8)	1 (1.8)	1.000
Staphylococcus aureus	**2 (0.8)**	**4 (7.3)**	**0.011**
Pseudomonas aeruginosa	4 (1.6)	1 (1.8)	1.000
Candida spp.	3 (1.2)	2 (3.6)	0.221
Enterococcus faecium	0 (0.0)	1 (1.8)	0.180
Coagulase-negative staphylococci	0 (0.0)	1 (1.8)	0.180
More than two pathogens	**0 (0.0)**	**3 (5.5)**	**0.006**
No growth	55 (21.9)	8 (14.5)	0.221
Others	15 (6.0)	4 (7.3)	0.757

Bolded values are significantly different between two groups ($p < 0.05$)

values, except for CRP, for which a ROC cutoff value was used), and the comparison between both groups is presented in Table 4. Platelet count < 141 × 10^3/μL, INR > 1.1, CRP > 16 mg/dL, procalcitonin > 0.5 mg/dL, lactic acids > 2.2 U/L, albumin < 3.5 g/dL, BUN > 23 mg/dL, creatinine > 1.2 mg/dL, and time to defervescence ≥ 48 h were associated with higher rates of positive FUBC.

Risk factors for a positive FUBC in bacteremic UTIs were analyzed and presented in Table 4. Of the variables available at the initial patient evaluation, DM, malignancy, initial ICU admission, and time to defervescence ≥ 48 h were used for multivariate analysis. Laboratory data deemed significantly different between two groups (CRP, procalcitonin, lactic acid, and creatinine) were also used for multivariate analysis. In the multivariate analysis using a logistic regression model, malignancy, initial ICU admission, CRP > 16 mg/dL, and a time to defervescence of more than 48 h were independent factors associated with a positive FUBC. In our study population, no subsequent bacteremia developed in patients without risk factors associated with a positive FUBC ($N = 74$; data not shown).

Discussion

This study demonstrated that clinical variables such as malignancy, initial ICU admission, a high CRP level, and longer time to defervescence could be used as predictors for positive FUBCs in bacteremic UTIs, and that no subsequent bacteremia developed in those without these risk factors. There are currently no definite guidelines in place regarding the necessity or usefulness of FUBCs for UTIs [15, 16, 19]. Despite the fact that CLSI guidelines do not recommend routine FUBCs except in cases of *S. aureus* bacteremia and infective endocarditis [10], FUBCs have been prescribed routinely and liberally. Our data support the hypothesis that FUBCs have little utility in the management of bacteremic UTIs.

The distribution of causative microorganisms in our study was similar to that of previous studies [3, 4], and the positive rate seen in FUBCs was similar to that of a previous study (17% vs. 14%) [5]. However, the incidence of persistent bacteremia in our study (1.6%) was significantly lower than that of similar studies (ranging from 7.2 to 22%) [20, 21]. We attempted to identify risk factors for positive FUBCs, and determine the patient groups that have bacteremia but do not need routine FUBCs. A high CRP level, which was associated with positive FUBCs in our study, may be related to septic shock [13] or persistent bacteremia [20]. Persistent fever was one risk factor associated with positive FUBCs in our study, similar to the findings of other studies [13, 20]. Initial ICU admission and presence of a malignancy were also associated with positive FUBCs in our study. Although we did not find any studies that accurately identified them as risk factors for positive FUBCs, we believe that they are reasonable risk factors. In our study population, no subsequent bacteremia

Table 4 Risk factors for positive FUBCs in bacteremic UTI: univariate and multivariate analyses

Risk factors (unit)	Univariate analysis			Multivariate analysis		
	OR	95% CI	*P* value	OR	95% CI	*P* value
Diabetes mellitus	**1.257**	**0.971–1.629**	**0.049**	1.886	0.727–4.892	0.192
Malignancy	**1.451**	**1.091–1.931**	**0.002**	**4.722**	**1.815–12.28**	**0.001**
Percutaneous nephrostomy	**1.158**	**1.028–1.304**	**< 0.001**			
Complicated UTI	**1.337**	**1.038–1.721**	**< 0.001**			
Initial ICU admission	**1.352**	**1.101–1.661**	**< 0.001**	**4.047**	**1.482–11.05**	**0.006**
Death	1.534	0.193–12.21	0.683			
White blood cell ≥ 10,580 (× 10^3/μL)	1.225	0.800–1.874	0.333			
Platelet < 141.000 (× 10^3/μL)	**1.360**	**1.047–1.767**	**0.006**			
Prothrombin time > 1.1 (INR)	**3.182**	**1.523–6.649**	**0.001**			
CRP > 16 (mg/dL)	**1.743**	**1.248–2.434**	**< 0.001**	**4.146**	**1.631–10.53**	**0.003**
Procalcitonin > 0.5 (mg/dL)	**6.241**	**1.448–26.90**	**0.006**	4.878	0.868–27.02	0.072
Lactic acid > 2.2 (U/L)	**1.931**	**1.046–3.566**	**0.034**	1.490	0.577–3.846	0.409
Albumin < 3.5 (g/dL)	**1.911**	**1.246–2.932**	**< 0.001**			
BUN > 23 (mg/dL)	**4.278**	**2.218–8.252**	**< 0.001**			
Creatinine > 1.2 (mg/dL)	**3.561**	**1.889–6.713**	**< 0.001**	1.028	0.392–2.699	0.955
Time to defervescence (after antibiotics) ≥ **48** (h)	**4.830**	**2.445–9.542**	**< 0.001**	**3.571**	**1.373–9.259**	**0.009**

Bolded values are significantly different between two groups ($p < 0.05$)

FUBC follow-up blood culture, OR odds ratio, CI confidence interval, UTI urinary tract infection, IC intensive care unit, INR international normalized ratio, CRP C-reactive protein

developed in patients without risk factors associated with positive FUBCs ($N = 74$). To provide a more accurate description of risk factors, further study of bacteremic UTIs is warranted.

This study has several strengths. First, it focused on bacteremic UTI, which is one of the most common bacterial infections in both community and healthcare settings. Although previous studies have been performed regarding FUBCs [5], persistent bacteremia [20], and blood cultures in UTI [3, 4, 6, 13], studies including only bacteremic UTIs are limited. Second, this study selected indications by disease entity and chose clinical variables that can be obtained at the initial patient examination. Previous studies regarding FUBCs or persistent bacteremia selected indications by organisms, not by the disease, and so made it difficult to use these clinical variables without identifying organisms. Currently, the management of bacteremia is determined largely by clinical judgment, and some clinicians draw blood cultures as a routine practice. Restricted use of FUBCs in certain patient groups has serious implications for both patient safety and healthcare costs. In addition, excessive FUBCs may lead to false positives, prompting further studies and possibly prolonged treatment courses and hospital stays [12].

This study has several limitations. First, due to the retrospective design, there may have been bias during data collection. Given that this study constituted exploratory research without an exact calculation of a sample size in a statistical manner, the study could be insufficiently powered to detect weaker, but potentially clinically significant, effects. Second, as the study was conducted at a single medical center, patient characteristics and the distribution of pathogens for UTIs could differ according to local epidemiology. Further multicenter studies are needed to overcome this limitation. Third, we did not analyze the effect of antimicrobial susceptibility and the use of appropriate antibiotics. The use of inappropriate antibiotics may affect FUBC results. Finally, the multivariate analysis may be limited by its small sample size. Although the univariate analyses revealed more than 15 statistically significant variables, we chose only seven variables of clinical importance because the number of the events (positive FUBCs) was 55. However, the significant variables were consistent in multivariate analyses, including different variables (data not shown).

Conclusions

In bacteremic UTIs, patients with positive FUBCs usually present with higher initial inflammatory markers, longer time to *defervescence*, more frequent ICU admission rates, and an elevated chance of having cancer. FUBCs may not be indicated in the setting of bacteremic UTIs, especially in mild to moderately severe cases or those exhibiting rapid clinical improvement. More careful clinical assessment before drawing FUBCs would reduce costs and inconvenience to patients.

Compliance with ethical standards

Conflicts of interest The authors declare that they have no conflicts of interest.

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