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(Citation)

Supportive Care in Cancer,29(2):653-659

(Issue Date)

2021-02

(Resource Type)

journal article

(Version)

Accepted Manuscript

(Rights)

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(URL)

<https://hdl.handle.net/20.500.14094/90007783>



Effects of preoperative dental examination and oral hygiene instruction on surgical site infection after hepatectomy: a retrospective study

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A short title: Effect of oral management after hepatectomy

Key words: oral health care, oral management, hepatectomy, infection, complication

ABSTRACT

Purpose: This study retrospectively investigated relationships among risk factors and post-hepatectomy surgical site infection (SSI) and other complications in patients who underwent hepatectomy for hepatocellular carcinoma (HCC).

Methods: We included 334 patients who underwent hepatectomies for liver cancers between January 2011 and December 2015 in this study. We evaluated risk factors for SSI and other post-hepatectomy complication, including demographic factors, preoperative factors, preoperative intervention including oral management, perioperative factors and length of hospital stay, with univariate and multivariate analyses. The oral management intervention included self-care instructions, extraction of infected teeth, removal of dental plaques and calculus (scaling), professional mechanical teeth cleaning, removal of tongue coating, and cleaning of dentures. SSI was defined in accordance with the guideline issued by the Centers for Disease Control and Prevention; it included purulent discharge from any incision or organ space within 30 days postoperatively, with or without microbiological evidence. Complications of grade II or greater, according to the Clavien-Dindo classification, were regarded as postoperative complications.

Results: We found bacterial infection of ascites (Odds ratio (OR) = 13.72), lack of preoperative oral management intervention (OR = 10.17), and severe liver fibrosis (OR = 2.76) to be associated with SSI; and severe liver fibrosis (OR = 2.28), hypoalbuminemia (OR = 2.02), blood transfusion (OR = 1.86), and longer operation time (OR = 1.80) to be associated with postoperative complications.

Conclusions: Preoperative oral management may reduce the risk of SSI in patients with HCC who undergo hepatectomy.

INTRODUCTION

Hepatocellular carcinoma (HCC) is the most common liver malignancy, and has an estimated annual death incidence of about 700,000 worldwide [1]. Although liver resections in the presence of cirrhosis had a high rate of mortality, at 10%–30% [2], better surgical techniques and postoperative care have improved patient outcomes [2, 3]. However, the high rate of complication after hepatectomy for HCC remains a major problem [4]. In particular, surgical site infections (SSI) are a potentially complication and costly complication [5]. Rates of SSI are 3.24%–7.04% following hepato-pancreaticobiliary surgery [6], and 3.1%–25.2% after hepatectomy [5, 7]. Additionally, the rate of postoperative bacterial infections after abdominal surgical procedures was 10%–30% in patients with cirrhosis or chronic liver dysfunction [8].

The preventive effect of perioperative oral management on postoperative pneumonia has been recently demonstrated [9, 10], and the effect of oral management on SSI prevention [11, 12], with particular respect to mechanisms such as intravascular invasion and transition to remote organs through blood vessels is the subject of increasing attention. Perioperative oral management has also been shown to reduce SSI in patients with colorectal cancer (CRC) and oral cancer [11, 12]. However, no studies have evaluated relationships between risk factors, including oral management, and postoperative SSI and other complications in patients with HCC who receive hepatectomies.

This study investigated relationships between risk factors, including oral management, and postoperative SSI and other complications in patients with HCC who receive hepatectomies.

METHODS

This was a retrospective cohort study. This study was approved by the institutional review board of Kobe University Graduate School of Medicine and by the institutional review boards of the participating hospitals (Authorization number: 160213). We included 334 patients (268 men and 66 women) who underwent hepatectomies for liver cancers between January 2011 and December 2015 at the Department of Hepato-Biliary-Pancreatic Surgery, Kobe University Hospital in this study. Their mean age was 66.6 ± 11.0 years (range: 21–86 years). There were hepatocellular carcinoma ($n = 194$) and metastatic liver cancer ($n = 74$) in 334 patients. Patients who underwent only cholecystectomy and simultaneous procedures, such as colorectal resection or stoma closure, were excluded from the study. Tumor staging was diagnosed by contrast-enhanced computed tomography (CT) scans, magnetic resonance imaging (MRI), hepatic arterial angiography and/or ultrasound.

One or two closed drains were inserted in the right subphrenic space, or the space of resected liver parenchyma before skin closure. Drains were removed after confirming no rebleeding or bile leakage on postoperative day (POD) 3 or 4. Patients were usually given 3.0 g of sulbactam/ampicillin (SBT/ABPC) three times per day as prophylactic antibiotics until POD 2. They also received 1.5 grams of SBT/ABPC within 30 minutes before skin incision, and additionally the same dose every 3 hours during the operation.

Data assessed for each patient included (1) demographic factors (sex, age, smoking history, alcohol drinking, performance status, American Society of Anesthesiologists [ASA] Physical Status Classification, body mass index, presence of diabetes mellitus and steroid therapy, underlying liver disease), (2) preoperative factors (Child–Pugh classification, liver fibrosis status, indocyanine green retention rate at 15 minutes [ICG-15], forced expiratory volume [FEV] 1.0%, hemoglobin [Hb], albumin [Alb]), (3) preoperative intervention (oral management, respiratory rehabilitation), and (4) perioperative factors (bacterial infection in sputum, bile or ascites, range of resected segments, laparoscopic or open approach, blood loss, surgical time, blood transfusion), and

(5) postoperative factors (length of hospital stay). Details of these characteristics and patient demographics are listed in Table 1. Liver fibrosis was scored according to the New Inuyama Classification from F0 to F4 [13]. Liver fibrosis stages were classified as F0 (no fibrosis), F1 (fibrous portal expansion), F2 (bridging fibrosis), F3 (bridging fibrosis with lobular distortion) or F4 (liver cirrhosis).

Dental examination and oral hygiene instruction were mainly performed as oral management intervention by dentists and dental hygienists. Patients received oral management until 2 weeks before hepatectomy. The oral management intervention included instructions regarding self-care, extraction of infected teeth, removal of dental plaques and calculus (scaling), professional mechanical teeth cleaning, removal of tongue coating, and cleaning of dentures. Self-care instructions included teeth brushing, interdental brushing, dental flossing, tongue brushing, denture brushing, and gargling. The purpose of this oral management program was mainly removal of infected teeth and improvement of patients' awareness of plaque control. Twenty-seven (8.1%) patients underwent extraction of teeth.

The data were introduced into a multiple logistic regression model, in which patients were divided by age (≥ 65 years vs. < 65 years); BMI (≥ 25 years vs. < 25 years); underlying liver disease (none or fatty liver vs. chronic hepatitis or liver cirrhosis); New Inuyama Classification (F0, F1, or F2 vs. F3 or F4); ICG-15 (≥ 10 % vs. < 10 %); FEV 1.0% (≥ 70 % vs. < 70 %); Alb (≥ 4 g/dl vs. < 4 g/dl); type of surgery (lobectomy with or without extended or segmentectomy vs. subsegmentectomy or wedge resection); blood loss (≥ 1000 ml vs. < 1000 ml) and operation time (≥ 480 minutes vs. < 480 minutes). This study investigated SSI rate as the primary outcome, and complication rate as the secondary outcome. Because the length of hospital stay is related to the primary outcome (SSI), it was excluded from the multivariate analysis. SSI was defined in accordance with the guideline issued by the Centers for Disease Control and Prevention (CDC) [6]; it included purulent discharge from any incision or organ space within 30 days postoperatively, with or without

microbiological evidence. Complications of grade II or greater, according to the Clavien-Dindo classification, were regarded as postoperative complications [14].

Statistical analysis

SPSS 22.0 (SPSS, Chicago, IL) and Ekuseru-Toukei 2012 (Social Survey Research Information Co., Ltd., Tokyo, Japan) were used for the statistical analyses. The association of each variable with the SSI and the complication was analyzed by the Mann-Whitney U nonparametric test for ordinal variables and the Fisher's exact test or the Chi-squared test for categorical variables. P value based on descriptive statistical analysis in this study. In all analyses, a two-tailed P value < 0.05 was considered statistically significant. All of the variables associated with the SSI and the complication were introduced into a multiple logistic regression model. Forward stepwise algorithms were used, with the rejection of those variables that did not fit the model significantly. Odds ratio (OR) and 95% confidence intervals (CIs) were also calculated.

RESULTS

Complications were diagnosed in 115 (34.3 %) patients. The major postoperative complications were 28 (8.4 %) cases of SSI and 28 (8.4 %) cases of ascites. Twenty-one patients (6.3 %) had biliary leakage (Table 1). In univariate analysis, severe liver fibrosis ($P = 0.011$), anemia, hypoalbuminemia ($P < 0.001$), bacterial infection of bile ($P = 0.050$), blood loss ($P < 0.001$), longer operation time ($P = 0.002$) and blood transfusion ($P = 0.001$) were significantly associated with postoperative complications (Table 1). Additionally, length of hospital stay was significantly longer among patients with complications than among patients without complications ($P < 0.001$; Table 1). Univariate analysis showed no association with complication incidence for other studied factors (Table 1).

A logistic regression model with forward stepwise algorithms showed that severe liver fibrosis (OR = 2.28) ($P = 0.003$), hypoalbuminemia (OR = 2.02) ($P = 0.008$), blood transfusion (OR = 1.86) ($P = 0.036$), and longer operation time (OR = 1.80) ($P = 0.033$) were significantly associated with postoperative complications (Table 2).

We diagnosed SSI in 28 (8.4 %) patients, including 16 (4.8 %) superficial SSIs and 12 (3.6 %) organ/space SSIs. In univariate analysis, lack of preoperative oral management intervention ($P = 0.005$) and open surgical approach ($P = 0.004$) were significantly associated with developing SSI (Table 3). Length of hospital stay among patients with SSI was significantly longer than that among patients without SSI ($P < 0.001$; Table 3). No significant differences in SSI incidence were observed according to other factors in univariate analysis (Table 3).

A logistic regression model with forward stepwise algorithms showed that bacterial ascites infection (OR = 13.72) ($P = 0.014$), lack of preoperative oral management intervention (OR = 10.17) ($P = 0.035$), and severe liver fibrosis (OR = 2.76) ($P = 0.025$) were significantly associated with SSI (Table 4).

DISCUSSION

Postoperative complication rates often vary in the literature because of different definitions or criteria. Reported rates of SSI and complications after hepatectomy are reportedly 3.1%–25.2 % [5, 7] and 24–70 %, [2, 3, 15, 16], respectively. This study had an 8.4 % SSI rate and a 34.3 % complication rate, which are similar to previous studies.

Numerous risk factors for postoperative SSI and complication after hepatectomy have been reported, including serum aspartate aminotransferase level, alanine aminotransferase level, platelet count, albumin, blood loss, blood transfusion, operation time, illness, Child–Pugh classification, ICG-15, surgical procedure, ASA score, extent of resection hepatic stenosis, ascites, liver fibrosis and other factors [2, 3, 15-17]. In particular, rates of postoperative SSI and complications are higher in patients with advanced liver fibrosis or cirrhosis [3, 7, 8, 18, 19]. In this study, severe liver fibrosis was a significantly risk factor for postoperative SSI and complications. Some investigator have speculated that cirrhotic patients have inadequate immune defense mechanisms such as reticulo-endothelial system dysfunction, granulocyte dysfunction, decreased complement concentrations, and changes in cell-mediated immunity [20, 21].

Blood transfusion, operative duration and albumin are well-established risk factors for postoperative complications after hepatic resection [12, 16, 19, 22, 23]. Tranchart et al concluded that postoperative complication rate increases by 60% with each additional operative hour in patients who undergo laparoscopic liver surgeries [23]. The longer duration of operation increases the possibility of blood loss, blood transfusion and hypoalbuminemia. Blood transfusion suppress the immune system to decrease natural killer cells and cytotoxic T cells [22]. Also, Sato et al reported that two preoperative parameters, serum albumin level and liver stiffness value, were risk factors for postoperative major complication [12]. Lee et al also reported that lower albumin was an independent risk factor for death [16]. Patients with lower nutrition values may be too weak to recover from catabolism exacerbated by surgical stress and inflammation. In this study, blood transfusion,

1 longer operation time and hypoalbuminemia were significant risk factors associated with
2 postoperative complication consistent with these above studies.

3 A common postoperative complication is continuous pleural effusion and ascites
4 [2, 15-17], at a rate of 5%–56% [24]. In this study, the major postoperative complication
5 was ascites (8.4 %), which is similar to these reports. Postoperative ascites frequently
6 occurs in patients with decreased liver functional reserve, and prolonged postoperative
7 hospital stays [25]. Yoshikawa et al reported that the intra-abdominal infection was 17.6 %
8 in patients with postoperative ascites and 4.8% without postoperative ascites [25]. Nitta et
9 al reported that the rate of the wound infection was 40.4 % in patients with infected ascites
10 and 25.0 % without infected ascites [24]. In particular, they concluded that postoperative
11 methicillin-resistant staphylococci infection in ascites was a potentially fatal hospital
12 complication [24]. In this study, bacterial infection of ascites was a significantly risk factor
13 associated with postoperative SSI.

14 Pathogenic microorganisms in the oral cavity cause infection of multiple organs
15 and affect various diseases [26–29]. Preventing infectious diseases and postoperative
16 complications by oral management intervention has become increasingly important. Some
17 investigators have demonstrated the preventive effect of perioperative oral management on
18 postoperative pneumoniae [9, 10]. Preventing the direct transfer of oral microorganisms
19 decreases aspiration of *pneumoniae* bacteria; and some hypotheses relate oral
20 microorganisms to infecting distant organs [11], via intravascular invasion and transition of
21 odontogenic bacteria by blood vessel or lymph duct, blood transfer of endotoxin or
22 inflammatory cytokine, change of intestinal flora and disorders of intestinal barrier function.
23 Actually, the CDC Guideline for preventing SSI describes that infectious lesions in distant
24 organs including the oral cavity should be treated before surgery [6]. Nobuhara et al
25 reported that perioperative oral management reduced SSI risk after CRC surgery and
26 shortened postoperative hospital stays [11]. In this study, not receiving preoperative oral
27 management intervention was significantly associated with postoperative SSI in

multivariate analysis. Therefore, preoperative oral management intervention may reduce infection in the liver in patients who receive hepatectomies, because bacterial flora are affected by infections of the oral cavity.

This study was limited by its retrospective, non-matched design. Therefore, dental factors such as periodontal issues, caries, or oral hygiene indexes could not be examined; and although multivariate analysis was performed to decrease the effect of confounding factors as far as possible, bias could not be completely excluded. Future research should involve a large-scale, prospective cohort study to evaluate predictors of postoperative SSI and complications.

In conclusion, we successfully demonstrated relationships among various risk factors for SSI and complication in patients with HCC who receive hepatectomy. Ascites, lack of preoperative oral management intervention, and severe liver fibrosis were significantly associated with the development of SSI. Severe liver fibrosis, hypoalbuminemia, blood transfusion, and Longer operation time were significantly associated with the development of postoperative complications. Our results indicate that preoperative oral management may reduce the risk of SSI in patients with HCC who receive hepatectomies.

ACKNOWLEDGEMENTS

We thank the Edanz Group (<https://en-author-services.edanzgroup.com>) for editing a draft of this manuscript.

Conflict of interest: Takumi Hasegawa, Daisuke Takeda, Motofumi Tanaka, Rika Amano, Izumi Saito, Yasumasa Kakei, Akira Kimoto, Takumi Fukumoto and Masaya Akashi declare that they have no conflict of interest.

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FIGURE CAPTIONS

Table 1 Characteristics of patients according to presence of postoperative complications

Table 2 Results of multivariate logistic regression analysis of the risk factors for postoperative complications

Table 3 Characteristics of patients according to presence of postoperative SSI

Table 4 Results of multivariate logistic regression analysis of risk factors for postoperative SSI

Table 1. Characteristics of patients according to presence of postoperative complications

Variables	Comorbidities		<i>P</i> value
	Present, n (%)	Absent, n (%)	
Number of patients	115 (34.4)	219 (65.6)	
Comorbidities (overlapping distribution)			
None	0 (0)	219 (65.6)	
SSI	28 (8.4)	0 (0)	
Ascites	28 (8.4)	0 (0)	
Biliary leakage	21 (6.3)	0 (0)	
Pleural effusion	14 (4.2)	0 (0)	
Liver failure	4 (1.2)	0 (0)	
Deep vein thrombosis	2 (0.6)	0 (0)	
Delirium	2 (0.6)	0 (0)	
Bleeding	1 (0.3)	0 (0)	
Others	20 (6.0)	0 (0)	
Sex			
Male	93 (80.9)	175 (79.9)	0.886 *
Female	22 (19.1)	44 (20.1)	
Age			
Range (Years)	37–86	21–86	
Mean $\pm$ SD	67.2 $\pm$ 10.4	66.3 $\pm$ 11.3	0.500 **
Smoking history			
No	43 (37.4)	83 (37.9)	1.000 *
Yes	72 (62.6)	136 (62.1)	
Alcohol drinking			
No	38 (33.0)	69 (31.5)	0.806 *
Yes	77 (67.9)	150 (68.5)	
Performance status			
0	113 (98.3)	213 (97.3)	0.205 *
1	2 (1.7)	6 (2.7)	
ASA Physical Status Classification			
1	56 (48.7)	123 (56.2)	0.425 ***
2	53 (46.1)	182 (37.4)	
3	6 (5.2)	14 (6.4)	

BMI				
Range (kg/m ²)	15.4–32.2	14.6–34.3		
Mean ± SD	22.9 ± 3.4	22.4 ± 3.4	0.157 **	
Diabetes mellitus				
No	81 (70.4)	165 (75.3)	0.361 *	
Yes	34 (29.6)	54 (24.7)		
Steroid therapy				
No	114 (99.1)	211 (96.3)	0.172 *	
Yes	1 (0.9)	8 (3.7)		
Underlying liver disease				
None	47 (40.9)	102 (46.6)	0.511 ***	
Fatty liver	2 (1.8)	8 (3.7)		
Chronic hepatitis	57 (49.6)	94 (42.9)		
Liver cirrhosis	9 (7.8)	15 (6.8)		
Child–Pugh classification				
A	108 (93.9)	214 (97.7)	0.118 *	
B	7 (6.1)	5 (2.3)		
C	0 (0)	0 (0)		
Liver fibrosis (New Inuyama Classification)				
F0	19 (16.5)	67 (30.6)	0.011 ***	
F1	12 (10.4)	30 (13.7)		
F2	30 (26.1)	56 (25.6)		
F3	36 (31.3)	41 (18.7)		
F4	17 (14.8)	22 (10.0)		
unknown	1 (0.9)	3 (1.4)		
ICG-15				
Range (%)	0.01–38.6	1.8–73.6		
Mean ± SD	12.0 ± 7.9	12.1 ± 8.0	1.000 **	
FEV1.0%				
Range (%)	22.2–102.0	30.9–108.0		
Mean ± SD	73.6 ± 14.4	76.8 ± 13.5	0.078 **	
Hemoglobin (Hb)				
Range (g/dl)	7.5–18.3	7.6–17.1		
Mean ± SD	12.7 ± 2.0	13.1 ± 1.8	0.049 **	
Albumin (Alb)				
Range (g/dl)	2.3–4.8	2.1–5.5		
Mean ± SD	3.8 ± 0.5	4.1 ± 0.5	< 0.001 **	
Preoperative oral management intervention				
No	89 (77.4)	161 (73.5)	0.355 *	

Yes	26 (22.6)	58 (26.5)	
Preoperative respiratory rehabilitation			
No	113 (98.3)	216 (98.6)	1.000 *
Yes	2 (1.7)	3 (1.4)	
Bacterial infection			
Sputum			
Negative	113 (98.3)	219 (100.0)	0.118 *
Positive	2 (1.7)	0 (0)	
Bile			
Negative	110 (95.7)	218 (99.5)	0.020 *
Positive	5 (4.3)	1 (0.5)	
Ascites			
Negative	110 (95.7)	217 (99.1)	0.050 *
Positive	5 (4.3)	2 (0.9)	
Resected segments			
Lobectomy with or without extended	58 (50.4)	90 (41.1)	0.053 ***
Segmentectomy	24 (20.9)	46 (21.0)	
Subsegmentectomy	12 (10.4)	27 (12.3)	
Wedge resection	21 (18.3)	56 (25.6)	
Surgical approach			
Open	110 (95.7)	198 (90.4)	0.116 *
Laparoscopic	5 (4.3)	21 (9.6)	
Blood loss			
Range (ml)	0–3480	0–3370	
Mean ± SD	934.6 ± 748.5	594.8 ± 573.2	< 0.001 **
Operation time			
Range (min)	199–891	84–804	
Mean ± SD	482.5 ± 138.4	428.1 ± 119.6	0.002 **
Blood transfusion			
No	69 (60.0)	171 (78.1)	0.001 *
Yes	46 (40.0)	48 (21.9)	
Length of hospital stay			
Range (days)	7–103	5–80	
Mean ± SD	29.7 ± 20.8	15.3 ± 6.7	< 0.001 **

*. Fisher's exact test. **. Mann–Whitney U test. ***: Chi-squared test.

Table 2. Results of multivariate logistic regression analysis of the risk factors for postoperative complications

Variable	P value	Odds ratio	95 % CI	
			Lower	Upper
Severe liver fibrosis (F3 or F4)	0.003	2.28	1.33	3.91
Hypoalbuminemia (< 4 g/dl)	0.008	2.02	1.20	3.40
Blood transfusion	0.036	1.86	1.04	3.34
Longer operation time (≥ 480 min)	0.033	1.80	1.05	3.08

CI: Confidence interval

Table 3. Characteristics of patients according to presence of postoperative SSI

Variables	SSI		<i>P</i> value
	Present, n (%)	Absent, n (%)	
Number of patients	28 (8.4)	306 (91.6)	
Sex			
Male	23 (82.1)	245 (80.1)	0.529 *
Female	5 (17.9)	61 (19.9)	
Age			
Range (Years)	47–83	21–86	0.913 **
Mean $\pm$ SD	67.5 $\pm$ 8.7	66.5 $\pm$ 11.2	
Smoking history			
No	10 (35.7)	116 (37.9)	1.000 *
Yes	18 (64.3)	190 (62.1)	
Alcohol drinking			
No	9 (32.1)	98 (32.0)	1.000 *
Yes	19 (67.9)	208 (68.0)	
Performance status			
0	27 (96.4)	299 (97.7)	0.507 *
1	1 (3.6)	7 (2.3)	
ASA Physical Status Classification			
1	15 (53.6)	164 (53.6)	0.706 ***
2	10 (35.7)	125 (40.8)	
3	3 (10.7)	17 (5.6)	
BMI			
Range (kg/m ²)	16.2–32.2	14.6–34.3	0.795 **
Mean $\pm$ SD	22.7 $\pm$ 3.6	22.6 $\pm$ 3.4	
Diabetes mellitus			
No	20 (71.4)	226 (73.9)	0.823 *
Yes	8 (28.6)	80 (26.1)	
Steroid therapy			
No	28 (100.0)	297 (97.1)	1.000 *
Yes	0 (0)	9 (2.9)	
Underlying liver disease			
None	12 (42.9)	137 (44.8)	0.779 ***
Fatty liver	0 (0)	10 (3.2)	

Chronic hepatitis	14 (50.0)	137 (44.8)	
Liver cirrhosis	2 (7.1)	22 (7.2)	
Child–Pugh classification			
A	27 (96.4)	295 (96.4)	1.000 *
B	1 (3.6)	208 (3.6)	
C	0 (0)	0 (0)	
Liver fibrosis (New Inuyama Classification)			
F0	3 (10.7)	83 (27.1)	0.116 ***
F1	3 (10.7)	39 (12.7)	
F2	6 (21.4)	80 (26.1)	
F3	11 (39.3)	66 (21.6)	
F4	5 (17.9)	34 (11.1)	
unknown	0 (0)	4 (1.3)	
ICG-15			
Range (%)	0.01–38.6	0.12–73.6	
Mean ± SD	13.5 ± 8.2	11.9 ± 8.0	0.071 **
FEV1.0%			
Range (%)	33.4–102.0	22.2–108.0	
Mean ± SD	71.6 ± 16.1	76.1 ± 13.6	0.178 **
Hemoglobin (Hb)			
Range (g/dl)	8.6–18.3	7.5–18	
Mean ± SD	13.3 ± 2.2	12.9 ± 1.9	0.388 **
Albumin (Alb)			
Range (g/dl)	3.3–4.8	2.1–5.5	
Mean ± SD	3.9 ± 0.4	4.0 ± 0.6	0.228 **
Preoperative oral management intervention			
No	27 (96.4)	224 (73.2)	0.005 *
Yes	1 (3.6)	82 (26.8)	
Preoperative respiratory rehabilitation			
No	27 (96.4)	302 (98.7)	0.356 *
Yes	1 (3.6)	4 (1.3)	
Bacterial infection			
Sputum			
Negative	28 (100.0)	304 (99.4)	1.000 *
Positive	0 (0)	2 (0.6)	
Bile			
Negative	28 (100.0)	300 (98.0)	1.000 *
Positive	0 (0)	6 (2.0)	
Ascites			

Negative	26 (92.9)	301 (98.4)	0.109 *
Positive	2 (7.1)	5 (1.6)	
Resected segments			
Lobectomy with or without extended	12 (42.9)	136 (44.4)	0.706 ***
Segmentectomy	7 (25.0)	63 (20.6)	
Subsegmentectomy	4 (14.3)	35 (11.4)	
Wedge resection	5 (17.8)	72 (23.5)	
Surgical approach			
Open	25 (89.3)	283 (92.5)	0.004 *
Laparoscopic	3 (10.7)	23 (7.5)	
Blood loss			
Range (ml)	0–3330	0–3480	
Mean ± SD	814.9 ± 846.5	702.4 ± 639.0	0.773 **
Operation time			
Range (min)	251–715	84–891	
Mean ± SD	459.0 ± 123.1	445.7 ± 129.4	0.652 **
Blood transfusion			
No	19 (67.9)	234 (76.5)	0.662 *
Yes	9 (32.1)	72 (23.5)	
Length of hospital stay			
Range (days)	9–84	5–103	
Mean ± SD	28.1 ± 18.5	19.6 ± 14.4	< 0.001 **

*: Fisher's exact test. **: Mann–Whitney U test. ***: Chi-squared test.

Table 4. Results of multivariate logistic regression analysis of risk factors for postoperative SSI

Variable	<i>P</i> value	Odds ratio	95 % CI	
			Lower	Upper
Bacterial infection of ascites	0.014	13.72	1.69	111.23
Lack of preoperative oral management intervention	0.035	10.17	1.18	87.52
Severe liver fibrosis (F3 or F4)	0.025	2.76	1.14	6.72

CI: Confidence interval