Risk Factors and Outcome Analysis of Surgical Site Infections in Chinese Elderly Patients with Intestinal Obstruction after Emergency Surgery

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Research Article

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Abstract

Background Surgical site infection (SSI) and antimicrobial resistance may adversely affect the clinical outcome of older patients.

Objective Investigate the etiology and outcome of SSIs in elderly patients who underwent emergency bowel surgery.

Methods We conducted a retrospective study of all patients aged ≥60 years who underwent emergency surgery due to an ileus from January 2014 to June 2019 in a tertiary teaching hospital in Western China. Demographic data, comorbidities, perioperative physiological and microbiological data, and information on the surgical technique and duration of hospitalization were extracted from clinical records to assess risk factors for SSIs.

Results Of 125 patients included, 115/125 (92%) had a duration of >48 hours postoperative prophylactic antibiotic use; 37 (29.6%) patients were diagnosed with SSI. All occurred within the period of postoperative antimicrobial prophylaxis or after an extended duration of >48 hours prophylactic antibiotic use. *Enterobacteriaceae* and *Enterococcus* were the most frequently isolated species (67.4% and 20.9%, respectively): 93.8% of *Escherichia coli* (15/16) and 46.2% of other *Enterobacteriaceae* (6/13) isolated were ceftriaxone-resistant. Incision site classification was an independent risk factor for SSI in multivariate analysis. SSI patients had a significantly longer length of stay than those without (29.81±12.96 days vs. 22.52±10.67 days, respectively; p=0.001).

Conclusion Higher rates of extended-spectrum beta-lactamase-producing *Enterobacteriaceae* carriage were associated with higher SSI, despite prolonged antimicrobial prophylaxis. This calls for the improved surveillance of resistance in order to offer an alternative prophylaxis for the prevention of these types of infections.

Introduction

Surgical site infection (SSI) is one of the most common postoperative complications [1]. It delays wound healing and may result in prolonged hospitalization and increased medical costs [2]. Some studies have reported that time to surgery, operation duration, blood loss, and the surgical wound classification were independently associated with SSI in elective abdominal surgery [3]. However, there are few data concerning the prediction of the efficacy of antimicrobial prophylaxis in the current context of increasing antimicrobial resistance [4]. In a previous study, we observed an increasing number of acute bowel obstructions over time among elderly patients [5]. Acute intestinal obstruction can cause a dysregulation of the body metabolism and multiple organ failure and thus surgeons must perform an emergency procedure to resolve the obstruction by intestinal resection, intestinal anastomosis, or by eliminating the adhesion zone. According to the type of obstruction, closed loop obstruction, bowel ischemia or volvulus may occur. However, an emergency procedure is also an important risk factor for SSI. In a recent study in Pakistan, it was reported that the rate of SSI was greater in older individuals with 44.4% of patients over

60 years who developed SSI postoperatively [6]. Given the global increase in the ageing population [7], future healthcare systems will have to adapt to the challenges associated with the management of an increasing number of elderly persons presenting with surgical emergencies. The aim of this retrospective study was to identify risk factors in emergency bowel obstruction surgery among patients ≥ 60 years in order to inform strategies to decrease the occurrence of SSI and compare patient outcomes between those with and without SSI.

Methods

Study Design and Patients

A retrospective chart review was performed of all patients ≥ 60 years who had undergone emergency surgery for bowel obstruction at the Third Affiliated Hospital of Zunyi Medical University, a 2500-bed tertiary teaching hospital in Western China, between January 1, 2014 and June 30, 2019. All patients had reported symptoms such as abdominal pain, abdominal distension, anal stop exhaust or vomiting, and undergone blood tests. An abdominal ultrasonography or computed tomography scan had been performed immediately upon presentation to the hospital. Diagnosis of bowel obstruction for all cases was based on the patient's medical history, physical examination and imaging findings. The diagnosis of SSI was defined by the criteria of the Chinese national guideline for the prevention and control of SSIs and included persistent wound discharge or dehiscence, visible abscess or gangrene, and the presence of bacteria confirmed by discharge liquid culture [8].

Statistical Analysis

The Kolmogorov–Smirnov test was used to test the normality of distribution. Normally distributed continuous data were assessed with Student's *t*-test. If the data were not normally distributed, continuous data were analyzed with the Mann-Whitney U-test. ROC curve analysis was used to determine cut-off values for age, time to onset of infection, operation duration, blood loss, preoperative white blood cell and neutrophil counts, and first-day postoperative albumin. The optimal cut-off values were selected according to the maximal Youden index. Multivariate logistic regression analysis was used to identify the risk factors associated with SSI. All statistical analyses were performed with SPSS software, version 17.0 (SPSS Inc. Chicago, IL, USA). A p value < 0.05 was considered to be statistically significant.

Results

Of 125 patients included, 67 (53.6%) were male. Patient characteristics are presented in Table 1. Forty-seven (37.6%) patients had a level II surgical incision. Twenty-three (18.4%), 40 (32.0%), 41 (32.8%) and 21 (16.8%) patients had bowel obstruction caused by strangulation, incarceration, adhesion and neoplasm, respectively. According to the World Health Organization (WHO) body mass index (BMI) classification, patients with a BMI less than 18.5, 18.5–25.0 and more than 25 accounted for 35.2%, 57.6% and 7.20% of cases, respectively. The average duration of onset of bowel obstruction was 68.98 ±

73.52 hours. Preoperative leukocyte counts were $10.82 \pm 5.68 \times 10^3/mm^3$ and preoperative neutrophil counts were $9.33 \pm 5.40 \times 10^3/mm^3$. Ninety-two percent (115/125) of patients had a duration of >48 hours postoperative prophylactic antibiotic. Average inpatient stay was 24.68 ± 11.82 days, with an average stay of 15.15 ± 5.82 days post-surgery.

Table 1
Patient characteristics.

Variable	**N**	**%**	**Mean**
Gender			
Male	67	53.6	
Female	58	46.4	
Duration of onset (hours)			68.98 ± 73.52
BMI (kg/m^2)			
< 18.5	44	35.2	
18.5–25.0	72	57.6	
>25.0	9	7.20	
Preoperative leukocyte count (×10^3/mm^3)			10.82 ± 5.68
Preoperative neutrophil count (×10^3/mm^3)			9.33 ± 5.40
Type of bowel obstruction			
Strangulation	23	18.4	
Incarceration	40	32.0	
Adhesion	41	32.8	
Neoplasm	21	16.8	
History of chronic disease			
Diabetes mellitus	7	20.59	
Cardiovascular disease	24	70.59	
Others	3	8.82	
Type of surgical incision			
II	47	37.6	
III	78	62.4	
Blood loss (ml)			113.08 ± 73.21
First-day postoperative albumin (g/L)			28.26 ± 4.65
ASA score			

BMI, body mass index; ASA, American Society of Anesthesiologists.

Variable	N	%	Mean
Grade I	25	20.0	
Grade II	52	41.6	
Grade III	35	28.0	
Grade IV	13	10.4	
Duration of postoperative prophylactic antibiotic use (> 48 hours)	115	92.0	
Hospitalization (days)			24.68 ± 11.82
Length of stay after surgery (days)			15.15 ± 5.82
BMI, body mass index; ASA, American Society of Anesthesiologists.			

Surgical site infections and isolates

Thirty-seven of 125 patients had a confirmed SSI. All presented deep SSIs, i.e., an infection occurring beneath the incision area in muscle and the tissues surrounding the muscles. Diagnosis of SSI was 6 ± 3 days after the surgical procedure. Five (14.7%) were identified after termination of a postoperative prophylactic antibiotic use of > 72 hours. Eight patients (23.5%) presented SSIs within a postoperative prophylactic antibiotic use of ≤ 48 hours, although prophylaxis was intended to continue beyond 48 hours following surgery. Diagnosis of the remaining 24 (70.6%) patients occurred 3 to 16 days after surgery during the course of postoperative prophylactic antibiotic use.

A total of 43 bacterial species were isolated from patients with SSIs. *Enterobacteriaceae* were predominant (29/43; 67.4%), with *Escherichia coli* (16/43; 37.2%) as the dominant species. Of note, 93.8% of *E. coli* (15/16) and 46.2% of other *Enterobacteriaceae* (6/13) isolated from the wounds of SSI patients were resistant to ceftriaxone. *Enterococcus* (9/43) was the second genus isolated, with 44.4% resistant to ampicillin (4/9); all isolates were susceptible to vancomycin, with the exception of *Enterococcus gallinarum*. The *Staphylococcus aureus* isolate was resistant to oxacillin. All isolated *Enterobacteriaceae* were susceptible to imipenem and both *Pseudomonas aeruginosa* isolates were susceptible to ceftazidime and ciprofloxacin (Table 2).

Table 2
Distribution of infectious pathogens of 37 surgical site incision infections among patients receiving emergency surgery for bowel obstruction.

Pathogen	Strains (n)	Constituent ratio (%)	ESBLs	VRE	MRSA	CRE/CRPA
Gram-negative bacteria	**31**	**72.09**				
Escherichia coli	16	37.21	15/16			0/16
Proteus species	3	6.98	2/3			0/4
Enterobacter cloacae	3	6.981	1/3			0/3
Enterobacter aerogenes	2	4.65	1/2			0/1
Enterobacter carcinogenic	1	2.33	0/1			0/1
Morganella morganii	1	2.33	0/1			0/1
Citrobacter braakii	1	2.33	0/1			0/1
Klebsiella pneumoniae	1	2.33	0/1			0/1
Pseudomonas aeruginosa	3	6.98				0/3
Gram-positive bacteria	**10**	**23.26**				
Enterococcus faecalis	4	9.30		0/4		
Enterococcus faecium	3	6.98		0/3		
Enterococcus avium	1	2.33		0/1		
Enterococcus gallinarum	1	2.33		1/1		
Staphylococcus aureus	1	2.33			1/1	
Fungi	**2**	**4.65**				
Candida albicans	2	4.65				

ESBL, extended spectrum beta-lactamase; VRE, vancomycin-resistant enterococci, MRSA, methicillin-resistant *Staphylococcus aureus*; CRE, carbapenem-resistant *Enterobacteriaceae;* CRPA, carbapenem-resistant *Pseudomonas aeruginosa*.

Risk Factors for Incision Infection

The optimal cut-off values for the onset duration of SSI, preoperative leukocyte and neutrophil counts, operation duration, first-day postoperative albumin, and blood loss were calculated by the ROC curve, which showed that the area under the curve for the duration of onset was 0.579. When the duration of onset value was 8, the Youden index was maximal and this was set as the cut-off value. Cut-off values for the other continuous variables were calculated in the same manner. Using ROC curve analysis, we determined the cut-off values for the preoperative leukocyte count ($< 14.8 \times 10^3/\geq 14.8 \times 10^3/mm^3$), preoperative neutrophil count ($< 13.5 \times 10^3/\geq 13.5 \times 10^3/mm^3$), operation duration (< 117/≥117 min), blood loss (< 135/≥135 ml), and first-day postoperative albumin (< 25/≥25 g/L). Statistically significant risk factors for incision infection were: duration of onset (≥ 8 hours; $p = 0.048$); preoperative leukocyte count ($\geq 14.8 \times 10^3/mm^3$; $p = 0.041$); preoperative neutrophil count ($\geq 13.5 \times 10^3/mm^3$; $p = 0.025$); operation duration (≥ 117 min; $p = 0.024$); a level III surgical incision ($p < 0.001$); blood loss (≥ 135 ml; $p = 0.005$); and first-day postoperative albumin (< 25 g/L; $p = 0.011$) (Table 3). Additionally, multivariate logistic regression analysis revealed that a level III surgical incision (odds ratio [OR], 5.564; 95% confidence interval [CI], 1.672–18.514; $p = 0.005$) was an independent risk factor for SSI (Table 4).

Table 3
Univariate logistic regression analysis for risk factors associated with surgical site infection.

Risk factor	**SSI n = 37 (%)**	**No SSI n = 88 (%)**	**Univariate logistic regression analysis**		**Multivariable logistic regression analysis**	
			OR (95% CI)	**P value**	**OR (95% CI)**	**P value**
Sex (reference: female)				0.646		
male	21 (57)	46 (52)	1.20 (0.55–2.60)			
Age (reference: <65 years)				0.555		
≥ 65 and < 70	11 (30)	20 (23)	1.17 (0.38–3.57)	0.784		
≥ 70 and < 75	8 (22)	26 (30)	0.65 (0.21–2.08)	0.471		
≥ 75 and < 80	7 (19)	11 (13)	1.35 (0.38–4.80)	0.640		
≥ 80and ≤ 93	3 (8)	14 (16)	0.46 (0.10–2.05)	0.305		
Duration of onset (reference: <8 hours)				**0.048**	8.78 (0.93–83.37)	0.058
≥ 8	36 (97)	72 (22)	8.00 (1.02–62.74)			
BMI (kg/m^2) (reference: <18.5)				0.183		
18.5 ≤ and ≤ 25	26 (70)	46 (52)	2.20 (0.92–5.28)	0.078		
25 < and ≤ 30	2 (5)	7 (8)	1.11 (0.20–6.29)	0.905		

BMI, body mass index; ASA, American Society of Anesthesiologists; NNIS, National Nosocomial Infections Surveillance System.

Risk factor	SSI n = 37 (%)	No SSI n = 88 (%)	Univariate logistic regression analysis		Multivariable logistic regression analysis	
			OR (95% CI)	P value	OR (95% CI)	P value
Preoperative leukocyte count ($\times10^3/mm^3$) (reference: < $14.8\times10^3/mm^3$)				**0.041**	0.93 (0.08–11.55)	0.955
≥ 14.8	12 (32)	14 (16)	2.54 (1.04–6.21)			
Preoperative neutrophil count ($\times10^3/mm^3$) (reference: < 13.5)				**0.025**	2.37 (0.16–34.36)	0.526
≥ 13.5	11 (30)	11 (12)	2.96 (1.15–7.63)			
Operation duration (reference: <117 min)				**0.024**	1.71 (0.49–5.91)	0.399
≥ 117	32 (86)	58 (66)	3.31 (1.17–9.37)			
Type of bowel obstruction (reference: neoplastic)				0.120		
Strangulation	9 (24)	14 (16)	1.05 (0.31–3.52)	0.944		
Incarceration	6 (16)	34 (39)	0.29 (0.08–0.98)	**0.048**		
Adhesion	14 (38)	27 (30)	0.84 (0.28–2.51)	0.759		
Type of surgical incision (reference: II)				**< 0.001**	5.56 (1.67–18.51)	0.005

BMI, body mass index; ASA, American Society of Anesthesiologists; NNIS, National Nosocomial Infections Surveillance System.

Risk factor	SSI n = 37 (%)	No SSI n = 88 (%)	Univariate logistic regression analysis		Multivariable logistic regression analysis	
			OR (95% CI)	P value	OR (95% CI)	P value
III	33 (89)	45 (51)	7.88 (2.58–24.13)			
Blood loss (ml) (reference: < 135ml)				**0.005**	2.18 (0.85–5.62)	0.105
≥ 135	19 (51)	22 (25)	3.17 (1.42–7.09)			
First day postoperative albumin (g/L) (reference: ≥25 g/L)				**0.011**	2.46 (0.82–7.39)	0.110
< 25 g/L	12 (32)	11 (13)	3.36 (1.32–8.55)			
ASA score (reference: Grade I)				0.443		
Grade II	14 (38)	38 (43)	0.55 (0.20–1.51)	0.249		
Grade III	8 (22)	27 (31)	0.44 (0.14–1.37)	0.157		
Grade IV	5 (13)	8 (9)	0.94 (0.24–3.71)	0.927		
Preoperative antimicrobial prophylaxis (reference: other antibiotics)				0.249		
Cephamycin	2 (5)	11 (13)	0.40 (0.08–1.90)			
Postoperative antimicrobial prophylaxis (reference: ≤48h)				0.999		

BMI, body mass index; ASA, American Society of Anesthesiologists; NNIS, National Nosocomial Infections Surveillance System.

Risk factor	SSI n = 37 (%)	No SSI n = 88 (%)	Univariate logistic regression analysis		Multivariable logistic regression analysis	
			OR (95% CI)	P value	OR (95% CI)	P value
> 48h	29 (100)	86 (97)	5.45 (0.00-Null)			
NNIS (reference: 0)				0.143		
1	20 (55)	40 (46)	5.50 (1.18–25.75)	0.030		
2	13 (35)	22 (25)	6.50 (1.31–32.25)	0.022		
3	2 (5)	4 (4)	5.50 (0.59–51.19)	0.134		
History of chronic disease (reference: no)				0.315		
Yes (diabetes mellitus/cardiovascular disease/ others)	10 (27)	32 (36)	0.65 (0.28–1.51)			
BMI, body mass index; ASA, American Society of Anesthesiologists; NNIS, National Nosocomial Infections Surveillance System.						

Table 4
Multivariable logistic regression analysis of risk factors predicting surgical site infection.

Risk factor	SE	Wald	*P*-value	Adjusted odds ratio	95% confidence interval
Preoperative leukocyte count ≥ 14.8×103/mm3	1.285	0.003	0.955	0.930	0.075–11.552
Preoperative neutrophil count ≥ 13.5×103/mm3	1.364	0.401	0.526	2.372	0.164–34.359
Duration of onset ≥ 8 hours	1.148	3.582	0.058	8.784	0.926–83.369
Operation duration ≥ 117 minutes	0.634	0.711	0.399	1.706	0.493–5.906
Level III surgical incision	0.613	7.830	0.005	5.564	1.672–18.514
First-day postoperative albumin < 25g/L	0.562	2.560	0.110	2.457	0.817–7.391
Blood loss ≥ 135 ml	0.482	2.632	0.105	2.184	0.850–5.615

The SSI rate was 30.1% (37/123) for patients with a long duration of postoperative antimicrobial prophylaxis (> 48 hours) and those undergoing an unforeseen extended prophylactic use of antimicrobials compared to patients with a short duration of antimicrobial prophylaxis (< 48 hours) (0/2; $p = 0.999$). However the latter group was very small as surgeons tended to favor a long-term prophylaxis strategy.

Clinical Outcomes of Patients With/Without SSI

Overall, patients with SSI had a more prolonged hospitalization than those without SSI (29.81 ± 12.96 vs. 22.52 ± 10.67 days, respectively; $p = 0.001$). Postoperative length of stay was also significantly longer among patients with SSI (19.70 ± 6.76 vs. 13.24 ± 4.10 days, respectively; $p < 0.001$). No death occurred among patients within 30 days after surgery (Table 5).

Table 5
Comparison of clinical outcomes between patients with and without surgical site infection.

Variable	Without surgical site infection (n = 88)	With surgical site infection (n = 37)	*p*-value
Within 30-day mortality	0	0	-
Hospitalization (days)	22.52 ± 10.67	29.81 ± 12.96	0.001
Length of stay after surgery (days)	13.24 ± 4.10	19.70 ± 6.76	< 0.001

Discussion

The incidence of SSI in abdominal surgery has been reported to range from 4.8–7.4% in China [9, 10]. In our study, we found a high rate of 29.6% (37/125) following emergency abdominal surgery (EAS) in elderly. Our high rate of SSI may be explained by the fact that a patient with acute bowel obstruction cannot receive sufficient bowel preparation prior to surgery. A meta-analysis has reported that mechanical bowel preparation can decrease the risk for SSI in elective bowel surgery [11], but this remains a controversial issue. A recent randomized controlled trial of 396 patients undergoing elective colonic surgery showed no difference in SSI and overall morbidity between the mechanical and oral antibiotic bowel preparation group and the no bowel preparation group [12]. However, confirmation of the relationship between the abundance of bacteria in the intestinal lumina and SSI needs to be addressed by more high-quality studies.

E. coli is reported as the most common pathogen causing SSI in abdominal surgery [13, 14]. Similarly, our findings showed that *E. coli* was the leading pathogen isolated from surgical sites (16/43; 37.2%), with most isolates resistant to third-generation cephalosporins (15/16; 93.8%). Resistance of pathogens isolated from abdominal surgical sites in a multicenter cross-sectional study in China were not available [9, 14]. This is higher than the prevalence (61.1%) of extended-spectrum beta-lactamase (ESBL)-producing *E. coli* from community-onset bloodstream infections reported in South-West China and associated with older age groups [15]. Golzarri et al also reported that patients colonized by ESBL-producing Enterobacteriaceae (ESBL-PE) were at high risk for SSI [16].

In our study, ESBL-PE isolated from surgical sites accounted for 72.4% (21/29) and would contribute the higher rate of patients with SSIs. For this reason, cefoxitin was chosen as the prophylactic agent for patients in the latter period of our study. Preoperative cefoxitin had a better efficacy to prevent SSI, but was less significant (SSI rate: cefoxitin vs. others: 15.4% vs. 31.3%, respectively; $p = 0.236$). Similarly, in a large study by Poeran et al [17], cephamycins did not demonstrate a better efficacy for SSI prevention compared with non-cephamycins. In another study, it was reported that cefoxitin concentrations were not sufficient in subcutaneous adipose tissue (< 8 mg/mL) at the time of surgical closure in obese patients who received a sleeve gastrectomy [18]. These findings suggest that it would be beneficial to develop a new prophylactic antimicrobial agent or enhance the potency of preoperative cefoxitin to prevent SSI with an appropriate dosage. Positive effect of preoperative surgical antibiotic prophylaxis on SSI have been recommended [19, 20], but the optimal timing is still a subject of debate. In our study, it was difficult to determine the beginning of the actual time of antibiotic administration as this information was not well documented for emergency patients and thus we were unable to assess the optimal timing of preoperative surgical antibiotic prophylaxis.

In this retrospective study, 92.0% (115/125) of patients had a longer (> 48 hours) duration of postoperative prophylactic antibiotic use than recommended (< 24 hours) by the ASHP [21] and national technical and administrative documents [8, 20], although 32 (86.5%) cases of SSIs were diagnosed before the end of the prophylaxis course. However, it’s hardly alone. Prolonged postoperative antimicrobial prophylaxis focusing on EAS was startling common in many settings during the same time [22], although it was limited by guideline from Chinese Surgical Society of Chinese Medical Association [20] and hardly supported/reported in literature in the country. In the multicenter, prospective, cross sectional study [22], adult patients who underwent EAS in 47 tertiary hospitals in China during 1–2 months from 2018 to 2019, only 3.46% patients were admitted with (less than) one-day perioperative prophylactic antibiotics. In our study and their studies, there was no evidence to show that longer use of postoperative antimicrobial prophylaxis had a protective role for the incidence of SSI and our findings confirm this observation compared with similar reports [6, 9, 14]. According to the WHO guidelines for the prevention of SSI, the panel recommends against the prolongation of surgical antibiotic prophylaxis administration after completion of the procedure for the purpose of preventing SSI [19]. However, there is ongoing controversy on this issue [23] and more randomized controlled trials are necessary to confirm or not the existence of any benefit of postoperative surgical antibiotic prophylaxis for the prevention of SSI.

We identified a level III surgical incision as an independent risk factor for SSI as it is more exposed to a contaminant and thus a high risk of infection. We observed that the duration ($\geq$ 117 min) of the surgical procedure was related to the occurrence of SSI. Complex procedures are often long and thus the incision and the wound are more exposed to the risk of SSI. Sattar et al [6] reported that SSIs were more likely in procedures with a duration greater than 90 min and particular attention should be paid to the wounds of patients undergoing a lengthy procedure. The serum albumin level has an important role in the development of SSI, but not well evaluated in elderly patients.. Liang et al [24] also reported that the rate of low albumin levels was 35.1% in SSI patients. In particular, a low preoperative albumin level (< 35 g/L) was associated with a 2.3-fold increased risk of SSI. In our study, we did not test the preoperative albumin level, but we analyzed the effect of the first day of postoperative albumin on SSI and demonstrated that a level of < 25 g/L was significantly associated with SSI in emergency bowel surgery, potential leading also to tissue edema, a delay of incision recovery and an increase in the risk of SSI. In a prospective cohort study, a decreased concentration of serum albumin $\geq$ 10 g/L on postoperative days 1 was associated with a threefold increased risk of overall postoperative complications [25]

WHO recommends that bathing or showering prior to surgery can reduce SSI by decreasing the bacterial load on the skin [19]. However, this is not always possible for emergency patients. We were unable to determine if a history of chronic disease, such as diabetes mellitus, cardiovascular disease or others, had any adverse influence on SSI. However, several observational studies have shown that hyperglycemia was related to SSI [26] and it would be relatively simple for our surgical teams to comply with the WHO recommendation to control blood glucose to reduce the risk of SSI [19]. No deaths occurred among our patients in the 30 days following emergency surgery. Gomila et al [27] reported that the overall 30-day mortality caused by organ-space SSI was 8.9% (30/336) in elective colon and rectal surgeries and these findings suggest that more attention should be paid to the prevention of deep SSI to help decrease mortality.

Our study has some limitations. First, this is a single-center study and data collection might be biased and some confounding factors may have been generated due to its retrospective nature, e.g. lack of antimicrobial exposure and previous administration history. Second, it was difficult to determine the beginning of the actual time of antibiotic administration as this information was not well documented for emergency patients. For this reason, we were unable to assess the optimal timing of preoperative surgical antibiotic prophylaxis, although the optimal timing is still a subject of debate [12]. Third, underlying risk factors, such as blood transfusion, hypothermia and preoperative albumin level, were not assessed. Fourth, perioperative management against SSI in this study was not based on evidence-based guidance [8] and the implementation of a bundle strategy for the prevention and management of SSI was not introduced during the study period [19, 28].

Conclusion

The incidence and burden of SSIs at our institution, including the prevalence of ESBLs isolated from SSIs, were high in bowel obstruction patients over 60 years of age who underwent emergency surgery and highlights the need to rapidly implement preventive strategies to improve quality of care. A level III surgical incision was identified as an independent risk factor for SSI.

Declarations

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

Ethics approval The study was approved by the ethics committee of the First People's Hospital of Zunyi (no. LL-2019-51). As this was a retrospective and non-interventional research study, the need for informed consent was waived.

Consent to participate (include appropriate statements) All participants listed declare that they have agreed to participate in the study.

Consent for publication All participants listed declare that they have agreed to publish the manuscript.

Availability of data and material All research data are reliable and available upon request to the corresponding author.

Code availability Not applicable.

Author contributions XX and BG were involved in the study design and implementation. SF, XX and WA undertook data collection. SF and XX performed the data analysis and designed the tables. SF, XX and BG were involved in data interpretation and study coordination. SF wrote the manuscript and BG reviewed the manuscript. All authors have read and approved the final version for publication.

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