Association between site of infection and mortality in patients with cancer with sepsis or septic shock: A retrospective cohort study

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Abstract. Infections are associated with increased mortality in patients with sepsis or septic shock. However, to the best of our knowledge, the influence of the site of infection on patients with cancer remains unclear. The present study aimed to evaluate the association between the site of infection and mortality in patients with cancer and sepsis or septic shock. The present study was conducted in a Lebanon tertiary care centre from July 2010 to April 2015. A total of 176 patients with active cancer presenting to the emergency department with sepsis or sepsis shock were included in the present analysis. Cox regression and Kaplan-Meier analysis of the effect of the site of infection on mortality were performed. The most common site of infection was the lung (37.50%), followed by the urinary tract (26.70%), unknown site (13.63%), gastrointestinal (13.07%) and others (9.10%). The overall mortality rate was 47.73%. Gastrointestinal infection (78.26%) was associated with the highest mortality, followed by pneumonia (62.12%). The urinary tract infection with the lowest mortality rate was the reference group. After adjusting for confounding variables, gastrointestinal infection was associated with the highest in-hospital mortality [hazard ratio (HR), 2.64; 95% CI, 1.25-5.55], followed by pneumonia (HR, 1.95; 95% CI, 1.03-3.68). The association between site of infection and 28-day and 60-day mortality was analysed by Cox regression, as well as by stratified analysis to investigate the association between site of infection and mortality from haematological and solid tumors. Gastrointestinal infection had a higher mortality rate. In conclusion, the site of infection had the same association with mortality in patients with solid and haematological tumours.

Introduction

Sepsis is life-threatening organ dysfunction in response to infection (1). Due to the immunosuppressed state, patients with cancer are prone to infection (2). Cancer accounts for an estimated 20% of >1 million sepsis hospitalizations (3). Sepsis and septic shock are the most common causes of death in patients with cancer. A study conducted by Rudd *et al* (4) showed that of the 48.9 million sepsis cases hospitalized in 2017, 22.5% died. Patients with cancer in combination with sepsis are associated with higher mortality rates compared to patients with sepsis (5). Studies have shown that 28-day mortality rates in patients with sepsis and combined active cancer ranged from 41.9 to 81.5% (6). A previous study has shown that mortality from sepsis is associated with anatomical site of infection (7). Assessing the strength of the association between the site of infection and prognosis in patients with cancer with sepsis or septic shock may help healthcare providers make better clinical decisions (8). However, to the best of our knowledge, few studies have addressed the impact of specific infection sites on mortality in patients with cancer with sepsis or sepsis shock. Hensley *et al* (3) showed differences in in-hospital mortality in patients with cancer and sepsis due to the site of infection. The study by Chebl *et al* (2) showed differences in common sites of infection in patients with hematologic and solid tumours. However, they did not further analyse the association between the site of infection and in-hospital mortality in cancer patients. Therefore, the present study described the distribution of infection sites in patients with cancer presenting to the emergency department (ED) with sepsis or septic shock and analysed the association of specific sites of infection with in-hospital mortality.

Patients and methods

Data collection. The present study assessed a retrospective single-centre cohort study by Dagher *et al* (9) at the American University of Beirut Medical Center (Beirut, Lebanon) from July 2010 to April 2015. Data was extracted free of charge from the Dryad Digital Repository database (doi.org/10.5061/dryad.6qk05). A total of 352 participants were retrospectively reviewed. 176 cancer-free patients were excluded and 176 patients with active cancer were selected for analysis. The requirement for ethics approval was waived. As data was anonymized, the requirement for informed consent was waived. Because this was a secondary retrospective chart review study, patients with cancer were not involved in the design.

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Sepsis (9,10) was defined as known or suspected source of systemic infection plus at least two of the following: i) Temperature >38 or <36˚C; ii) heart rate >90 beats/min; iii) respiratory rate >20 breaths/min or arterial carbon dioxide tension <32 mmHg and iv) white cell count >12,000 or <4,000/ml.

Septic shock (9,10) was defined as fulfilling requirements for sepsis plus one of the following: Systolic blood pressure <90 mmHg, mean arterial pressure <65 mmHg or lactate >2 mmol/l following initial fluid replacement.

Bacteraemia was defined as two positive blood cultures of known skin flora pathogens or one positive blood culture of non-skin flora pathogens.

Active cancer (9) was defined as solid or haematological malignancy currently receiving at least one therapy as follows: i) Chemotherapy; ii) radiation therapy and iii) surgery.

Statistical analysis. Categorical variables were compared using χ^2 or Fisher's exact probability test. Continuous variables were compared by Kruskal-Wallis test. Categorical variables were reported as percentage. Non-normal variables were reported as the median and interquartile range (IQR). The effect of the site of infection on mortality was analysed by Cox regression. Covariates in the multivariate model included age (20-50, 51-70 and >70 years), sex, hypertension, congestive heart failure, ejection fraction <40%, tumour type, white blood cell count, haemoglobin, diagnosis, bacteraemia, chemotherapy, radiation, surgery, time to antibiotics and steroids. In addition, all-cause mortality within 60 days was assessed using Kaplan-Meier curves according to the site of infection. Differences were compared by the log-rank test. All statistical analyses were performed with Empower (empowerstats.com; X&Y Solutions, version 4.1) and R software (R-project.org version 4.1.3). P<0.05 (two-sided) was considered to indicate a statistically significant difference.

Results

Baseline characteristics and clinical outcomes. The baseline characteristics of patients with cancer are shown in Table I. Sites of infection included lung (n=66; 37.50%), urinary tract (n=47; 26.70%), unknown (n=24; 13.63%), gastrointestinal (n=23; 13.07%) and other (n=16; 9.10%). Other sites of infection included skin, oral cavity, catheter, bile and liver (2.84, 0.57, 2.27, 2.84 and 0.57%, respectively). A total of 176 patients with active cancer were included in the present study, of which 35 patients (19.89%) had haematological tumours and 141 patients (80.11%) had solid tumours. In 35 haematological tumours, leukaemia (57.14%) was the most prevalent type of cancer. In 141 cases of solid tumours, lung cancer (22.70%) was the most prevalent type of cancer, followed by breast cancer (14.18%). Overall in-hospital mortality was 47.73% (n=84), with the lowest mortality in patients with cancer with urinary tract infection (n=15; 31.91%). Gastrointestinal infection (n=18; 78.26%) had a higher mortality rate, followed by pneumonia (n=41; 62.12%).

In the univariable analysis for the entire cohort (Table II), diagnosis and chemotherapy were significantly associated with survival. These variables were included in further analyses.

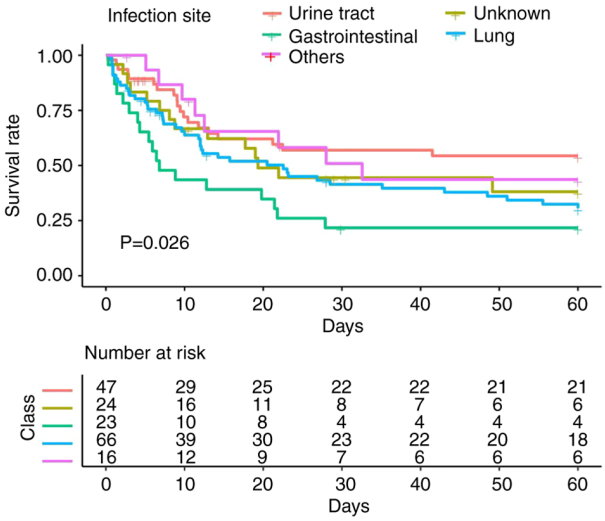

Figure 1. Kaplan-Meier curves of overall survival of patients with cancer with different sites of infection.

Association between site of infection and mortality. The urinary tract infection with the lowest mortality rate (31.91%) was the reference group (Table III). After adjusting for confounding variables, gastrointestinal infection was associated with highest in-hospital mortality [hazard ratio (HR), 2.64; 95% CI, 1.25-5.55), followed by pneumonia (HR, 1.95; 95% CI, 1.03-3.68). The confidence intervals are wide, reflecting the limited number of patients. The association between site of infection and 28-day and 60-day mortality was analysed by Cox regression. Gastrointestinal infection and pulmonary infection had a higher mortality rate.

Kaplan-Meier survival curve for each infection site with 60 day follow-up showed a consistent pattern (Fig. 1) with the highest cumulative mortality from gastrointestinal infection and pneumonia. Patients with urinary tract and other site infections had the lowest cumulative mortality.

To evaluate the relationship between the site of infection and the mortality of patients with solid or haematological tumours, a stratified analysis was performed. Among solid and haematological tumours, gastrointestinal infections were associated with the highest in-hospital mortality after adjusting for confounding variables. They were [HR, 2.36; 95% CI, 1.05-5.31], [HR, 179.91; 95% CI, 5.69-5693.31), respectively (Tables IV and V). The confidence intervals are wide, reflecting the limited number of patients. Through stratified analysis to investigate the association between site of infection and mortality from haematological and solid tumours. We found that gastrointestinal infection had a higher mortality rate.

Discussion

Although infection is the most common cause of in-hospital mortality in patients with cancer (11), to the best of our knowledge, there are no previous studies examining the influence of infection sites on patients with cancer.

In the present single cohort study of patients with cancer admitted to the ED due to sepsis or septic shock, it was found that the site of infection was associated with in-hospital mortality when the urinary tract infection group was used

Table I. Baseline characteristics of patients with cancer.

Variable	Infection site					P-value
	Urine tract (n=47.00)	Unknown (n=24.00)	Gastrointestinal (n=23.00)	Lung (n=66.00)	Other (n=16.00)	
Age, years, n (%)						0.374
20-50	3.00 (6.38)	6.00 (25.00)	2.00 (8.70)	10.00 (15.15)	2.00 (12.50)	
51-70	19.00 (40.43)	9.00 (37.50)	12.00 (52.17)	32.00 (48.48)	9.00 (56.25)	
>70	25.00 (53.19)	9.00 (37.50)	9.00 (39.13)	24.00 (36.36)	5.00 (31.25)	
Male, n (%)	34.00 (72.34)	9.00 (37.50)	17.00 (73.91)	43.00 (65.15)	9.00 (56.25)	0.039
Hypertension, n (%)	30.00 (63.83)	8.00 (33.33)	16.00 (69.57)	34.00 (51.52)	6.00 (37.50)	0.039
Congestive heart failure ejection fraction <40%, n (%)	8.00 (17.02)	1.00 (4.17)	2.00 (8.17)	13.00 (19.70)	1.00 (6.25)	0.255
Tumour type, n (%)						0.626
Haematological malignancy, n (%)	7.00 (14.89)	6.00 (25.00)	3.00 (13.04)	16.00 (24.24)	3.00 (18.75)	
Solid tumour, n (%)	40.00 (85.11)	18.00 (75.00)	20.00 (86.96)	50.00 (75.76)	13.00 (81.25)	
White blood cell ($1x10^9$/l), n (%)						0.682
>10	27.00 (57.45)	11.00 (45.83)	12.00 (52.17)	35.00 (53.03)	6.00 (37.50)	
≤10	20.00 (42.55)	13.00 (54.17)	11.00 (47.83)	31.00 (46.97)	10.00 (62.50)	
Haemoglobin (g/l), n (%)						0.600
>100	22.00 (46.81)	10.00 (41.67)	13.00 (56.52)	32.00 (48.48)	5.00 (31.25)	
≤100	25.00 (53.19)	14.00 (58.33)	10.00 (43.48)	34.00 (51.52)	11.00 (68.75)	
Diagnosis, n (%)						0.193
Septic shock	23.00 (48.94)	15.00 (62.50)	17.00 (73.91)	45.00 (68.18)	9.00 (56.25)	
Sepsis	24.00 (51.06)	9.00 (37.50)	6.00 (26.09)	21.00 (31.82)	7.00 (43.75)	
Bacteraemia, n (%)	18.00 (38.30)	13.00 (54.17)	7.00 (30.43)	18.00 (27.27)	10.00 (62.50)	0.032
Chemotherapy, n (%)	42.00 (89.36)	18.00 (75.00)	14.00 (60.87)	58.00 (87.88)	15.00 (93.75)	0.011
Radiation therapy, n (%)	13.00 (27.66)	8.00 (33.33)	3.00 (13.04)	31.00 (46.97)	7.00 (43.75)	0.030
Surgery, n (%)	26.00 (55.32)	11.00 (45.83)	9.00 (39.13)	22.00 (33.33)	10.00 (62.50)	0.093
Time to antibiotics, h, n (%)						0.832
0-1	17.00 (36.17)	9.00 (37.50)	11.00 (50.00)	25.00 (37.88)	7.00 (43.75)	
>1	30.00 (63.83)	15.00 (62.50)	11.00 (50.00)	41.00 (62.12)	9.00 (56.25)	
Steroids, n (%)	13.00 (27.66)	9.00 (37.50)	5.00 (21.74)	27.00 (40.91)	3.00 (18.75)	0.239
Hospital days, median (IQR)	7.71 (4.44-10.29)	11.64 (5.10-20.99)	5.92 (3.50-16.29)	11.57 (5.05-22.91)	10.12 (6.30-16.14)	0.126
In-hospital mortality, n (%)	15.00 (31.91)	14.00 (58.33)	18.00 (78.26)	41.00 (62.12)	7.00 (43.75)	0.002

as a reference group. The present data showed that the lung, urinary system, gastrointestinal tract, and unknown site are common sites of infection, which is consistent with previous studies (3,12).

The highest mortality was associated with gastrointestinal infection. Chemotherapy and radiation therapy have been widely used in patients with cancer in recent years, as well as repeated antibiotics to prevent infections (13). The treatment of cancer and antibiotics may promote intestinal mucosal destruction, placing patients at a significantly higher risk of developing refractory enteritides, such as clostridium difficile-associated colitis and neutropenic enterocolitis (14). The treatment of gastrointestinal infection is becoming clinically challenging due to long-term chemotherapy and depressed immune systems (15). Despite improvements in management of pneumonia, this remains a common cause of morbidity and mortality in patients with cancer (16).

Unknown site infections may lead to poor outcomes due to the inability to obtain culture samples of unknown site infections in a short time and the inability to select appropriate treatment regimens based on pathogenetic and drug distribution characteristics. Unknown site infection is associated with fatal outcomes in patients without cancer (8). However, infection of unknown site was not considered statistically significant in the present study after adjusting for comorbidities and severity markers. Given the small sample size of the present study, the association between infection of the unknown site and in-hospital mortality needs to be confirmed in other studies.

The association between infection site and mortality may differ due to differences in underlying immune mechanisms

Table II. Univariate analysis of prognostic factors in the derivation cohort.

Variable	Total number of patients (%)	In-hospital mortality HR (95% CI)	28 day mortality HR (95% CI)	60 day mortality HR (95% CI)
Age, years				
20-50	23.00 (13.07)	1.00	1.00	1.00
51-70	81.00 (46.02)	0.73 (0.41-1.30)	0.74 (0.41-1.35)	0.80 (0.45-1.41)
>70	72.00 (40.91)	0.75 (0.42-1.34)	0.71 (0.39-1.30)	0.79 (0.44-1.40)
Sex				
Female	64.00 (36.36)	1.00	1.00	1.00
Male	112.00 (63.64)	1.00 (0.66-1.52)	0.97 (0.63-1.50)	0.97 (0.65-1.45)
Hypertension				
No	82.00 (46.59)	1.00	1.00	1.00
Yes	94.00 (53.41)	1.09 (0.73-1.63)	1.09 (0.71-1.65)	1.08 (0.73-1.60)
Congestive heart failure ejection fraction <40%				
No	151.00 (85.80)	1.00	1.00	1.00
Yes	25.00 (14.20)	0.77 (0.41-1.44)	0.67 (0.34-1.34)	0.87 (0.48-1.55)
Tumour type				
Solid tumour	141.00 (80.11)	1.00	1.00	1.00
Haematological malignancy	35.00 (19.89)	0.86 (0.51-1.43)	0.98 (0.58-1.64)	0.79 (0.48-1.32)
White blood cell ($1x10^9$/l), n (%)				
>10	91.00 (51.70)	1.00	1.00	1.00
≤10	85.00 (48.30)	0.83 (0.55-1.24)	0.88 (0.58-1.34)	0.87 (0.59-1.29)
Haemoglobin categorical, g/l				
>100	82.00 (46.59)	1.00	1.00	1.00
≤100	94.00 (53.41)	0.97 (0.65-1.46)	0.99 (0.65-1.51)	1.01 (0.68-1.49)
Diagnosis				
Septic shock	109.00 (61.93)	1.00	1.00	1.00
Sepsis	67.00 (38.07)	0.26 (0.16-0.43)	0.27 (0.16-0.45)	0.31 (0.19-0.49)
Bacteraemia				
No	110.00 (62.50)	1.00	1.00	1.00
Yes	66.00 (37.50)	0.88 (0.57-1.36)	0.95 (0.61-1.47)	0.92 (0.61-1.39)
Chemotherapy				
No	29.00 (16.48)	1.00	1.00	1.00
Yes	147.00 (83.52)	0.52 (0.32-0.85)	0.51 (0.31-0.85)	0.56 (0.35-0.91)
Radiation therapy				
No	114.00 (64.77)	1.00	1.00	1.00
Yes	62.00 (35.23)	0.92 (0.60-1.42)	0.85 (0.54 -1.34)	1.01 (0.67-1.53)
Surgery				
No	98.00 (55.68)	1.00	1.00	1.00
Yes	78.00 (44.32)	0.97 (0.65-1.46)	1.02 (0.67 -1.56)	1.07 (0.72-1.58)
Time to antibiotics, h				
>1	106.00 (60.57)	1.00	1.00	1.00
0-1	69.00 (39.43)	0.71 (0.46-1.09)	0.67 (0.43-1.05)	0.70 (0.47-1.07)
Steroids				
No	119.00 (67.61)	1.00	1.00	1.00
Yes	57.00 (32.39)	1.19 (0.78-1.83)	1.21 (0.78-1.88)	1.25 (0.83-1.88)

HR, hazard ratio.

between detailed cancer types and cancer sites (2). It has been reported that the risk of death associated with sepsis varies by tumour location and treatment (17). Through stratified analysis, the present study found that the infection site had a

Table III. Cox regression model for mortality.

Variable	Not adjusted HR (95% CI)	P-value	Model I[a] HR (95% CI)	P-value	Model II[b] HR (95% CI)	P-value
In-hospital mortality						
Urinary tract	1.00		1.00		1.00	
Unknown	1.93 (0.93-3.99)	0.078	1.88 (0.91-3.91)	0.089	1.91 (0.88-4.16)	0.103
Gastrointestinal	3.45 (1.74-6.68)	<0.001	2.78 (1.38-5.60)	0.004	2.64 (1.25-5.55)	0.011
Lung	2.19 (1.21-3.96)	0.009	1.91 (1.06-3.46)	0.032	1.95 (1.03-3.68)	0.039
Other	1.30 (0.53-3.19)	0.566	1.35 (0.55-3.31)	0.519	1.31 (0.51-3.37)	0.577
28 day mortality						
Urinary tract	1.00		1.00		1.00	
Unknown site	1.59 (0.77-3.31)	0.212	1.53 (0.74-3.19)	0.255	1.43 (0.65-3.12)	0.376
Gastrointestinal	2.87 (1.45-5.68)	0.003	2.29 (1.14-4.60)	0.020	2.10 (1.00-4.44)	0.051
Lung	1.75 (0.97-3.16)	0.062	1.52 (0.84-2.74)	0.165	1.55 (0.82-2.94)	0.175
Other	1.02 (0.40-2.60)	0.971	1.02 (0.40-2.63)	0.962	0.92 (0.34-2.46)	0.870
60 day mortality						
Urinary tract	1.00		1.00		1.00	
Unknown site	1.52 (0.76-3.03)	0.237	1.49 (0.75-2.98)	0.256	1.47 (0.70-3.09)	0.307
Gastrointestinal	2.74 (1.43-5.23)	0.002	2.26 (1.17-4.38)	0.016	2.22 (1.10-4.48)	0.026
Lung	1.78 (1.03-3.05)	0.038	1.56 (0.91-2.69)	0.108	1.58 (0.88-2.84)	0.124
Other	1.17 (0.51-2.68)	0.708	1.20 (0.52-2.76)	0.664	1.09 (0.45-2.62)	0.847

[a]Adjusted for diagnosis and chemotherapy. [b]Adjusted for age (20-50, 51-70 and >70 years), sex, diagnosis, congestive heart failure ejection fraction <40%, hypertension, tumour type, bacteraemia, chemotherapy, radiation, surgery, white blood cell, haemoglobin and time to antibiotics. HR, hazards ratio.

Table IV. Cox regression models for mortality in 141 patients with solid tumours.

Variable	Not adjusted HR (95% CI)	P-value	Model I[a] HR (95% CI)	P-value	Model II[b] HR (95% CI)	P-value
In-hospital mortality						
Urinary tract	1.0		1.0		1.0	
Unknown	2.21 (0.99-4.95)	0.053	2.25 (1.00-5.05)	0.049	2.33 (0.97-5.63)	0.060
Gastrointestinal	2.93 (1.39-6.16)	0.005	2.22 (1.04-4.75)	0.039	2.36 (1.05-5.31)	0.039
Lung	2.32 (1.22-4.42)	0.010	2.07 (1.08-3.95)	0.028	2.19 (1.10-4.35)	0.026
Other	1.05 (0.37-2.94)	0.929	1.14 (0.40-3.22)	0.807	1.14 (0.37-3.50)	0.816
28 day mortality						
Urinary tract	1.0		1.0		1.0	
Unknown	1.75 (0.78-3.93)	0.179	1.74 (0.77-3.93)	0.181	1.65 (0.68-4.01)	0.269
Gastrointestinal	2.37 (1.13-4.97)	0.023	1.81 (0.85-3.85)	0.124	1.70 (0.75-3.85)	0.201
Lung	1.76 (0.93-3.34)	0.085	1.56 (0.82-2.99)	0.176	1.65 (0.83-3.31)	0.156
Other	0.76 (0.25-2.31)	0.626	0.80 (0.26-2.44)	0.689	0.69 (0.21-2.27)	0.539
60 day mortality						
Urinary tract	1.0		1.0		1.0	
Unknown	1.69 (0.79-3.62)	0.175	1.72 (0.80-3.69)	0.161	1.71 (0.74-3.95)	0.207
Gastrointestinal	2.24 (1.12-4.49)	0.023	1.77 (0.87-3.60)	0.115	1.95 (0.92-4.17)	0.084
Lung	1.83 (1.02-3.28)	0.042	1.64 (0.91-2.95)	0.099	1.72 (0.92-3.21)	0.092
Other	0.96 (0.38-2.43)	0.925	1.02 (0.40-2.61)	0.966	0.95 (0.34-2.63)	0.920

[a]Adjusted for diagnosis and chemotherapy. [b]Adjusted for age (20-50, 51-70 and >70 years), sex, diagnosis, congestive heart failure ejection fraction <40%, hypertension, bacteraemia, chemotherapy, radiation, surgery, white blood cell, haemoglobin and time to antibiotics. HR, hazard ratio.

Table V. Cox regression models for mortality in 35 patients with haematological tumours.

Variable	Not adjusted HR (95% CI)	P-value	Model I[a] HR (95% CI)	P-value	Model II[b] HR (95% CI)	P-value
In-hospital mortality						
Urinary tract	1.0		1.0		1.0	
Unknown site	1.45 (0.24-8.71)	0.683	1.68 (0.28-10.20)	0.571	76.67 (1.84-3202.38)	0.022
Gastrointestinal	13.99 (2.04-95.89)	0.007	30.51 (3.71-251.17)	0.002	179.91 (5.69-5693.31)	0.003
Lung	2.05 (0.43-9.67)	0.366	2.59 (0.54-12.43)	0.234	16.96 (0.86-334.76)	0.062
Other	3.16 (0.44-22.66)	0.253	4.95 (0.66-37.40)	0.121	66.81 (1.10-4062.06)	0.045
28 day mortality						
Urinary tract	1.0		1.0		1.0	
Unknown site	1.45 (0.24-8.71)	0.683	1.68 (0.28-10.20)	0.571	76.67 (1.84-3202.38)	0.023
Gastrointestinal	13.99 (2.04-95.89)	0.007	30.51 (3.71-251.17)	0.002	179.91 (5.69-5683.31)	0.003
Lung	2.05 (0.43-9.67)	0.366	2.59 (0.54-12.43)	0.234	16.96 (0.86-334.76)	0.063
Other	3.16 (0.44-22.66)	0.253	4.95 (0.66-37.40)	0.121	66.81 (1.10-4062.06)	0.045
60 day mortality						
Urinary tract	1.0		1.0		1.0	
Unknown site	1.45 (0.24-8.71)	0.683	1.68 (0.28-10.20)	0.571	76.67 (1.84-3202.38)	0.023
Gastrointestinal	13.99 (2.04-95.89)	0.007	30.51 (3.71-251.17)	0.002	179.91 (5.69-5693.31)	0.003
Lung	2.05 (0.43-9.67)	0.366	2.59 (0.54-12.43)	0.234	16.96 (0.86-334.76)	0.063
Other	3.16 (0.44-22.66)	0.253	4.95 (0.66-37.40)	0.121	66.81 (1.10-4062.06)	0.045

[a]Adjusted for diagnosis and chemotherapy. [b]Adjusted for age (20-50, 51-70, >70), sex, diagnosis, congestive heart failure ejection fraction <40%, hypertension, bacteraemia, chemotherapy, radiation, surgery, white blood cell, haemoglobin and time to antibiotics. HR, hazard ratio.

consistent effect on the mortality of patients with solid and haematological tumours. However, due to the limitation of the sample size, it is not possible to analyse the effect of the infection site on the mortality of solid tumours such as lung cancer or other types of tumour. Therefore, the association between infection sites and mortality in different types of cancer needs further study.

The present study has certain limitations. First, the site of infection may be misclassified because there may be not enough time in a busy ED to estimate the exact site of infection. Second, this was a single-centre retrospective study to evaluate the association between the site of infection and mortality in patients with solid or haematological tumours admitted to the ED with sepsis or septic shock. Thus, the findings may not be generalizable to the general population. Third, the patient stage of disease may be a factor in mortality. However, the present study was a secondary analysis and cannot further assess the stage of patients with cancer. Therefore, in-hospital mortality may be overestimated because the population analysed in the current study included patients diagnosed with terminal cancer (9).

In conclusion, the site of infection was associated with in-hospital mortality in patients with cancer diagnosed with sepsis or septic shock.

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Availability of data and materials

The datasets generated and/or analysed during the current study are available in the Dryad Digital Repository database (doi.org/10.5061/dryad.6qk05).

Authors' contributions

YC, JH, JX, RQ and TL made substantial contributions to conception and design, acquisition of data and analysis and interpretation of data. YC and TL were involved in drafting the manuscript and revising it critically for important intellectual content. TL gave final approval of the version to be published. All authors have participated sufficiently in the work to take responsibility for appropriate portions of the content. YC and TL agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. YC was responsible for the drafting of the manuscript. YC and JH confirm the authenticity of all the raw data. YC, JH, JX and RQ conceived and designed the study. YC and TL performed the literature research. YC, JH and RQ performed the data analysis. YC and TL edited the manuscript. TL reviewed the manuscript. All authors have read and approved the final manuscript.

Ethics approval and consent to participate

The requirement for ethics approval and informed consent was waived as the data were anonymized.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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