Epidemiology and outcomes of bloodstream infections in patients discharged from the emergency department

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ABSTRACT

Objective: To determine the outcomes of patients discharged from the emergency department (ED) with a bloodstream infection (BSI) and how these outcomes are influenced by antibiotic treatment.

Methods: We identified every BSI in adult patients discharged from our ED to the community between July 1, 2002, and March 31, 2011. The medical records of all cases were reviewed to determine antibiotic treatment in the ED and at discharge. Microorganism sensitivities were used to determine whether antibiotics were appropriate. These data were linked to population-based administrative data to determine specific patient outcomes within the subsequent 2-week period: death, urgent hospitalization, or an unplanned return to the ED.

Results: A total of 480 adults with BSI were identified (1.49 cases per 1,000 adults discharged from the department). Compared to controls (321,048 patients), BSI patients had a significantly higher risk of urgent hospitalization (adjusted OR 2.1 [95% CI 1.6–2.8]) and unplanned return to the ED (adjusted OR 4.1 [95% CI 3.3–4.9]). Outcome risk was significantly lowered in BSI patients who received appropriate antibiotics in the ED and at discharge. In elderly patients, the risk of urgent hospitalization increased significantly as the time to appropriate antibiotics was delayed.

Conclusions: BSI patients discharged from the ED have a significantly increased risk of urgent hospitalization and unplanned return to the ED in the subsequent 2 weeks. These risks decrease significantly with the timely provision of appropriate antibiotics. Our results support the aggressive use of measures ensuring that such patients receive appropriate antibiotics as soon as possible.

RÉSUMÉ

Objectif: L'étude visait à déterminer les résultats cliniques chez des patients souffrant d'une infection hématogène (IH) et renvoyés du service des urgences (SU) et la façon dont le traitement antibiotique influait sur ces résultats.

Méthode: Nous avons procédé à la recherche de tous les cas d'IH observés chez des adultes qui avaient été renvoyés du SU dans la collectivité, entre le 1er juillet 2002 et le 31 mars 2011. Les dossiers médicaux de tous les patients ont été revus afin que soit déterminé le traitement antibiotique prescrit au SU et au moment du congé. La pertinence des antibiotiques prescrits a été établie en fonction de la sensibilité des micro-organismes. Les données recueillies ont été liées à des données administratives fondées sur la population pour permettre de dégager certains résultats cliniques au cours des 2 semaines suivantes: la mort, une hospitalisation urgente, ou un retour imprévu au SU.

Résultats: Au total, 480 adultes souffrant d'une IH ont ainsi été trouvés (1.49 cas pour 1,000 adultes renvoyés du service). Les patients atteints d'une IH avaient un risque significativement plus élevé d'hospitalisation urgente (risque relatif approché [RRA] rajusté: 2.1 [IC à 95%: 1.6–2.8]) et de retour imprévu au SU (RRA rajusté: 4.1 [IC à 95%: 3.3–4.9]) que les témoins (321,048 patients). Toutefois, les risques liés aux résultats étaient significativement diminués chez les patients atteints d'une IH qui avaient reçu un traitement antibiotique approprié au SU et au moment du congé. Chez les personnes âgées, le risque d'hospitalisation urgente augmentait sensiblement à mesure qu'était retardée la mise en route d'un traitement antibiotique approprié.

Conclusions: Les patients atteints d'une IH et renvoyés à domicile depuis le SU connaissent un risque significativement accru d'hospitalisation urgente et de retour imprévu au SU au cours des 2 semaines suivantes. Toutefois, l'administration rapide d'antibiotiques appropriés permet de diminuer sensiblement ce risque. Les résultats confirment la pertinence de mesures énergiques visant l'administration la plus rapide possible d'antibiotiques appropriés chez ces patients.

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Many acutely ill patients seen in emergency departments (EDs) require extensive laboratory investigations. Some of these patients will be discharged prior to the results of some tests being available. Blood cultures are a prime example, with either negative and positive results having both clinical and administrative implications. Results should be reviewed by clinicians, with true positive results being communicated to patients so that proper treatment and follow-up can be initiated. This task can be administratively and logistically burdensome for health care staff, requiring the review of patient records to ensure the validity of the result; the determination of whether adequate antibiotic therapy had been administered or prescribed; and contact attempts to patients to assess their clinical status and ensure proper treatment.

In a review of the literature, we identified seven studies of adult patients discharged from the ED found subsequently to have bloodstream infections (BSIs).[1–7] These studies have included between 5[4] and 247[5] patients discharged from single centres. Patients were typically followed until they were reassessed at the index department. These studies restricted their follow-up to encounters at the index ED. With the exception of Terradas and colleagues' study,[5] hard outcomes (including death, urgent admission to hospital, and unplanned return to ED) were not reported. In particular, the risk of these outcomes relative to other patients discharged from the ED and the impact of antibiotic treatment on such outcomes have not been studied. We examined the outcomes of ED BSIs (including death, urgent admission, and unplanned return to the ED) relative to other patients and examined the influence of antibiotic therapy on these outcomes.

METHODS

Study sites and sample

This was a cohort study that took place at a tertiary care teaching facility with two emergency sites that recorded between 30,000 and 40,000 adult visits annually during the study period.

We used data from our hospital's data warehouse to identify all cases for our study (adults discharged to the community with a subsequently identified BSI). Our data warehouse records basic demographic, laboratory, and pharmacologic data on all patients who attended the hospital for any in-patient, emergency, or outpatient service. Data are complete for both hospital sites from June 2002 onward. We linked to population-based administrative data to identify all control patients (i.e., all adults discharged from our ED, excluding BSI cases). These population-based data were also used to capture all outcomes and post-discharge antibiotic exposure for those exceeding 65 years of age. Our hospital's research ethics board approved the study.

Identification of all significant BSIs discharged from the ED

We identified all blood cultures collected between July 1, 2002, and March 31, 2011, in which one or more microorganisms were grown. Using the sample collection data, we linked to other hospital data sets to determine if the patient was in the hospital's ED when the blood culture was collected. Our cases included all patients discharged to the community after an ED assessment whose blood culture subsequently grew relevant microorganisms.

We excluded patients whose blood cultures grew probable contaminants (including specimens growing coagulase-negative *Staphylococcus*, *Corynebacterium* species, *Micrococcus* species, *Bacillus* species, *Propionibacterium* species, and viridans group streptococci[8]). We also excluded patients who did not have a valid health care number (making it impossible to link them to population-based data sets); who died during their index encounter; whose medical record was unavailable for review; who were palliative based on information in the medical record; and who were transferred from the ED to another hospital. Lastly, we excluded all but the initial ED visit in patients with multiple BSI ED encounters.

Blood culture methods and notification protocols

Blood cultures involved one or two blood specimens (obtained by separate venipunctures) with each containing 10 to 15 mL of blood. Our laboratory uses the BacTAlert system (bioMérieux Canada Inc, Saint-Laurent, QC). Cultures were held for 5 days with isolates identified using various methods depending on Gram stain results. Antimicrobial susceptibility is primarily tested using the bioMérieux Vitek card system.

The results of positive blood cultures in patients who had been discharged from the ED were telephoned to the nursing care facilitator of the ED. During regular business hours, cases were forwarded to the quality assurance coordinator, who immediately reviewed the case with the quality assurance physician to determine the result's significance and whether appropriate treatment had been initiated. Patients were contacted and informed of the result, and treatment was determined. During off-hours, these tasks were completed by the care facilitator and one of the physicians present.

Primary data collection for BSI patients

We (J.C., C.v.W.) manually reviewed the medical record of all patients discharged with a BSI to abstract the following information: patient comorbidities, clinical discharge diagnosis documented by treating ED physician, antibiotics provided during the ED stay (with route), and whether the patient was discharged home with an antibiotic prescription (along with type, dose, and duration). We also noted whether staff documented the presence of the BSI (after the patient had been discharged from the ED) and whether they had successfully contacted the patient or family members about the infection.

Linkage to population-based health care data sets and selection of control patients

The study data set was linked anonymously (via encrypted health care number) to population-based administrative databases. We linked to the National Ambulatory Care Reporting System (NACRS) to identify the ED encounters of all BSI cases. Also from the NACRS, we identified all other people (i.e., those without BSI) during the study period who were discharged from our ED to the community after an unscheduled visit. From this group of encounters, we randomly selected one per person to create a control group.

For BSI and control group encounters, we retrieved the following information from the NACRS: patient age and sex, whether the patient arrived by ambulance, and acuity of the visit (classified using the Canadian Triage and Acuity Scale [CTAS] score[9]).

In Ontario, all medications for patients older than 65 years are captured in the Ontario Drug Database (ODD). We linked to the ODD for BSI patients older than 65 years to determine if they were dispensed antibiotics within the first week of their ED visit. We also determined the number of days following the index ED visit that seniors were dispensed an antibiotic effective against the cultured microorganism based on sensitivity testing.

Study outcomes

We linked to population-based data sets to capture study outcomes on all BSI and control patients. We linked to the Registered Patients Database (RPDB) to determine if and when patients died (RPDB captures all births and deaths in Ontario). All deaths were included in the analysis regardless of stated cause. We linked to the Discharge Abstract Database (DAD) to determine if and when patients were urgently admitted to hospital (the DAD records demographic, diagnostic, and procedural information about all Ontario hospitalizations; all admissions to hospital are coded as elective or urgent). Finally, we linked to the NACRS to determine if and when patients returned to any ED for unplanned visits. All ED visits in the NACRS are coded as planned or unplanned.

Analysis

Antibiotic appropriateness during the ED visit and at discharge was determined by comparing antibiotics to microorganism sensitivities. All isolates underwent sensitivity testing in the microbiological laboratory. These results were compared to antibiotics provided in the ED, at discharge, and in the community. Antibiotic treatment in the ED was categorized into one of four mutually exclusive groups based on whether appropriate antibiotics were given during the ED visit and prescribed at discharge. These four groups were determined by if and when appropriate antibiotics were given: 1) in the hospital and at discharge; 2) in the hospital only; 3) at discharge only; or 4) neither in the hospital nor at discharge.

We determined the association between antibiotic treatment category and patient outcomes using three multivariate binomial logistic regression models (one for each 2-week outcome of all-cause death, all-cause urgent admission to hospital, and unplanned return to the ED). Models included antibiotic treatment category, patient age and sex, whether or not the BSI was polymicrobial, index ED triage level, and whether the patient was brought to the ED by ambulance. As a sensitivity analysis, we repeated the analysis as a survival model with a 2-month (instead of 2-week) time horizon.

We explored the influence of appropriate antibiotic timeliness in a subanalysis limited to patients older than 65 (people whose medications are captured in the ODD). The ODD was used to determine the time to appropriate antibiotics, which was entered as a log-transformed time-dependent covariate into separate survival models, each having time to death, time to urgent hospitalization, and time to unplanned ED visit as the outcomes. We censored observation in each model at 2 months and controlled for factors that were independently associated ($p < 0.2$) with time to appropriate antibiotics. In the death model, we accounted for the fact that the ODD does not capture drugs provided during hospitalization by assuming that patients admitted to hospital received appropriate antibiotics at the time of their admission (if appropriate antibiotics had not been previously dispensed). All analyses used *SAS* 9.3 (SAS Institute, Cary, NC).

RESULTS

During the study period, 576 clinically significant BSIs in adult patients were discharged from the ED. Ninety-six (16.7%) cases were excluded from the analysis: 38 (6.6%) did not have valid Ontario health card numbers and were "unlinkable" to the administrative data sets; 8 (1.4%) died during their index encounter; 21 (3.6%) had no medical record available for review or were palliative; 8 (1.4%) were discharged to another hospital; and 21 (3.5%) were already included in the study for a previously identified BSI.

This left 480 patients, a rate of more than one nonpalliative clinically significant BSI patient discharged from our ED every week. During the same time period, 321,528 adults were discharged to the community from our hospital's ED following an unplanned visit at least once. This translates to an incidence rate of 1.49 significant BSIs (95% CI 1.36–1.63) per 1,000 adults discharged from our ED. Neither blood culture use rate nor the BSI incidence rate changed notably during the study period.

BSI patients were elderly, with 242 (50.4%) age 65 years and above (Table 1). The most common comorbidities included hypertension, coronary artery disease, and diabetes. A dozen patients (2.4%) had a history of intravenous drug use, and 27 patients (5.6%) were immunocompromised for assorted reasons, the most common reason being the use of immunosuppressive drugs (13), neutropenia (5), and human immunodeficiency virus (HIV) disease (4). Persistent body breaches were notable, with 30 patients (6.2%) having a vascular access instrument and 21 patients (4.4%) having a permanent bladder catheter.

During the same time period, 321,048 adults without an identified BSI were discharged to the community from an unscheduled ED visit at our hospital. These control patients had the same sex distribution but were significantly younger (mean age [SD] 45.7 [19.7] years), less likely to arrive by ambulance (18.9% v. 44.0%), and less likely to be triaged with an emergent or urgent condition (16.7% and 55.4%, respectively) compared to patients with a BSI (25.2% and 67.1%, respectively).

Microbiology and treatment of ED BSIs

Table 2 presents the microbiology, treatment, and processes of care for patients with ED BSIs. More than 95% of BSIs had a solitary organism (464, 96.5%), and only four included fungal organisms. A total of 339 patients (70.4%) received antibiotics in the ED, but less than two-thirds (294, 61.3%) of patients received antibiotics to which the microorganism was sensitive. A total of 370 patients (77.1%) were prescribed antibiotics when discharged from the ED, with just over half of patients (293, 60.9%) being prescribed antibiotics that covered the microorganism. Just over half of patients (262, 54.6%) received appropriate antibiotics both in the ED and when discharged.

BSIs were noted in the chart by ED staff almost 90% of the time (424, 88.3%). Patients, family members, or patient representatives were successfully notified about the BSI in 365 cases (76.0%). In 19 cases where patients were not contacted, the reviewing physician had determined that the patient was discharged on an antibiotic that was effective against the BSI microorganism. In several cases, follow-up had already been arranged with another service or the patient had returned spontaneously to the ED.

A total of 242 BSI patients (50.3%) were older than 65, and 187 (77.3%) of these people were dispensed at least one antibiotic within a week of the ED visit, with 164 of 187 patients (87.7%) receiving an appropriate antibiotic (given the isolated microorganism's sensitivities). There was a highly significant agreement

Table 1. Description of 480 adults with bloodstream infection discharged from the ED to the community

Factor	Value	*n* (average)	% (SD)
Age		(62)	(20.6)
Female		254	52.9
Came in by ambulance		208	41.9
Triage status	Resuscitation	1	0.2
	Emergent	120	25.1
	Urgent	321	67.2
	Less than urgent	36	7.5
Chronic medical conditions	Cerebrovascular disease	42	8.7
	Dementia	42	8.7
	Congestive heart failure	24	5.0
	Hypertension	150	31.2
	Atrial fibrillation	47	9.8
	Valvular heart disease	14	2.9
	Coronary artery disease	72	15.0
	Dyslipidemia	55	11.5
	Hypothyroidism	29	6.0
	COPD/asthma	34	7.0
	Diabetes mellitus	76	15.8
	Cirrhosis	4	0.8
	Chronic kidney disease	29	6.0
	Hemodialysis	12	2.5
	Intravenous drug user	12	2.5
	Immunocompromised	27	5.6
Vascular access present		30	6.2
Indwelling bladder catheter		21	4.4
Discharge diagnosis	UTI	200	41.7
	Pneumonia	64	13.3
	Fever NYD/viral	61	12.7
	Soft tissue infection	28	5.3
	Gastroenteritis	9	1.9
	Other	118	24.6
Discharge disposition	Community	421	87.7
	Supervised setting*	59	12.3

COPD = chronic obstructive pulmonary disease; ED = emergency department; NYD = not yet diagnosed; UTI = urinary tract infection.
*Includes nursing homes and retirement residences.

between antibiotics being prescribed at discharge from the ED and antibiotics being dispensed within the first week following discharge from the ED ($\chi^2 = 10.4$, $p = 0.0013$; Table 3).

Postdischarge outcomes of patients with BSI

Of all patients discharged from the ED, 1,138 people (0.35%) died within 2 weeks (Table 4). This risk of death did not differ between the two groups: BSI (0.83% of 480) versus control (0.35% of 321,045) ($p = 0.093$). After adjusting for age and sex, polymicrobial status, triage level, and ambulance status, patients with a BSI did not have a significantly higher 2-week risk of death (adjusted OR 0.72 [95% CI 0.27–1.95]). The lack of an association between BSI and the risk of 2-week death did not change when the antibiotic treatment category was considered (see Table 4). However, patients with a BSI were significantly more likely to die within 2 months of their ED visit (adjusted HR 1.85, 95% CI 1.2–2.9). This significantly increased risk was absent in patients who received appropriate antibiotics at discharge from hospital (regardless of hospital antibiotic status). Increased death risk persisted in the other antibiotic treatment categories (Appendix A).

Urgent admission to hospital within 2 weeks occurred in 11,209 people (3.5%) (see Table 4), with the risk being significantly higher in patients with BSI

Table 2. Microbiology, treatment, and processes of care for 480 adults with bloodstream infections discharged from the ED to the community

Factor	Value	n	%
Microbiology			
Polymicrobial microorganisms (n = 506)		16	3.3
	Escherichia coli	224	44.3
	Staphylococcus aureus	40	7.9
	Streptococcus pneumoniae	37	7.3
	Klebsiella pneumoniae	37	7.3
	Eneterococus faecalis	14	2.8
	Group B *Streptococcus*	13	2.6
	Pseudomonas aeruginosa	12	2.4
	Other	119	23.5
Antimicrobial treatment in ED			
None given		141	29.4
Any given	Any route	339	70.6
	Intravenous	231	48.1
	Oral	108	22.5
Microorganism(s) susceptible to antibiotic(s) given in ED		294	61.3
Antimicrobial prescribed at discharge			
None given		110	22.9
Any given	Any route	370	77.1
	Intravenous	18	4.7
	Oral	351	92.4
	Intramuscular	1	0.2
Microorganism(s) susceptible to antibiotic(s) prescribed at discharge		293	60.9
Antimicrobial treatment category			
Appropriate antibiotics given in ED and prescribed at discharge		262	54.6
Appropriate antibiotics given in ED alone		32	6.7
Appropriate antibiotics prescribed at discharge alone		38	7.9
Appropriate antibiotics neither given in ED nor prescribed at discharge		148	30.8
Processes of care			
Bloodstream infection noted in ED chart		424	88.3
Patient (or representative) successfully contacted		365	76.0

ED = emergency department.

(12.1%) than in patients without (3.5%, $\chi^2 = 105.6$, $p < 0.0001$). After adjusting for other covariates, hospital admission was significantly more common in patients with a BSI (adjusted OR 2.1 [95% CI 1.6–2.8]). This risk varied significantly by antibiotic treatment category, with patients receiving appropriate antibiotics at discharge having an adjusted risk that was not significantly distinct from that of control patients (see Table 4). In contrast, patients who did not receive appropriate antibiotics at discharge were significantly more likely to be admitted urgently to hospital in the subsequent 2 weeks. Result patterns were similar when

Table 3. Agreement between antibiotic prescription and dispensation in elderly patients with bloodstream infection

	Antibiotics dispensed within 1 wk of ED visit, n (%)		
	Yes	No	Total
Antibiotics prescribed at discharge			
Yes	159 (65.7)	36 (14.9)	195 (80.6)
No	28 (11.6)	19 (7.8)	47 (19.4)
Total	187 (77.3)	55 (22.7)	242

Table 4. Risk of 2-week death, urgent admission to hospital, or unplanned return to ED in ED bloodstream infections by antibiotic treatment

Factor	Level	Outcome (% of patient group with outcome)	Adjusted odds ratio	95% CI	*p* value
Death					
No bloodstream infection		1,134 (0.35)	—	—	—
Bloodstream infection present and appropriate antibiotics given:	Hospital and discharge	0 (0)	U	U	0.9417
	Hospital only	0 (0)	U	U	0.9786
	Discharge only	1 (2.6)	3.15	(0.41–24.1)	0.2694
	None	3 (2.0)	2.06	(0.64–6.71)	0.2277
Polymicrobial bloodstream infection		0 (0)	U	U	0.9797
Patient age increased by 10 yr		—	1.07	(1.06–1.07)	< .0001
Female sex		598 (0.36)	0.75	(0.67–0.85)	< .0001
Triage level	Resuscitation	33 (3.8)	—	—	—
	Emergent	312 (0.58)	0.29	(0.20–0.42)	< .0001
	Urgent	705 (0.40)	0.23	(0.16–0.34)	< .0001
	Other	88 (0.10)	0.11	(0.08–0.17)	< .0001
Arrived at ED by ambulance		756 (1.24)	3.18	(2.78–3.63)	< .0001
Urgent admission to hospital					
No bloodstream infection		11 151 (3.5)	—	—	—
Bloodstream infection present and appropriate antibiotics given:	Hospital and discharge	13 (5.0)	0.75†‡	(0.43–1.32)	0.3167
	Hospital only	6 (18.8)	3.57	(1.43–8.92)	0.0065
	Discharge only	4 (10.5)	1.86	(0.65–5.32)	0.2467
	None	35 (23.6)	5.52	(3.69–8.24)	< .0001
Polymicrobial bloodstream infection		2 (12.5)	0.78	(0.15–3.95)	0.7627
Patient age increased by 10 yr		—	1.03	(1.03–1.03)	< .0001
Female sex		5,807 (3.4)	0.90	(0.87–0.94)	< .0001
Triage level	Resuscitation	68 (7.8)	—	—	—
	Emergent	2,461 (4.6)	0.71	(0.55–0.92)	0.0089
	Urgent	7,302 (4.1)	0.71	(0.55–0.91)	0.0079
	Other	1,378 (1.6)	0.33	(0.25–0.42)	< .0001
Arrived at ED by ambulance		3,547 (5.8)	1.24	(1.18–1.29)	< .0001
Unplanned return to ED					
No bloodstream infection		28,428 (8.85)	—	—	—
Bloodstream infection present and appropriate antibiotics given:	Hospital and discharge	70 (26.7)	2.83‡	(2.15–3.74)	< .0001
	Hospital only	13 (40.6)	5.49	(2.69–11.2)	< .0001
	Discharge only	10 (26.3)	2.86*	(1.38–5.93)	0.0046
	None	69 (46.6)	7.46	(5.35–10.4)	< .0001
Polymicrobial bloodstream infection		5 (31.5)	0.73	(0.24–2.23)	0.5852
Patient age increased by 10 yr		—	1.01	(1.01–1.01)	< .0001
Female sex		15,180 (9.0)	1.01	(0.98–1.03)	0.5889
Triage level	Resuscitation	110 (12.7)	—	—	—
	Emergent	5,363 (10.0)	0.85	(0.70–1.04)	0.1234
	Urgent	17,320 (9.7)	0.87	(0.71–1.07)	0.1923
	Other	5,797 (6.6)	0.62	(0.51–0.76)	< .0001
Arrived at ED by ambulance		6,927 (11.4)	1.15	(1.12–1.19)	< .0001

ED = emergency department; U = undefined.
*$p = 0.019$ v. "none."
†$p = 0.0044$ v. "hospital only."
‡$p < 0.0001$ v. "none."

analyzed as a survival model with outcomes at 2 months (see Appendix A).

Unplanned return to ED within 2 weeks was the most common outcome, occurring in 28,590 patients (8.9%), with a much greater risk in BSI patients (33.7%) than controls (8.8%, $\chi^2 = 366.7$, $p < 0.0001$). The risk of an unplanned return to the ED within 2 weeks increased significantly with any BSI (adjusted OR 4.1 [95% CI 3.3–4.9]). Again, this risk varied notably by antibiotic status; adjusted risk was lowest in those receiving appropriate antibiotics in the ED and at discharge (adjusted OR 2.8 [95% CI 2.0–3.5]) and was highest in those with neither (adjusted OR 7.5 [95% CI 5.4–10.4]). Compared to patients who received no appropriate antibiotics, outcome risk was significantly lower in patients who received appropriate antibiotics during the ED visit and at discharge ($p < 0.0001$) and in patients who received appropriate antibiotics at discharge ($p = 0.019$).

Influence of time to appropriate antibiotics on outcomes in the elderly

We determined if and when BSI patients 65 years and older ($n = 242$) were dispensed antibiotics that covered the microorganism(s) grown in their bloodstream.

A total of 178 patients (73.6%) were dispensed appropriate antibiotics within the first 4 weeks after the index ED visit; in the entire group, the median time to appropriate antibiotics was 1 day (95% CI 1–2). The only covariates associated with time to appropriate antibiotics included the presence of hypertension (adjusted HR 1.32, 95% CI 0.98–1.79) or hemodialysis (adjusted HR 0.23, 95% CI 0.06–0.92).

Time until appropriate antibiotic dispensation was expressed as a time-dependent covariate in three separate survival models having time to death, emergent hospitalization, and unplanned ED visit as the outcomes (Figure 1). Each model controlled for hypertension and hemodialysis status (Appendix B). The only outcome that was significantly and independently influenced by the amount of time without appropriate antibiotics was urgent admission to hospital; the hazard of urgent admission to hospital in a person having 1 week without appropriate antibiotics was 1.29 times that of someone being treated immediately with appropriate antibiotics. Increased time to appropriate antibiotics also increased the risk of death and unplanned return to the ED, but these associations were not statistically significant (see Figure 1).

DISCUSSION

Inherent delays between collection of blood for culture and the identification of a BSI may result in these patients being discharged from the ED. To our knowledge, this is the largest cohort of such patients assembled to date. We found that 1 of every 670 adults discharged from our ED had an important BSI. Patients with a BSI had a significantly increased adjusted risk of urgent admission to hospital and unplanned return to ED. Those risks were significantly reduced in patients

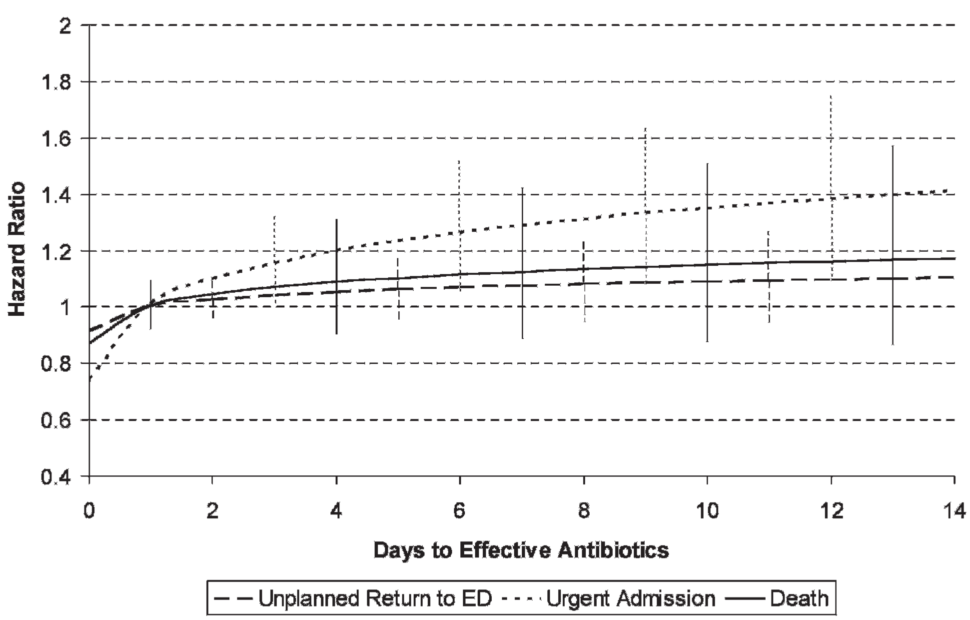

Figure 1. Influence of time without appropriate antibiotics after discharge from emergency department (ED) with a bloodstream infection on risk of death, admission to hospital, and unplanned return to ED in elderly patients. This plot illustrates the association between days to appropriate antibiotics (*horizontal axis*) and all-cause death (*solid line*), urgent admission to hospital (*dotted line*), and unplanned return to the ED (*dashed line*). The association is presented as a hazard ratio (vertical axis), with a value of 1 indicating no association. Ninety-five percent confidence intervals are presented for each outcome. These models control for covariates associated with time to effective antibiotics, including hypertension and hemodialysis.

who received appropriate antibiotics during their ED encounter and at discharge. In elderly patients, the risk of urgent admission to hospital increased significantly as time without appropriate antibiotics increased. These results indicate that BSIs in the ED have important implications for patient outcomes, and their prompt treatment should be a priority.

Our results highlight the importance of providing appropriate antibiotics quickly to ambulatory patients with a BSI. Although patients who received appropriate antibiotics in the ED and at discharge did not have a different rate of subsequent hospital admission, they did have a significantly and independently decreased risk (compared to other BSI patients) of both death in the subsequent 2 months and unplanned return to the ED in the subsequent 2 weeks. In addition, we found that timely provision of appropriate antibiotics significantly decreased the risk of urgent hospitalization in elderly patients. Since BSI patients have a significantly increased risk of poor postdischarge outcomes, and this risk varies significantly by antibiotic treatment, hospitals should review how they handle ambulatory BSIs in their ED patients to ensure that the likelihood of successfully following these patients is maximized.

Several issues about our study should be kept in mind when interpreting its results. First, our study excluded cultures isolating microorganisms that are commonly classified as contaminants. The prevalence of indwelling vascular devices in BSI patients might have been higher if we included such organisms in our study. However, contamination status can be accurately determined only with a detailed review of each patient's case. Although our study may have excluded a real BSI from an organism commonly ascribed to contamination, this should not seriously bias our study because such cases are relatively uncommon. Importantly, the exclusion of probable contaminants will underestimate the burden that postdischarge positive blood cultures have on EDs because each positive culture needs to be investigated by staff to determine its significance. Second, our study is notable for containing a large control group. This is a distinct strength of the study because it let us measure the relative risk of important outcomes in patients discharged with a BSI and establish that such patients are high risk. Third, we found that BSIs were noted in the chart by ED staff in 87% of cases. This might be an underestimate because BSIs might have been noted and acted upon by staff without documentation in the patient record. Fourth, the differences in outcomes between cases and controls in our study might have been smaller than what we measured if our models had included more covariates that captured comorbidities.

CONCLUSION

BSIs in patients discharged from the ED are relatively common and are associated with a significantly increased risk of urgent hospitalization and unplanned return to the ED in the subsequent 2 weeks. These risks decrease significantly with the timely provision of appropriate antibiotics. Hospitals should employ systems to ensure that patients discharged from the ED with BSIs get appropriate antibiotics as soon as possible.

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Appendix A: Survival models for study outcomes at 2 months following discharge from ED

Factor	Level	Hazard ratio	95% CI	*p* value
Time to death				
No bloodstream infection		—	—	—
Bloodstream infection present and adequate antibiotics given	Hospital and discharge	1.26	(0.63–2.52)	0.5199
	Hospital only	3.39	(1.09–10.52)	0.0347
	Discharge only	2.80	(0.70–11.21)	0.1454
	None	2.48	(1.18–5.22)	0.0163
Polymicrobial bloodstream infection		0	U	0.8971
Patient age increased by 10 yr		1.98	(1.93–2.03)	< .0001
Female sex		0.60	(0.56–0.65)	< .0001
Triage level	Resuscitation	—	—	—
	Emergent	0.84	(0.51–1.38)	0.4976
	Urgent	0.95	(0.58–1.56)	0.8415
	Other	0.45	(0.27–0.75)	0.0021
Arrived at ED by ambulance		1.40	(1.29–1.52)	< .0001
Time to urgent admission to hospital				
No bloodstream infection		—	—	—
Bloodstream infection present and adequate antibiotics given	Hospital and discharge	1.11	(0.79–1.54)	0.546
	Hospital only	2.57	(1.34–4.94)	0.0047
	Discharge only	1.44	(0.65–3.21)	0.3717
	None	3.63	(2.74–4.80)	< .0001
Polymicrobial bloodstream infection		0.60	(0.20–2.05)	0.4591
Patient age increased by 10 yr		1.38	(1.37–1.39)	< .0001
Female sex		0.91	(0.88–0.93)	< .0001
Triage level	Resuscitation	—	—	—
	Emergent	0.85	(0.70–1.03)	0.0997
	Urgent	0.84	(0.69–1.02)	0.0799
	Other	0.44	(0.36–0.54)	< .0001
Arrived at ED by ambulance		1.12	(1.08–1.15)	< .0001
Unplanned return to emergency department				
No bloodstream infection		—	—	—
Bloodstream infection present and adequate antibiotics given	Hospital and discharge	1.44	(1.28–1.63)	< .0001
	Hospital only	2.04	(1.44–2.88)	< .0001
	Discharge only	1.59	(1.15–2.18)	0.0046
	None	1.80	(1.53–2.12)	< .0001
Polymicrobial bloodstream infection		0.90	(0.57–1.54)	0.7912
Patient age increased by 10 yr		1.05	(1.05–1.06)	< .0001
Female sex		1.04	(1.04–1.05)	< .0001
Triage level	Resuscitation	—	—	—
	Emergent	1.22	(1.14–1.30)	<.0001
	Urgent	1.10	(1.03–1.18)	0.0058
	Other	1.00	(0.94–1.07)	0.9487
Arrived at ED by ambulance		1.10	(1.09–1.11)	<.0001

ED = emergency department; U = undefined.

Appendix B: Models determining association between time to appropriate antibiotics and outcomes in elderly patients with bloodstream infection

	Hazard ratio	95% CI	*p* value
Time to death			
Log (days to effective antibiotics)	1.15	(0.89–1.48)	0.2884
Hypertension	0.57	(0.24–1.34)	0.1967
Hemodialysis	2.44	(0.56–10.6)	0.2325
Time to urgent admission to hospital			
Log (days to effective antibiotics)	1.35	(1.1–1.66)	0.0046
Hypertension	0.59	(0.33–1.07)	0.0834
Hemodialysis	2.4	(0.85–6.79)	0.0981
Unplanned return to ED			
Log (days to effective antibiotics)	1.09	(0.95–1.25)	0.2153
Hypertension	0.84	(0.57–1.23)	0.3718
Hemodialysis	1.33	(0.54–3.29)	0.534

ED = emergency department.