Clinical experience in management of bloodstream infection in emergency medical ward: A preliminary report

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Abstract

Background: Bloodstream infection is a life-threatening clinical condition posing significant morbidities and mortalities. An “Emergency Critical Care Management Program” has been implemented in the Emergency Medicine Ward at North Lantau Hospital as a pilot critical care service model in the local emergency medicine wards. Patients with bloodstream infection are recruited in the program and managed under pre-defined guideline.

Objectives: We report our experience in managing patients with bloodstream infection in the Emergency Medicine Ward and analyzed their clinical outcomes.

Methods: This was a retrospective cohort study including a total of 64 patients with bloodstream infection admitted to the Emergency Medicine Ward from 1 March 2015 and 31 March 2018. Patients’ characteristics, microbiology, and risk factors associated with adverse outcomes including in-hospital mortality were analyzed.

Results: The most common organism isolated from blood cultures was Escherichia coli (56%). Eight patients were transferred to the tertiary hospital. The overall in-hospital mortality was 7.8% (5/64). From the univariate analysis, advanced age (p < 0.001), higher Sequential Organ Failure Assessment score and quick Sequential Organ Failure Assessment score (p < 0.001), higher Charlson Comorbidity Index (p = 0.003), more organ dysfunction (p < 0.001), pre-existing medical history of chronic liver disease (p = 0.001), dysfunction in respiratory system (p = 0.032), cardiovascular system (p = 0.044) and the central nervous system (p < 0.001), presence of septic shock (p = 0.004), and need for higher level of organ support from the use of inotropes (p < 0.001) and mechanical ventilation (p = 0.024) were associated with in-hospital mortality. In the subgroup analysis, the in-hospital mortality rate for the patients with Sequential Organ Failure Assessment score less than 6 was 1.56% (1/64). Among the five in-hospital mortality cases, four of them were managed in the Emergency Medicine Ward under the End-of-Life Care Program. Decision for withholding and withdrawing life-sustaining therapy was made with the patients’ families.

Conclusion: This preliminary report demonstrated that with careful patient selection, adoption of guidelines, and availability of expertise, critical care service can be safely implemented in the emergency medicine ward.

Keywords
Bacteremia, sepsis, critical care, emergency medicine ward

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Introduction

There is an increasing number of patients presenting to the Emergency Department (ED) for sepsis. These patients are often critically ill and require immediate treatment and even resuscitation. Bloodstream infection (BSI) is a common cause of sepsis and carries high morbidity and mortality. BSI is also one of the prognostic factors for patient with sepsis. The reported mortality rates were around 30%–50% worldwide. In the United State, the reported mortality rates associated with bacterial BSI ranged from 14% to 37%. In Southeast Asia, the incidence of community-acquired BSI between 2001 and 2010 rose from 16.7 to 38.1 per 100,000 people per year.

North Lantau Hospital (NLTH) is a community hospital located in central Tung Chung of Lantau Island serving the population of the Lantau Island and also the floating population at the Hong Kong International Airport at Chek Lap Kok. The Emergency Medical Ward (EMW) of NLTH serves all the acute in-patient service in the hospital. The service of EMW in NLTH has been enhanced to cater the need of the local community. An “Emergency Critical Care Management Program” (Table 1), as one of the enhanced service programs, has been launched to improve the care of the critically ill patients by minimizing the risk of long distance of transport to the tertiary hospital and also to maximize the resource utilization in NLTH. Up to two beds in EMW of NLTH are used for managing selected critically ill patients and these “Emergency Critical Care Beds” are under the care of emergency physicians and EMW nursing staff, supervised by emergency physicians with fellowship training in intensive care medicine or critical care medicine.

Patients with sepsis fulfilling the admission criteria of the Emergency Critical Care Management Program are managed following the departmental guideline. A pair of standard aerobic and anaerobic blood cultures is performed. Other clinical relevant investigations, for example, chest radiograph, bedside ultrasound assessment and bacterial cultures of urine and sputum, are also performed according to the clinical indications. Empirical antibiotic is initiated as soon as possible. The choice of antibiotic depends on the clinical condition, possible source of infection, risk of infection by antibiotic-resistant strain microbial, and drug allergy history. Once blood culture result confirms BSI, patients are managed according to the departmental guideline for management of BSI (Figure 1). Abdominal ultrasound is done to identify the possible source from intra-abdominal infection. Blood culture is repeated to confirm clearance of bacteremia, and other assessments are arranged according to the indications of specific BSI and its clinical manifestations, for example, Klebsiella bacteremia and fungemia.

The aim of this study is to report the clinical experience of managing patients with BSI in the EMW of a local community hospital. The characteristics of patients with BSI and independent risk factors associated with adverse clinical outcomes are evaluated.

Table 1. Emergency Critical Care Management Program in EMW of NLTH.

| Target groups of critically ill patients |
|-----------------------------------------|
| Severe sepsis or septic shock*           |
| Respiratory failure (chronic obstructive airway disease exacerbation and acute pulmonary edema) requiring non-invasive ventilation support |
| Diabetic emergencies (diabetic ketoacidosis and hyperosmolar hyperglycemic state) |
| Hypertensive urgency                     |
| Severe electrolytes disturbance (e.g. hyper/hypokalaemia and hyper/hyponatremia) |
| Critical toxicology conditions           |
| Environmental emergencies, for example, hypothermia, heat exhaustion/ stroke |

*Old definitions of severe sepsis and septic shock were adopted in the first version of departmental guideline for sepsis management.
Methods

This was a retrospective cohort study of patients with BSI admitted to the EMW from 1 March 2015 to 31 March 2018. Patients with positive blood cultures due to contamination were excluded. These included skin flora, such as coagulase-negative Staphylococci, Corynebacterium species, Bacillus species, micrococci, and Propionibacterium acnes, which only grew in one culture set rather than multiple. The source of BSI was determined clinically on the basis of the presence of an active infection site coincident with the BSI or isolation of the organisms from other clinical specimens prior to or on the same day as the onset of BSI. BSI without identifiable source was regarded as primary BSI.

The following groups of patients were excluded from the Emergency Critical Care Management Program: Patients who required cardiac care or intensive care units (ICUs); patients who were classified as priority 1 or 2 in the ICU admission, discharge, and triage guidelines; patients indicated for renal replacement therapy; patients who required in-patient consultation of other specialties which were not available in NLTH; patients who required surgical intervention; immunocompromised patients including those on chemotherapy or immunosuppressants; patients with decompensated liver cirrhosis; patients with high infectious risks; pregnant patients; patients under the age of 18 years.

The Accident and Emergency Department (AED) and hospital records of each EMW admission were reviewed and particular data collected and analyzed. Clinical data were collected from the hospital electronic record database and the Clinical Data Analysis and Reporting System that was a computerized data retrieval system of the Hong Kong Hospital Authority. These include age, gender, clinical presentations including symptoms and durations, underlying chronic illnesses including diabetes mellitus, hypertension, cerebrovascular accident, ischemic heart disease, congestive heart failure, atrial fibrillation, renal impairment, chronic obstructive pulmonary disease, chronic liver disease, dementia, and malignancy. Sequential Organ Failure Assessment (SOFA) score and quick SOFA (qSOFA) score were calculated using the worst parameters recorded within the first 24 h of admission to the EMW. Charlson Comorbidity Index, microbe identified in blood cultures, source of BSI, type and number of organ dysfunctions, requirement of inotropic support, and ventilation support were also collected.

Primary outcomes were in-hospital and 28-day mortality. Secondary outcomes included prolonged hospital stay for more than 7 or 14 days (only including patients who were discharged from EMW) and need of transfer out to another hospital.

The entire study was approved by the institutional review board at the Kowloon West Cluster of the Hospital Authority. Informed consent was not necessary as no patient identifying data were included in this article.

Statistical analysis

The Statistical Package for the Social Sciences (Windows version 19.0; SPSS Inc, Chicago, IL, USA) was used for data analysis. Descriptive statistics were used to summarize patient demographics. Univariate analysis was performed with the chi-square test or Fisher’s exact test for comparison of proportions and Student’s t test for comparison of means. Independent risk factors for adverse outcomes, including in-hospital mortality, 28-day mortality, prolonged hospital stay, and transfer-out rate were evaluated by multivariate analysis, and statistical significance was set at p value <0.05.

Results

A total of 1210 patients with blood culture taken in the AED were admitted to the EMW during the study period. Among those, 64 patients had a final diagnosis of BSI and were managed in the EMW under the guideline for management of BSI. There were 32 (50%) females and 32 males, mean age of 75 years (SD = 14.5; range = 42-96). Eight (12.5%) of them were transferred to the tertiary hospital, Princess Margaret Hospital (PMH), for further management including a case of Klebsiella bacteremia complicated with liver abscess (diagnosed by bedside ultrasound in EMW), a case of Klebsiella bacteremia complicated by diabetic ketoacidosis, a case of Escherichia coli bacteremia complicated by renal abscess, a case of E. Coli bacteremia complicated by Fitz Hugh Curtis syndrome, a case of Eggerthella lenta bacteremia complicated by pulmonary tuberculosis, a case of Group G Streptococcus bacteremia complicated by psoas abscess, a case of Staphylococcus aureus bacteremia complicated by psoas abscess, and a case of persistent Methicillin-resistant S. aureus (MRSA) bacteremia from exfoliative dermatitis (n=1). Three cases (4.7%) were transferred to the Extended Care (EC) beds under the medical team within NLTH for convalescent care.

The most common organism isolated from the blood cultures were E. coli (56.3%, 36/64), followed by Klebsiella (12.5%, 8/64), Streptococcus (Groups A, B, and G) (9.4%, 6/64) (Table 2). Two patients had polymicrobial growths in their blood cultures. The most common source of infection was genitourinary system (58%), followed by soft tissue (13%). Seven cases (10.9%) had unknown source of infection and were regarded as primary BSI.

All of the patients included in this study had ultrasound assessment of the abdomen as suggested by the EMW guideline. Fifteen of those who either had an abnormal ultrasound scan or no obvious source of infection went on to have computed tomography (CT) scan to further identify the source of infection. Details of the CT scan findings are summarized in Table 3 and Figure 2.
Table 2. Organisms isolated from blood cultures.

| Organism                          | n  |
|-----------------------------------|----|
| Escherichia coli                  | 36 |
| Klebsiella pneumoniae             | 8  |
| Streptococcus (A/B/G)             | 6  |
| Proteus mirabilis                 | 3  |
| MSSA                              | 2  |
| MRSA                             | 2  |
| Enterococcus                      | 2  |
| Candida Glabrata                  | 2  |
| Pseudomonas aeruginosa            | 1  |
| Aeromonas species (ICBL)          | 1  |
| Eggerthella                       | 1  |
| Salmonella species                | 1  |
| Bacteroides fragilis              | 1  |
| Total                             | 66 |

MSSA: Methicillin-susceptible Staphylococcus aureus; MRSA: Methicillin-resistant Staphylococcus aureus; ICBL: inducible beta-lactamases.

*Two patients had polymicrobial growths in their blood cultures.

In hospital mortality

The overall in-hospital mortality was 7.8% (5/64), none died within 28 days after hospital discharge, including those cases who were subsequently transferred to PMH and the EC beds. From the univariate analysis, factors associated with in-hospital mortality included advanced age (p < 0.001), higher SOFA (p < 0.001), higher qSOFA scores (p < 0.001), higher Charlson Comorbidity Index (p = 0.003), pre-existing medical history of chronic liver disease (p = 0.001), more organ dysfunction (p < 0.001), dysfunction in respiratory system (p = 0.032), cardiovascular system (p = 0.044) and the central nervous system (p < 0.001), presence of septic shock (p = 0.004), need for higher level of organ support from the use of inotropes (p < 0.001) and mechanical ventilation (p = 0.024) (Table 4). In the subgroup analysis of our cohort, the in-hospital mortality rate for the patients with SOFA score less than 6 was 1.56% (1/64).

For the five cases of in-hospital mortality, all of the patients were at advanced age, mean age 89.2 years (range = 82–94 years) and had multiple comorbidities. One of whom transferred to orthopedic team in PMH after diagnosis of psoas abscess, developed hospital acquired pneumonia and subsequently died 2 months after admission. The other four patients all died in the EMW after discussion with the patients and their families, shared decision for withholding, and withdrawing of life-sustaining treatment was made. The hospital policy for “Do Not Attempt Cardio-Pulmonary Resuscitation” was adopted and End-of-Life Care service was provided.

28 days mortality

There was no mortality within 28 days of discharge.

Length of stay more than 7 days

For those 53 patients who were managed in the EMW, the average length of stay was 11.6 days (median = 10 days). Eleven of them (20.8%) were managed and discharged from the EMW within 7 days of admission. In the univariate analysis, there were no factors found to be statistically significant that was associated with hospital stay of more than 7 days. However, two factors were close to statistical significance; these include the presence of pre-existing dementia (p = 0.052) and unidentifiable source of infection (p = 0.054) (Table 5). This might be accounted for the fact that more workups to identify the cause of infection were required.

Length of stay more than 14 days

Ten out of the 53 patients (18.9%) had hospital stay more than 14 days. Univariate analysis identified factors associated with hospital stay more than 14 days including higher SOFA score (p = 0.009), more organ dysfunction (p = 0.02), medical history of congestive heart failure (p = 0.03), atrial fibrillation (p = 0.031), and dementia (p = 0.022). Microbial not sensitive to beta lactam (p = 0.015), organ dysfunction including respiratory (p = 0.011) and cardiovascular system (p = 0.002), and requirement of inotropic support (p = 0.002) were also associated with prolonged length of stay (Table 5).

Transfer out

Eleven patients (17.2%) were transferred out for further management, including eight cases to PMH and three cases to EC beds. The three cases transferred to EC were excluded from this univariate analysis. Factors identified in the univariate analysis associated with transfer-out were likely source of infection from genitourinary (p = 0.047) and lung (p = 0.005), and microbial not sensitive to beta lactam. On the other hand, patients with higher Charlson Comorbidity Index were more likely to continue management in the EMW (p = 0.03) (Table 6).

Owing to the limited number of cases in this preliminary study, no independent predictor for the prolonged length of stay (both more than 7 and 14 days), in-hospital mortality, 28 days mortality and transfer-out could be identified in the multivariate analysis.

Discussion

BSI carries a high mortality and generally requires urgent management for sepsis control and identification of underlying source of infection.\(^6\) BSI can be categorized into community-acquired (BSI occurring within 48 h of hospital admission or in the outpatient setting) and nosocomial. Only a few studies in the literature reported the epidemiology of patients with community-acquired BSI presenting to the ED. Ortega at al.\(^{10}\) reported the
Table 3. Radiological findings of patients requiring CT scan assessment.

| Admission condition         | Ultrasound findings                  | CT scan findings                                                                 | Outcomes                                                                 |
|-----------------------------|-------------------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| *Escherichia coli* bacteremia | Gall bladder sludge, renal cyst      | Left subcapsular collection of left kidney, perinephric inflammatory changes    | Consulted surgical team, managed conservatively in EMW                  |
| *E. coli* septicemia        | No intrahepatic lesion, no hydronephrosis | Bilateral tubo-ovarian complexes, secondary to pelvic inflammatory disease.    | Transferred to PMH gynecology unit                                       |
| *E. coli* bacteremia        | No intrahepatic lesion, no hydronephrosis | Left acute pyelonephritis with infected or inflamed left ureter                | Discharged from EMW                                                     |
| *Group G Streptococcus* bacteremia | No intrahepatic lesion, no hydronephrosis | Infected pyomyositis of psoas muscles with abscess                            | Transferred to PMH orthopedic unit                                      |
| *Klebsiella* bacteremia     | Hypoechoic liver lesions             | Two liver abscesses                                                            | Consulted surgical team, managed conservatively in EMW                  |
| *E. coli* bacteremia        | No intrahepatic lesion, no hydronephrosis | Unremarkable                                                                  | Discharged from EMW                                                     |
| *Urosepsis/septic shock*    | No intrahepatic lesion, no hydronephrosis | Left upper urinary tract infection                                             | Discharged from EMW                                                     |
| *Diabetic ketoacidosis/Klebsiella septicemia* | No gross intrahepatic lesion, no hydronephrosis | Infarct in segment IVb of liver secondary to venous thrombosis. Small bilateral renal infarcts; extensive consolidations in both lung bases; mild right pleural effusion | Transferred to PMH ICU                                                  |
| *E. coli* bacteremia        | Swollen left kidney, dilated common bile duct | Left pyelonephritis, dilated intrahepatic duct and common bile duct           | Discharged from EMW                                                     |
| *Klebsiella* bacteremia     | Gallbladder stones and sludge         | 2.8 cm abscess at splenorenal recess                                           | Consulted surgical team, managed conservatively in EMW                  |
| *E. coli* bacteremia        | Unremarkable                         | Unremarkable                                                                  | Discharged from EMW                                                     |
| *Enterococcus* bacteremia   | Right hydronephrosis                 | Right upper ureteric stone with right hydroureteronephrosis                    | Family declined surgical intervention, conservative management in EMW  |
| *MSSA* septicemia           | No vegetation in echocardiogram; ultrasound abdomen unremarkable | Left iliopectoas abscess                                                      | Transferred to PMH orthopedic unit                                      |
| *E. coli* bacteremia        | Suspected right renal abscess        | Right renal abscess                                                           | Transferred to PMH surgical unit                                        |
| *Group A Streptococcus* bacteremia | No intrahepatic lesion, no hydronephrosis | Renal cysts otherwise unremarkable                                            | Discharged from EMW                                                     |

CT: computed tomography; EMW: Emergency Medicine Ward; PMH: Princess Margaret Hospital; ICU: intensive care unit; MSSA: Methicillin-susceptible Staphylococcus aureus.
characteristics and clinical outcomes of 1640 episodes of community-acquired BSI presenting to an ED Spain. Among all the episodes of community-acquired BSI, 12% were classified as primary BSI. The most frequently isolated organism in both primary and secondary BSI was \textit{E. coli} which was similar to our study. The most common source of infection for secondary BSI was urinary tract infection (40%). The overall mortality rate was 9% while primary BSI was associated with significantly higher mortality. Independent predictors for mortality were lack of fever, fatal prognosis of the underlying disease, and incorrect empirically therapy.\textsuperscript{10}

In recent years, there were changes in the health care systems which shifted much of the patient care from the in-hospital to the community. Consequently, infections traditionally classified as community-acquired or nosocomial infections could not be readily classified into either category. Therefore, a subgroup of BSI, healthcare-associated BSI, had been recently introduced and this distinct category of BSI was reported to have different epidemiologic, bacteriologic characteristics, and antibiotic susceptibility profiles.\textsuperscript{11} Healthcare-associated BSI was defined as BSI occurring in patients who had history of recent hospitalization for more than 2 days, received hemodialysis, intravenous chemotherapy, or invasive procedures less than 3 months before a BSI episode, or who resided in a nursing home.\textsuperscript{12} Kao et al. described the clinical characteristics and outcomes of 263 (29.5%) episodes of healthcare-associated BSI in a total 890 episodes of BSI in adult patients presenting to an ED in a tertiary referral center in Taiwan. The overall crude mortality rate of all the patients was 21%. Patients with healthcare-associated BSI had higher mortality than true community-acquired BSI (23.1% vs. 16.1%). Although \textit{E. coli} remained the most common isolated organism among all the categories of BSI, MRSA was more common in both nosocomial and healthcare-associated BSI than true community-acquired BSI.\textsuperscript{12} The incidence of healthcare-associated BSI was not specifically evaluated in our study but the incidence of MRSA bacteremia was relatively low in our cohort (3.1%).

EMW or observation ward in the ED was originally designed to provide short duration of in-patient care only. Patients with sepsis are generally excluded from the EMW admission criteria. Therefore, experience in managing patients with BSI by the emergency physicians is limited. Our study represents the first local study on the management of BSI in a pilot program of critical care implemented in the EMW. Owing to the pre-defined selection criteria of our Emergency Critical Care Management Program, the etiology, microbiological characteristics and clinical outcomes might not be comparable with those reported in the community-acquired and healthcare-associated BSI in the literature. The incidence of primary BSI in our cohort was about 5% (64/1210) which was slightly lower compared with the reported incidence in the literature. However, the most common source of secondary BSI was urinary tract infection which was similar to the literature. The overall in-hospital mortality rate in our cohort (7.8%) was comparable to the reported mortality rates of community-acquired BSI in the literature.\textsuperscript{10,12,13} In our study, the in-hospital

\begin{figure}[h]
\centering
\includegraphics[width=\linewidth]{figure2}
\caption{CT image of selected cases with positive findings. (a) Left iliopsoas abscess at lower L4 level as indicated by the non-enhanced low attenuation areas in the left iliopsoas muscle (arrow). (b) Increased perinephric stranding and patchy hypoenhancing areas in the left renal parenchyma (arrow), suggestive of pyelonephritis. (c) Right renal abscess as a hypoenhancing lesion with rim enhancement at the right kidney (arrow). (d) A rim enhancing hypodense lesion at the left lobe of liver (arrow), suggestive of a liver abscess. (e) A rim enhancing collection at splenorenal recess (arrow), suggestive of a splenorenal abscess.}
\end{figure}
mortality rate for the patients with SOFA score less than 6 was only 1.56%. From a prospective study from Belgian in 2001, the estimated mortality rate of critically ill patients in ICU with SOFA score less than 6 was less than 10%. Fever was reported in 83% (53/64) of our patients. Some of elderly patients presented with non-specific symptoms of sepsis including decreased general condition, malaise, or shortness of breath. Lee et al. compared the clinical

Table 4. Univariate analysis of factors associated with in-hospital mortality.

| In-hospital mortality | p value |
|-----------------------|---------|
|                       | Yes     | No     | Yes | No |
| Past medical health   |         |        |     |     |
| Diabetes mellitus     | 3       | 2      | 21  | 38  | 0.279a |
| Hypertension          | 5       | 0      | 31  | 38  | 0.062b |
| Cerebrovascular accident | 5   | 0      | 45  | 14  | 0.577a |
| Ischemic heart disease | 1      | 4      | 21  | 38  | 0.481a |
| Congestive heart failure | 1      | 4      | 4   | 55  | 0.290a |
| Atrial fibrillation   | 1       | 4      | 9   | 50  | 0.779a |
| Renal impairment      | 1       | 4      | 9   | 50  | 0.779a |
| Chronic obstructive airway disease | 0 | 5 | 4 | 55 | 1.00b |
| Liver disease         | 2       | 3      | 2   | 57  | 0.001ab |
| Dementia              | 2       | 3      | 13  | 46  | 0.363a |
| Cancer                | 1       | 5      | 4   | 54  | 0.396a |
| Likely source         |         |        |     |     |
| Genitourinary tract   | 2       | 3      | 35  | 24  | 0.401a |
| Gastrointestinal tract | 0     | 5      | 5   | 54  | 1.00b |
| Lung                  | 1       | 4      | 2   | 57  | 0.092a |
| Soft tissue           | 1       | 4      | 7   | 52  | 0.637a |
| Unknown               | 0       | 5      | 7   | 52  | 0.414a |
| Bacteria              |         |        |     |     |
| Gram positive         | 1       | 4      | 14  | 45  | 0.850a |
| Gram negative         | 3       | 2      | 44  | 15  | 0.479a |
| Sensitive to beta lactam | 3 | 2 | 49  | 10  | 0.205a |
| Organ dysfunction     |         |        |     |     |
| Renal dysfunction     | 4       | 1      | 26  | 33  | 0.122a |
| Liver dysfunction     | 2       | 3      | 27  | 32  | 0.804a |
| Respiratory dysfunction | 3     | 2      | 11  | 48  | 0.032ab |
| Cardiovascular dysfunction | 3 | 2 | 12  | 47  | 0.044b |
| Central nervous system | 3      | 2      | 4   | 55  | <0.001ab |
| Platelet              | 3       | 2      | 16  | 43  | 0.122a |
| Coagulopathy          | 1       | 4      | 2   | 57  | 0.092a |
| Septic shock          | 22      | 3      | 7   | 52  | 0.004ab |
| Support               |         |        |     |     |
| Inotropic support     | 4       | 1      | 8   | 51  | <0.001ab |
| Mechanical ventilation | 1      | 4      | 1   | 58  | 0.024ab |
| Age (mean (SD))       | 89.4 (4.4) | 73.8 (14.4) | <0.001ab |
| SOFA score (mean (SD)) | 8.4 (4.3) | 2.27 (2.2) | <0.001ab |
| qSOFA score (mean (SD)) | 1.6 (0.9) | 0.46 (0.7) | <0.001ab |
| Charlson Comorbidity Index (mean (SD)) | 8.8 (3.2) | 4.6 (2.6) | 0.003ab |
| No. of organ dysfunction (mean (SD)) | 3.6 (1.1) | 1.6 (1.1) | <0.001ab |

SOFA: Sequential Organ Failure Assessment; qSOFA: quick Sequential Organ Failure Assessment.

a Chi-square test.
b Fisher’s exact test.
c Student’s t test.
d Statistically significant.
manifestations and outcomes of 890 adult and elderly patients with community-acquired BSI presenting to the emergency department of a university medical center in Taiwan. Urinary tract infection remained the main source of BSI in the elderly patients. Compared with the adult patients, elderly patients more frequently had atypical clinical manifestations of BSI, for example, more afebrile episodes. This highlights the importance of awareness of atypical presentations of sepsis in the elderly patients. Moreover, elderly patients with BSI also had higher risk organ failure, more frequency of septic shock and poor prognosis. Some specific pathogens required special evaluations for the underlying source of infection and associated complications. All the patients with *S. aureus* or MRSA bacteremia

| Table 5. Univariate analysis of factors associated with length of stay > 7 and > 14 days. |
|---------------------------------------------------------------|
| **LOS > 7 days** | **LOS > 14 days** |
| **p value** | **p value** | **p value** |
| **Yes** | **No** | **Yes** | **No** | **Yes** | **No** | **Yes** | **No** |
| Diabetes mellitus | 12 | 30 | 6 | 5 | 0.0105<sup>a</sup> | 3 | 7 | 15 | 28 | 0.769<sup>a</sup> |
| Hypertension | 23 | 19 | 2 | 9 | 0.0102<sup>a</sup> | 7 | 3 | 25 | 18 | 0.490<sup>a</sup> |
| Cerebrovascular accident | 26 | 16 | 1 | 10 | 0.067<sup>c</sup> | 7 | 3 | 10 | 33 | 0.004<sup>a</sup> |
| Ischemic heart disease | 16 | 26 | 3 | 8 | 0.505<sup>a</sup> | 3 | 7 | 16 | 27 | 0.669<sup>a</sup> |
| Congestive heart failure | 4 | 38 | 0 | 11 | 0.569<sup>b</sup> | 3 | 7 | 1 | 42 | 0.003<sup>a</sup> |
| Atrial fibrillation | 7 | 35 | 2 | 9 | 0.905<sup>a</sup> | 4 | 6 | 5 | 38 | 0.031<sup>a</sup> |
| Renal impairment | 8 | 34 | 1 | 10 | 0.434<sup>a</sup> | 2 | 8 | 7 | 36 | 0.778<sup>a</sup> |
| Chronic obstructive airway disease | 3 | 39 | 0 | 11 | 1.00<sup>b</sup> | 1 | 9 | 2 | 41 | 0.510<sup>a</sup> |
| Liver disease | 2 | 40 | 1 | 10 | 0.580<sup>a</sup> | 0 | 10 | 30 | 40 | 1.00<sup>b</sup> |
| Dementia | 12 | 30 | 0 | 11 | 0.052<sup>ab</sup> | 5 | 5 | 7 | 36 | 0.022<sup>ab</sup> |
| Cancer | 4 | 38 | 2 | 9 | 0.420<sup>a</sup> | 0 | 10 | 6 | 37 | 0.581<sup>a</sup> |
| Likely source | Genitourinary tract | 27 | 15 | 6 | 5 | 0.553<sup>a</sup> | 5 | 5 | 28 | 15 | 0.374<sup>a</sup> |
| | Gastrointestinal tract | 5 | 37 | 0 | 11 | 0.229<sup>a</sup> | 1 | 9 | 4 | 39 | 0.946<sup>a</sup> |
| | Lung | 1 | 41 | 0 | 11 | 1.00<sup>b</sup> | 4 | 9 | 6 | 37 | 0.486<sup>a</sup> |
| | Soft tissues | 4 | 38 | 1 | 10 | 0.965<sup>a</sup> | 2 | 8 | 3 | 40 | 0.204<sup>a</sup> |
| | Unknown | 5 | 37 | 4 | 7 | 0.054<sup>ab</sup> | 1 | 9 | 8 | 35 | 0.514<sup>a</sup> |
| Bacteria | Gram positive | 9 | 33 | 2 | 9 | 0.813<sup>a</sup> | 2 | 8 | 9 | 34 | 0.948<sup>a</sup> |
| | Gram negative | 31 | 11 | 9 | 2 | 0.583<sup>a</sup> | 6 | 4 | 34 | 9 | 0.207<sup>a</sup> |
| | Sensitive to beta lactam | 36 | 6 | 9 | 2 | 0.748<sup>a</sup> | 6 | 4 | 39 | 4 | 0.015<sup>ab</sup> |
| Organ dysfunction | Renal | 20 | 22 | 6 | 5 | 0.682<sup>a</sup> | 7 | 3 | 19 | 24 | 0.141<sup>a</sup> |
| | Liver | 17 | 25 | 5 | 6 | 0.765<sup>a</sup> | 2 | 8 | 20 | 23 | 0.125<sup>a</sup> |
| | Respiratory | 10 | 32 | 1 | 10 | 0.284<sup>a</sup> | 5 | 5 | 6 | 37 | 0.011<sup>ab</sup> |
| | Cardiovascular | 11 | 31 | 1 | 10 | 0.228<sup>a</sup> | 6 | 4 | 4 | 37 | 0.002<sup>ab</sup> |
| | Central nervous system | 4 | 38 | 1 | 10 | 0.967<sup>a</sup> | 1 | 9 | 4 | 39 | 0.946<sup>a</sup> |
| | Platelet | 10 | 32 | 4 | 7 | 0.401<sup>a</sup> | 4 | 6 | 10 | 33 | 0.279<sup>a</sup> |
| | Coagulopathy | 2 | 40 | 0 | 11 | 1.00<sup>b</sup> | 0 | 10 | 2 | 41 | 1.00<sup>b</sup> |
| | Septic shock | 5 | 37 | 2 | 9 | 0.584<sup>a</sup> | 3 | 7 | 4 | 39 | 0.082<sup>a</sup> |
| Support | Inotrope | 7 | 35 | 2 | 9 | 0.905<sup>a</sup> | 5 | 5 | 4 | 39 | 0.002<sup>ab</sup> |
| | Mechanical ventilation | 0 | 42 | 1 | 10 | 0.208<sup>b</sup> | 0 | 10 | 1 | 42 | 1.00<sup>b</sup> |
| Age (mean (SD)) | 76.4 (14.4) | 72.6 (14.4) | 0.43<sup>c</sup> | 81.40 (13.1) | 74.2 (14.1) | 0.15<sup>c</sup> |
| SOFA (mean (SD)) | 2.5 (2.5) | 2.9 (4.2) | 0.67<sup>c</sup> | 4.7 (3.3) | 2.07 (2.6) | 0.009<sup>a</sup> |
| qSOFA (mean (SD)) | 0.55 (0.7) | 0.4 (0.7) | 0.46<sup>c</sup> | 0.80 (0.9) | 0.4 (0.7) | 0.16<sup>c</sup> |
| Charlson Comorbidity Index (mean (SD)) | 5.2 (2.7) | 4 (2.3) | 0.32<sup>c</sup> | 6.8 (3.7) | 4.6 (2.3) | 0.30<sup>c</sup> |
| No. of organ dysfunction (mean (SD)) | 1.67 (1.2) | 1.6 (1.6) | 0.78<sup>c</sup> | 2.5 (1.4) | 1.44 (1.2) | 0.020<sup>c</sup> |

**LOS**: length of stay; **SOFA**: Sequential Organ Failure Assessment; **qSOFA**: quick Sequential Organ Failure Assessment.

*Chisquare test.

Fisher’s exact test.

Student’s t test.

*Statistically significant.
required echocardiogram assessment for possible underlying endocarditis. In this study, we identified eight cases (12.5%) of BSI due to *Klebsiella pneumoniae*. *Klebsiella* bacteremia is an invasive syndrome with a rising incidence in Asia. The unique microbiological characteristics of *K. pneumoniae* lead to disseminated infections, such as liver abscesses, endophthalmitis, and central nervous system infection. It is currently the main cause of pyogenic liver abscess in Hong Kong and also other countries of Southeast Asia including Singapore and China. All of the patients with *Klebsiella* bacteremia went on to have abdominal ultrasound as per EMW guideline and three cases required

| Table 6. Univariate analysis of factors associated with patients transferred out (excluding those transferred to EC beds). |
|---------------------------------------------------------------|
| **Transfer out**                      | **p value** |
|                                 | **Yes** | **No** | **Yes** | **No** |
| **Past medical health**               |         |         |         |         |
| Diabetes mellitus                   | 5       | 3       | 18      | 35      | 0.121a |
| Hypertension                        | 2       | 6       | 32      | 21      | 0.060a |
| Cerebrovascular accident            | 0       | 8       | 17      | 36      | 0.092b |
| Ischemic heart disease              | 3       | 5       | 19      | 34      | 0.928a |
| Congestive heart failure            | 1       | 7       | 4       | 49      | 0.634a |
| Atrial fibrillation                 | 1       | 7       | 9       | 44      | 0.750a |
| Renal impairment                    | 1       | 7       | 9       | 44      | 0.750a |
| Chronic obstructive airway disease  | 1       | 7       | 3       | 50      | 1.00a  |
| Liver disease                       | 0       | 8       | 3       | 50      | 1.00b  |
| Dementia                            | 1       | 7       | 12      | 41      | 0.514a |
| Cancer                              | 0       | 8       | 6       | 47      | 1.00b  |
| **Likely source**                   |         |         |         |         |
| Genitourinary tract                 | 2       | 6       | 33      | 20      | 0.047ab |
| Gastrointestinal tract              | 0       | 8       | 5       | 48      | 1.00b  |
| Lung                                | 2       | 6       | 1       | 52      | 0.005ab |
| Soft tissue                         | 2       | 6       | 5       | 48      | 0.198a |
| Unknown                             | 0       | 8       | 9       | 44      | 0.591b |
| **Bacteria**                        |         |         |         |         |
| Gram positive                       | 3       | 5       | 11      | 42      | 0.294a |
| Gram negative                       | 5       | 3       | 40      | 13      | 0.437a |
| Sensitive to beta lactam            | 4       | 4       | 45      | 8       | 0.021ab |
| **Organ dysfunction**               |         |         |         |         |
| Renal                               | 3       | 5       | 26      | 27      | 0.543a |
| Liver                               | 6       | 2       | 22      | 31      | 0.076a |
| Respiratory                         | 3       | 5       | 11      | 42      | 0.294a |
| Cardiovascular                      | 2       | 6       | 12      | 41      | 0.881a |
| Central nervous system              | 2       | 6       | 14      | 39      | 0.786a |
| Platelet                            | 2       | 2       | 16      | 43      | 0.122a |
| Coagulopathy                        | 0       | 8       | 2       | 51      | 0.576b |
| Septic shock                        | 2       | 6       | 7       | 46      | 0.381a |
| **Support**                         |         |         |         |         |
| Inotropic support                   | 2       | 6       | 9       | 44      | 0.582a |
| Mechanical ventilation              | 1       | 7       | 1       | 52      | 0.116a |
| **Age (mean (SD))**                 | 66.75 (15.6) | 75.6 (14.0) | 0.11c |
| **SOFa score (mean (SD))**          | 3.50 (3.1) | 2.57 (2.9) | 0.40c |
| **qSOFA score (mean (SD))**         | 0.50 (0.5) | 0.51 (0.7) | 0.98c |
| **Charlson Comorbidity Index (mean (SD))** | 2.71 (2.3) | 5.04 (2.7) | 0.03c |
| **No. of organ dysfunction (mean (SD))** | 2.13 (1.1) | 1.64 (1.3) | 0.31c |

EC: Extended Care; SOFA: Sequential Organ Failure Assessment; qSOFA: quick Sequential Organ Failure Assessment.

aChi-square test.
bFisher’s exact test.
cStudent’s t test.
*Statistically significant.
further assessment by the CT scan. Intra-abdominal abscesses were identified in two cases, including one case with liver abscesses and one case with abscess in splenorenal recess. Both patients were managed and discharged from EMW. Ophthalmology assessment were also sought in all the cases and none of them had ocular complications from Klebsiella infection.

Patients with fungemia also require special evaluation. Community-acquired fungemia is rare. Risk factors for fungemia include sepsis, the use of central venous catheters, and underlying immunocompromised states. Invasive system infections can be resulted from hematogenous spread to other visceral organs, such as eye, kidney, heart, brain. Two cases of Candida glabrata fungemia were identified. C. glabrata is the second most common Candida species after Candida albicans causing BSI, and the incidence of C. glabrata infection has been increasing recently. Both patients in this study had C. glabrata isolated in their blood and urine cultures. Both of them had echocardiogram assessment to rule out endocarditis, and ophthalmologist’s reviews were also arranged to assess for potential ophthalmological complications, such as chorioretinitis. No sonographic evidence of endocarditis and ophthalmological complications were identified in both patients.

Lin et al. reported the independent predictors for 28-day mortality of bacteremic patients in the ED to be age more than 60 years, alcoholism, underlying malignancy and liver cirrhosis, polymicrobial infections, and sepsis. However, we were unable to identify the independent risk factors for the adverse outcomes including the mortality in this study due to the small number of cases.

For the prolonged length of stay, it was noted the SOFA score, Charlson Comorbidity Index, number of organ dysfunction and age were all notably higher in the group of patients with length of stay more than 14 days. Given the mean patient age for those with length of stay more than 14 days was 81.4 years in this study, together with higher severity of their illnesses and significant comorbidities, prolonged length of hospital stay was expected. However, the mean Charlson Comorbidity Index was also noted to be higher in the patients who stayed in the EMW ongoing management compared with the transfer-out cases. This indicated this EMW play a much extended role in the acute in-patient care service in the hospital. Most of the patients and their relatives expected in-patient care and EDICU serves a designated area in the ED providing comparable care for the critically ill as standard ICUs. This novel model of practice has also been developed in the EDs in some of our nearby countries and cities, including mainland China, Taiwan, Singapore, Japan, and Macau. In Hong Kong, a dual-fellowship training program in emergency medicine and intensive care medicine has been approved by the Hong Kong College of Emergency Medicine and Hong Kong College of Anaesthesiologists in 2012. This post-fellowship training program for the emergency physicians provides a strong foundation for the development of advanced critical care in the local AEDs. Our Emergency Critical Care Management Program is the first pilot program of critical care service in the local EMWs. Sepsis is one of the most common critical conditions. This program enhances the knowledge and experience of the emergency physicians in managing critically ill patients with sepsis. On the other hand, critically ill patients can also receive high quality of care in the ED from trained emergency intensivists.

There were several limitations in this study. First, this was a retrospective study and data analysis depended on the
Critical care is an important field of development in emergency medicine. The EMW service in NLTH has been enhanced due to the unique condition of the hospital and critical care is one of the important enhanced services to meet the community’s need. This study demonstrated that without compromising mortality, and with the appropriate expertise and guidelines, patients with BSI could be successfully managed by the trained emergency physicians and emergency intensivists in the EMW. This could not only reduce the risk of transportation of the critically ill patients but also relieved the pressure of the general medical wards and ICU in the tertiary hospitals. In the future, we would like to carry out more studies, ideally prospective studies using existing protocols and guidelines to further evaluate the safety, practicality, and cost implication of the management of critical care patients in the EMW. Moreover, studies on the application of the existing skills and hardware to patients not only with BSI but also extending to other medical related critical illness such as other forms of sepsis or diabetes ketoacidosis may be beneficial. We look forward to seeing whether this model would be feasible and most of all helpful to the healthcare system if it would be implemented to other peripheral hospitals or even tertiary centers.

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Availability of data and materials

All participants’ identifications were removed before storage. The master dataset was kept by the investigators in computer and password was required to open the file. Access to the data would be limited to the investigators and clinical research ethics committees of Kowloon West Cluster, Hong Kong Hospital Authority. Please contact principal investigator if further information of the data is required.

Informed consent

Informed consent was waived by the clinical research ethics committees of Kowloon West Cluster, Hong Kong Hospital Authority.

Ethical approval

This study was approved by the clinical research ethics committees of Kowloon West Cluster, Hong Kong Hospital Authority.

Human rights

The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki.

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