Thoracic empyema in patients with liver cirrhosis: Clinical characteristics and outcome analysis of thoracoscopic management

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Objective: Thoracic empyema in cirrhotic patients is a challenging situation, and the clinical characteristics are rarely reported. The objective of this study was to report the clinical characteristics among this group and to evaluate whether thoracoscopic intervention would affect clinical outcomes.

Methods: Between 2001 and 2010, we retrospectively reviewed the clinical characteristics, bacteriologic studies, and treatment outcomes of 63 cirrhotic patients with thoracic empyema. A propensity-score based process, matched on age, sex, diabetes mellitus, malignancy, cause, and Child-Pugh classification (A, B, or C), was performed to equalize potential prognostic factors in thoracoscopy and nonthoracoscopy groups. The Kaplan–Meier curve and log-rank test were applied to compare the survival to discharge between the 2 matched groups.

Results: The median patient age was 61 years. Thirty-two patients (51%) underwent thoracoscopic management, and the remaining patients underwent thoracocentesis or tube thoracostomy. The median hospital stay was 28 days, and 19 patients (30%) had in-hospital mortality. Multivariate analysis showed that Child-Pugh C disease and positive blood cultures were risk factors for in-hospital mortality ($P = .016$ and $.027$, respectively), whereas thoracoscopic management may be favorable for survival ($P = .041$). The propensity score-matched analysis showed a significant reduction in intensive care unit stay ($P = .044$) in the thoracoscopy group. Kaplan–Meier survival analysis revealed a higher survival to discharge, favoring thoracoscopy over nonthoracoscopy treatment ($P = .035$).

Conclusions: Management of thoracic empyema in cirrhotic patients is complicated and associated with a high mortality. With proper patient selection, thoracoscopic management is feasible and may provide a better chance of survival. (J Thorac Cardiovasc Surg 2012;143:1144–51)

Thoracic empyema in patients with liver cirrhosis poses a significant challenge to the clinician. In addition to a higher risk of hepatic failure, the pleural infection makes cirrhotic patients more susceptible to critical condition and mortality. Cirrhosis is also regarded as a contraindication to major surgery because of frequent hemostatic abnormalities and malnutrition, which lead to increasing postoperative morbidity or mortality.¹ Patients with cirrhosis are reported

to die because of postoperative complications from hepatic failure with intractable ascites.¹ Moreover, surgical procedures have a high risk of hemorrhage, infection, and metabolic imbalance, and are sometimes withheld from cirrhotic patients for fear of complications.

Since its introduction, video-assisted thoracoscopic surgery (VATS) has become an attractive modality for treating complicated empyema because of its minimal invasiveness and satisfactory efficacy.^{2–7} Although clinical evidence showing VATS is beneficial in the thoracic empyema, the clinical characteristics and the role of VATS in managing patients with empyema with liver cirrhosis are unknown. We report our 10-year experience in managing cirrhotic patients with empyema, especially focusing on analysis of the risk factors. We also examine the therapeutic effect of thoracoscopy in this specific group of patients, compared with nonthoracoscopic treatment, on survival to discharge.

MATERIALS AND METHODS

Patients

The medical records of all patients with thoracic empyema who were discharged with a diagnosis of liver cirrhosis at the National Taiwan University Hospital and National Taiwan University Hospital Yun-Lin Branch, a 3200-bed tertiary medical center, from January 2001 to June 2010 were reviewed retrospectively. Exclusion criteria included empyema caused by

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Abbreviations and Acronyms

CI	= confidence interval
HBV	= hepatitis B virus
HCV	= hepatitis C virus
ICU	= intensive care unit
MRSA	= methicillin-resistant <i>Staphylococcus aureus</i>
OR	= odds ratio
VATS	= video-assisted thoracoscopic surgery

esophageal rupture, mediastinitis, tuberculosis, fungal infection, and postoperative empyema. Information collected included demographic features, clinical characteristics, microbiologic and laboratory data, radiographic studies, hospital course, intervention modality, and treatment outcome.

The diagnosis of thoracic empyema was made if a patient had at least 1 of the following conditions: the presence of purulent material in the pleural space, positive result for loculated pleural fluid culture or Gram stain for microorganisms, and biochemical evidence suggestive of empyema.⁸ A diagnosis of liver cirrhosis was based on the patients' clinical histories and findings of typical morphologic change of the liver and spleen. The severity of liver cirrhosis was graded according to the Child-Pugh classification, which is based on the following 5 factors graded from 1 to 3: degree of encephalopathy, ascites, prothrombin time, level of albumin, and total bilirubin.⁹ The cause of liver cirrhosis was established according to standard criteria for infection with hepatitis B virus (HBV) (positive serum test for hepatitis B surface antigen), hepatitis C virus (HCV) (seropositivity for HCV antibody), coinfection HBV and HCV, or alcoholism related. Other causes included autoimmune disease and cardiac liver cirrhosis. When no cause was identified, liver cirrhosis was classified as cryptogenic.

The Research Ethics Committee of National Taiwan University Hospital approved this study and waived the requirement for informed consent because of its retrospective nature (approval number: 201102015RC).

Demographic and Clinical Features

The algorithm for patient selection is shown in Figure 1. Sixty-three of 888 patients had liver cirrhosis (7.1%). The characteristics and demographics of the cirrhotic patients with thoracic empyema are listed in Table 1. The median age was 61 years, and 39 patients were male. Most patients (87.3%) had chronic underlying diseases or associated medical conditions, including malignancy (33.3%), diabetes mellitus (31.7%), hepatic hydrothorax (30.2%), chronic renal insufficiency (22.2%), and congestive heart failure (11.1%). Among those with malignancy, 18 patients (85.7%) had hepatocellular carcinoma, 2 patients had buccal cancer, and 1 patient had nasopharyngeal cancer. The causes of cirrhosis, the number of Child-Pugh A, B, and C cases, and the inciting infections of thoracic empyema are listed in Table 1.

Management

All patients received empiric broad-spectrum intravenous antibiotics as soon as the diagnosis of thoracic empyema was suspected. Once the causative pathogen was cultured, the antibiotics were adjusted according to sensitivity testing results. Sonography-guided thoracocentesis was performed on all patients, and the aspirates were sent for laboratory examination. Chest computed tomography was performed to evaluate the extent of the empyema and the severity of pulmonary parenchymal lesions, and all patients were noted with fibropurulent stage in this study. The primary physician selected repeated thoracocentesis, pigtail insertion, or tube thoracostomy as the method of drainage. If drainage was not effective,

chest surgeons were consulted to evaluate the feasibility of thoracoscopic management. Before diagnosis, thoracocentesis, and drainage of the empyema, patients may have required albumin and blood component infusions to improve hypoalbuminemia, anemia, thrombocytopenia, or prolonged bleeding time or coagulation time. Patients were admitted to the intensive care unit (ICU) for respiratory distress, organ failure, or unstable vital signs requiring the use of inotropic agents, whether with or without surgical intervention.

Thoracoscopic Procedures

The patients who were treated with thoracoscopy underwent general anesthesia using double-lumen endotracheal tubes for selective 1-lung ventilation. The procedure was performed by means of a 3-port access. On the basis of preoperative sonography and computed tomography, suitable intercostal sites were selected for port placement. Fluid, loculations, and septa were removed under endoscopic vision. Adherent peel was carefully removed from visceral pleural surface, and the lung was freed circumferentially from the apex to the diaphragm. Complete decortication of the visceral pleura and the fissures was performed by use of an endoscopic dissector device and a peanut dissector as in open decortication. At the end of the procedure, 2 chest tubes were placed. The abscess and necrotic tissue from the empyema collection were sent for bacterial cultures and pathologic examination. The postoperative duration of drainage depended on the patient's clinical progress and results of the cultures of fluids aspirated from the drainage tubes.

Statistical Analyses

The primary outcome variable assessed in this study was in-hospital mortality. Categorical variables were compared using chi-square and Fisher exact tests, and continuous variables were compared with the Student *t* test. The median of hospital stays was compared by Mann-Whitney *U* test. Univariate analyses were performed to assess the association between each risk factor and in-hospital mortality. Variables that had a *P* value less than .1 in the univariate analyses were subjected to multivariate analysis using a stepwise binary logistic regression model. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated to determine significance by multivariate analysis. *P* values of less than .05 were regarded as significant. Statistical analyses were performed using SPSS release 18 (SPSS Inc, Chicago, Ill), and all statistical tests were 2-sided.

Propensity Score-Matching Methods

Propensity score matching is a method used to balance observed covariates in the 2 treatment groups. In this study, the propensity score was the conditional probability for receiving thoracoscopy, as a binary dependent variable, under a set of measurements. Age, sex, diabetes mellitus, malignancy, cause of empyema, and Child-Pugh class of liver cirrhosis were added into a nonparsimonious multivariable logistic regression model to predict the effect of thoracoscopy. The predicted probability derived from the logistic equation was used as the propensity score for each individual. Sixty-three patients were pooled and sorted according to their propensity score in ascending order. The selection process began from the first 2 cases with the lowest propensity score. If 1 case underwent thoracoscopy and the other case underwent nonthoracoscopy management, both were selected as a matched pair. If this was not the case, then 4 cases were included. In the same way, thoracoscopy and nonthoracoscopy cases were matched by their propensity score in 1:1, 2:2, 3:3, or 4:4 blocks. A patient who did not have a suitable match within the acceptable rank range was excluded from further analysis, and the matching process moved down the sort list until all possible matched pairs were included.¹⁰ The selected patients formed well-matched 1:1 pairs in both groups (thoracoscopy and nonthoracoscopy). Kaplan-Meier curves, with follow-up until hospital discharge, were plotted to show survival trend. Log-rank test was used to compare the difference between the 2 matched groups. The survival time

FIGURE 1. Algorithm for patient selection.

was defined as the duration from admission to death in the mortality cases and as the duration from admission to discharge in the survivors. A logistic regression model was used for the propensity score calculation using SPSS release 18 (SPSS Inc). Propensity scores in both the thoracoscopy and non-thoracoscopy groups were used to draw box-plots.

RESULTS

Bacteriology

Bacteriologic results from samples obtained from the empyema specimens or blood showed 41 patients (65%) with positive culture results, including positive empyema cultures in 38 patients and positive blood cultures in 12 patients (Table 1). A total of 48 microorganisms were identified, including polymicrobial infections in 4 patients (9.8%) and monopathogens in 37 patients (90.2%). The most common pathogen was *Klebsiella pneumoniae*, found in 11 patients, which was followed by methicillin-resistant *Staphylococcus aureus* (MRSA) in 7 patients (Table 2). When the cause of empyema was stratified by the pathogen isolated, we found *K pneumoniae* was the most common pathogen in patients with parapneumonic

empyema, and *Escherichia coli* and MRSA were more common in empyema due to hepatic hydrothorax (Table 2).

Treatment and Outcome

Of the 63 patients, 32 finally underwent thoracoscopic debridement and drainage of the empyema. The median duration from admission to thoracoscopy was 3 days (range, 1–10 days). The median operation time was 113 minutes (range, 48–172 minutes), and the median intraoperative blood loss was 325 mL (range, 30–580 mL). After the operation, 4 patients (12.5%) required additional procedures for complications, including 1 patient who required repeated thoracoscopy for hemothorax and 3 patients who required open drainage for residual empyema. The remaining 31 patients underwent thoracentesis or tube thoracostomy. The median hospital stay was 28 days. Forty-eight patients (76.2%) were admitted to the ICU for critical conditions, with a ICU stay of 10 days. After treatment, 44 patients survived to discharge, whereas the remaining 19 patients (30.2%) died in the hospital (Table 1). The mortality rates

TABLE 1. Clinical characteristics and treatment outcome of 63 cirrhotic patients with empyema

Variables	Result
	No. (%), or median (range)
Age, y	61 (38~80)
Male	39 (61.9%)
Ever smoker	33 (52.4%)
Right sided	43 (68.3%)
Comorbidity	55 (87.3%)
Malignancy	21 (33.3%)
Diabetes mellitus	20 (31.7%)
Hepatic hydrothorax	19 (30.2%)
Chronic renal insufficiency	16 (25.4%)
Congestive heart failure	7 (11.1%)
Cause of liver cirrhosis	
HBV	28 (44.4%)
HCV	14 (22.2%)
HBV and HCV	5 (7.9%)
Alcoholism	7 (11.1%)
Autoimmune diseases	5 (7.9%)
Others	4 (6.3%)
Child-Pugh class	
A	21 (33.3%)
B	17 (27.0%)
C	25 (39.7%)
Cause of empyema	
Pneumonia	37 (58.7%)
Hepatic hydrothorax	19 (30.2%)
Others	7 (11.1%)
Positive bacterial culture	41 (65.1%)
Empyema	38 (60.3%)
Blood	12 (19.0%)
Thorascopic management	32 (50.8%)
Total hospital stay, d	28 (5~150)
ICU stay, d	10 (0~89)
Mortality	19 (30.2%)

HBV, Hepatitis B virus; HCV, hepatitis C virus; ICU, intensive care unit.

stratified by Child-Pugh cirrhosis class were 14.3% (3/21) in class A, 5.9% (1/17) in class B, and 60% (15/25) in class C. The causes of mortality included sepsis in 9 patients, multiple organ failure in 5 patients, hepatic failure in 4 patients, and intractable gastrointestinal bleeding in 1 patient.

To identify the factors associated with in-hospital mortality, the clinical characteristics, bacteriology, and management between survivors and nonsurvivors are summarized and compared in Table 3 by univariate analysis. We found that patients with Child-Pugh class C and positive blood cultures were associated with a higher rate of in-hospital mortality. On the other hand, patients with male gender, with Child-Pugh class B, and undergoing thorascopic management were associated with a lower rate of in-hospital mortality. Multivariate logistic regression analysis showed that Child-Pugh class C (OR, 6.89; 95% CI, 1.43–33.18) and positive blood cultures (OR, 13.97; 95% CI,

TABLE 2. Microorganisms (n = 48) isolated from 41 patients

Isolates	All isolates n = 48	Cause of empyema		
		Pneumonia n = 27	hydrothorax n = 13	Others n = 8
<i>Klebsiella pneumoniae</i>	11 (22.9%)	8 (29.6%)	1 (7.7%)	2 (25.0%)
<i>MRSA</i>	7 (14.6%)	3 (11.1%)	2 (15.4%)	2 (25.0%)
<i>Escherichia coli</i>	5 (10.4%)	2 (7.4%)	2 (15.4%)	1 (12.5%)
<i>Streptococcus constellatus</i>	3 (6.3%)	2 (7.4%)	1 (7.7%)	0
<i>Enterobacter cloacae</i>	3 (6.3%)	0	1 (7.7%)	2 (25.0%)
<i>MSSA</i>	2 (4.2%)	1 (3.7%)	1 (7.7%)	0
<i>Enterococcus</i>	2 (4.2%)	1 (3.7%)	0	1 (12.5%)
<i>Pseudomonas aeruginosa</i>	2 (4.2%)	2 (7.4%)	0	0
<i>Aeromonas hydrophila</i>	2 (4.2%)	1 (3.7%)	1 (7.7%)	0
<i>A sobria</i>	2 (4.2%)	1 (3.7%)	1 (7.7%)	0
<i>S intermedius</i>	2 (4.2%)	1 (3.7%)	1 (7.7%)	0
<i>S anginosus</i>	2 (4.2%)	2 (7.4%)	0	0
<i>MRCNS</i>	2 (4.2%)	1 (3.7%)	1 (7.7%)	0
<i>PDRAB</i>	2 (4.2%)	1 (3.7%)	1 (7.7%)	0
<i>Salmonella</i>	1 (2.1%)	1 (3.7%)	0	0

MRSA, Methicillin-resistant *Staphylococcus aureus*; MSSA, methicillin-sensitive *Staphylococcus aureus*; MRCNS, methicillin-resistant coagulase-negative staphylococci; PDRAB, pan-resistant *Acinetobacter baumannii*.

1.36–143.57) were risk factors for in-hospital mortality, whereas thorascopic management may be favorable to survival (OR, 0.16; 95% CI, 0.03–0.93) (Table 4).

Thorascopic Versus Nonthorascopic Management

To analyze the role of thorascopic management in cirrhotic patients with empyema, patients were grouped according to receiving or not receiving thorascopic management. There were 32 patients in the thorascopy group and 31 patients in the nonthorascopy group. Patients in the thorascopy group were associated with a lower rate of Child-Pugh class C (21.9% vs 58.1%, $P = .005$), a shorter duration of ICU stay (median, 6 vs 15.0 days; $P < .001$), and a lower rate of in-hospital mortality (12.5% vs 48.4%, $P = .003$). The total hospital stay between the 2 groups was comparable (Table 5). The propensity score-matching method selected 19 patients from the thorascopy group and 19 patients from the nonthorascopy group for further analysis (Figure 2, A and B). Baseline characteristics, including age, gender, comorbidity, and Child-Pugh class, were all comparable in the 2 groups. The results showed that only ICU stay was longer in the nonthorascopy group (median, 13 days) than in the thorascopy group (6 days, $P = .044$). The difference of in-hospital mortality was nonsignificant ($P = .714$, Table 6). Kaplan–Meier survival analysis revealed a higher

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TABLE 3. Clinical characteristics, bacteriology, and management between survivors and nonsurvivors

Variables	Survivors (N = 44)	Nonsurvivors (N = 19)	P
	No. (%), or median (range)	No. (%), or median (range)	
Age, y	61 (38~80)	63 (49~77)	.250
Male	31 (70.5%)	8 (42.1%)	.048
Ever smoker	25 (56.8%)	8 (42.1%)	.410
Right sided	29 (65.9%)	14 (73.7%)	.769
Comorbidity			
Malignancy	13 (29.5%)	8 (42.1%)	.381
Diabetes mellitus	15 (34.1%)	5 (26.3%)	.770
Hepatic hydrothorax	12 (27.3%)	7 (36.8%)	.552
Chronic renal insufficiency	8 (18.2%)	8 (42.1%)	.061
Congestive heart failure	5 (11.4%)	2 (10.5%)	1.000
Child-Pugh class			<.001
A	18 (40.9%)	3 (15.8%)	.080
B	16 (36.4%)	1 (5.3%)	.013
C	10 (22.7%)	15 (78.9%)	<.001
Cause of empyema			
Pneumonia	26 (59.1%)	11 (57.9%)	1.000
Hepatic hydrothorax	12 (27.3%)	7 (36.8%)	.552
Others	6 (13.6%)	1 (5.3%)	.664
Positive culture			
Empyema	26 (59.1%)	12 (63.2%)	1.000
Blood	3 (6.8%)	9 (47.4%)	<.001
Causing pathogen			
<i>Klebsiella pneumoniae</i>	7 (15.9%)	4 (21.1%)	1.000
MRSA	4 (9.1%)	3 (15.8%)	.160
<i>Escherichia coli</i>	2 (4.5%)	3 (15.8%)	.160
Others	18 (40.9%)	7 (36.8%)	1.000
Thoracoscopic management	28 (63.6%)	4 (21.1%)	.003

MRSA, Methicillin-resistant *Staphylococcus aureus*.

survival to discharge, favoring thoracoscopy over non-thoracoscopy treatment (log-rank $P = .035$, Figure 3).

DISCUSSION

Our study aimed to identify the clinical characteristics and prognostic factors affecting in-hospital mortality and to analyze the role of thoracoscopic management in cirrhotic patients with thoracic empyema. The study showed that management of thoracic empyema in cirrhotic patients was challenging and associated with a high mortality rate, especially when patients had Child-Pugh C disease and

TABLE 4. Multivariate logistic regression analysis of risk factors affecting mortality

Associated variables	OR	95% CI	P value
Male	0.51	0.10~2.59	.419
Chronic renal insufficiency	1.21	0.17~8.50	.848
Child-Pugh C*	6.89	1.43~33.18	.016
Positive blood culture	13.97	1.36~143.57	.027
Thoracoscopic management	0.16	0.03~0.93	.041

*Child-Pugh C vs Child-Pugh A and B.

TABLE 5. Clinical characteristics, bacteriology, and treatment outcome between patients undergoing thoracoscopic and non-thoracoscopic management

Variables	Thoracoscopy (N = 32)	Nonthoracoscopy (N = 31)	P
	No. (%), or median (range)	No. (%), or median (range)	
Age, y	59 (38~80)	62 (38~77)	.390
Male	22 (68.8%)	17 (54.8%)	.310
Ever smoker	18 (56.3%)	15 (48.4%)	.617
Right sided	20 (62.5%)	23 (74.2%)	.419
Comorbidity			
Malignancy	11 (34.4%)	10 (32.3%)	1.000
Diabetes mellitus	14 (43.8%)	6 (19.4%)	.060
Hepatic hydrothorax	6 (18.8%)	13 (41.9%)	.060
Chronic renal insufficiency	8 (25.0%)	8 (25.8%)	1.000
Congestive heart failure	5 (15.6%)	2 (6.5%)	.430
Child-Pugh class			.010
A	13 (40.6%)	8 (25.8%)	.290
B	12 (37.5%)	5 (16.1%)	.090
C	7 (21.9%)	18 (58.1%)	.005
Cause of empyema			
Pneumonia	21 (65.6%)	16 (51.6%)	.311
Hepatic hydrothorax	6 (18.8%)	13 (41.9%)	.058
Others	5 (15.6%)	2 (6.45%)	.426
Positive culture			
Empyema	21 (65.6%)	17 (54.8%)	.446
Blood	5 (15.6%)	7 (22.6%)	.536
Causing pathogen			
<i>Klebsiella pneumoniae</i>	6 (18.8%)	5 (16.1%)	1.000
MRSA	5 (15.6%)	2 (6.5%)	.430
<i>Escherichia coli</i>	1 (3.1%)	4 (12.9%)	.196
Others	12 (37.5%)	13 (41.9%)	.799
Total hospital stay, d	29 (9~150)	28 (5~56)	.140
ICU stay, d	6 (0~70)	15 (0~89)	<.001
Mortality	4 (12.5%)	15 (48.4%)	.003

MRSA, Methicillin-resistant *Staphylococcus aureus*; ICU, intensive care unit.

positive blood cultures. Nonetheless, with comparable baseline patient characteristics, thoracoscopic management is feasible and may provide a better chance of survival than nonthoracoscopic management.

Taiwan is an HBV and HCV endemic area¹¹; therefore, it was not surprising that the most common cause of liver cirrhosis was HBV infection, followed by HCV infection.¹²⁻¹⁴ In addition to liver cirrhosis, we also noticed that 87.3% of our patients with empyema had additional chronic underlying diseases or associated medical conditions. Comorbidities make the management of thoracic empyema more complicated and difficult. As a result, the median hospital stay was significantly longer (28 days) and overall in-hospital mortality was high (30.2%).

The Child-Pugh class is a useful model to predict the relative risk of mortality in patients with end-stage liver disease, with or without surgical intervention.^{9,15,16} In the

FIGURE 2. Propensity analysis. Distribution of propensity scores in the nonthoracoscopy and thoracoscopy groups before (A, n = 63) and after (B, n = 38) matching.

present study, Child-Pugh class C remained an important factor associated with a higher rate of in-hospital mortality in multivariate analysis. When the mortality rate was stratified by Child-Pugh class, mortality was 14.3%, 5.9%, and 60% in Child-Pugh A, B, and C cases, respectively. In our patients, sepsis and hepatic failure were common causes of death. A possible explanation is that the immunity and hepatic reserve of patients with Child-Pugh class C cirrhosis were severely compromised, so that retained pus immediately resulted in sepsis and hepatic failure.¹

As for coexisting cancer, 18 of 21 patients (85.7%) had hepatocellular carcinoma. Although no significance was found, the cirrhotic patients with malignancy were worth noticing because their immunity may be weakened by the cancer.

Multivariate analysis also showed that positive blood cultures were an independent risk factor for a higher rate of mortality. Bacterial overgrowth, despite antibiotic therapy and

TABLE 6. Propensity analysis baseline characteristics and clinical outcomes between patients undergoing thoracoscopic and nonthoracoscopic management

Variables	Thoracoscopy (N = 19)	Nonthoracoscopy (N = 19)	P value
	No. (%), or median (range)	No. (%), or median (range)	
Age, y	57.5 (38–80)	60.5 (38–77)	.676
Male	14 (73.7%)	13 (68.4%)	1.000
Ever smoker	12 (63.2%)	11 (57.9%)	1.000
Right sided	12 (63.2%)	12 (63.2%)	1.000
Comorbidity			
Malignancy	7 (36.8%)	6 (31.6%)	1.000
Diabetes mellitus	4 (21.1%)	5 (26.3%)	1.000
Hepatic hydrothorax	6 (31.6%)	7 (36.8%)	1.000
Chronic renal insufficiency	4 (21.1%)	3 (15.8%)	1.000
Congestive heart failure	3 (15.8%)	1 (5.3%)	.604
Child-Pugh class			
A	9 (47.4%)	8 (42.1%)	1.000
B	4 (21.1%)	5 (26.3%)	1.000
C	6 (31.6%)	6 (31.6%)	1.000
Cause of empyema			
Pneumonia	10 (52.6%)	10 (52.6%)	1.000
Hepatic hydrothorax	6 (31.6%)	7 (36.8%)	1.000
Others	3 (15.8%)	2 (10.5%)	1.000
Positive culture			
Empyema	12 (63.2%)	10 (52.6%)	.743
Blood	3 (15.8%)	4 (21.1%)	1.000
Causing pathogen			
<i>Klebsiella pneumoniae</i>	4 (21.1%)	2 (10.5%)	.659
MRSA	5 (26.3%)	1 (5.3%)	.180
<i>Escherichia coli</i>	1 (5.3%)	1 (5.3%)	1.000
Others	8 (42.1%)	9 (47.4%)	1.000
Total hospital stay, d	30 (13–150)	28 (5–52)	.139
ICU stay, d	6 (0–70)	13 (0–89)	.044
Mortality	4 (21.1%)	6 (31.6%)	.714

MRSA, Methicillin-resistant *Staphylococcus aureus*; ICU, intensive care unit.

drainage, indicates potentially greater bacterial toxicity or poor host immunity, resulting in poor outcomes. The results of our study showed that *K pneumoniae* was the most common pathogen (26.8%), as in many other patients with non-cirrhotic empyema in Taiwan.^{17,18} When taking the cause of empyema into consideration, *K pneumonia* was the main causative pathogen in parapneumonic empyema, whereas *E coli* and MRSA were more common in hepatic hydrothorax. Our results are comparable to those of a previous report showing that *E coli* was the most common pathogen in cirrhotic patients with spontaneous bacterial empyema.¹⁹

One of the most challenging decisions in treating cirrhotic patients with empyema is to select the optimal intervention to evacuate the pus and obliterate the pleural space. Open thoracotomy offers the best efficacy but is considered contraindicated in this patient group because of the high risk of perioperative complications. However, the role of

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FIGURE 3. Kaplan-Meier plot of the survival-to-discharge in the non-thoracoscopy and thoracoscopy groups.

thoracoscopy in managing these vulnerable patients has never been published. We found that thoracoscopic management was associated with a better chance of survival. Thoracoscopy provides minimal invasive access to the pleural space and is effective in evacuating viscous pleural fluid, lysing adhesions to promote the drainage of locules, and placing chest tubes in dependent regions of empyema under direct visualization.^{20,21} According to our experience, thoracoscopy drains most of the loculated empyema with minimal trauma to the pleural cavity, which is especially beneficial in cirrhotic patients with bleeding tendencies. In addition, less invasiveness and less surgical trauma of thoracoscopy also reduce impairment of patient immunity and inflammatory and cytokine responses.²¹⁻²⁴ Although a repeated operation is sometimes required (12.5%) for bleeding and inadequate drainage, thoracoscopy is feasible in selected patients after proper preoperative management.

Limitations

There are limitations to this study because it is retrospective. Selection bias may exist. It could be argued that the surgeons tended to choose patients with better general conditions because patients in the thoracoscopic group had a lower rate of Child-Pugh class C cirrhosis. Although the multivariate analysis showed that thoracoscopic management was an independent factor associated with better survival, some residual bias could still remain. We then performed the propensity score-matching method to avoid the bias. Because of the small case number after meticulous selection, there was no sufficient power to detect the difference in mortality rate at discharge (thoracoscopy 21.1% vs no thoracoscopy 31.5%, $P = .714$). However, there is still

a statistically significant reduced hazard favoring thoracoscopy (log-rank test $P = .035$), indicating a prolonged median survival after the intervention. In addition, treatment policy was not standardized among physicians and surgeons, especially for the timing for thoracoscopic intervention. We believe that a prospective study with precise definitions of variables and standardized treatment protocols would be helpful in validating our results.

CONCLUSIONS

Thoracic empyema in cirrhotic patients represents a clinical challenge, with a high in-hospital mortality rate. Prompt identification of the causative pathogens and aggressive evacuation of pus from the pleural space are mandatory to rescue these vulnerable patients. Our results also showed that, with proper patient selection, thoracoscopic management is feasible and may provide a better chance of survival.

References

- del Olmo JA, Flor-Lorente B, Flor-Civera B, et al. Risk factors for nonhepatic surgery in patients with cirrhosis. *World J Surg.* 2003;27:647-52.
- Luh SP, Chou MC, Wang LS, et al. Video-assisted thoracoscopic surgery in the treatment of complicated parapneumonic effusions or empyemas: outcome of 234 patients. *Chest.* 2005;127:1427-32.
- Solaini L, Prusciano F, Bagioni P. Video-assisted thoracic surgery in the treatment of pleural empyema. *Surg Endosc.* 2006;21:280-4.
- Wozniak CJ, Paull DE, Moezzi JE, et al. Choice of first intervention is related to outcomes in the management of empyema. *Ann Thorac Surg.* 2009;87:1525-31.
- Chambers A, Routledge T, Dunning J, et al. Is video-assisted thoracoscopic surgical decortication superior to open surgery in the management of adults with primary empyema? *Interact Cardiovasc Thorac Surg.* 2010;11:171-7.
- Shahin Y, Duffy J, Beggs D, et al. Surgical management of primary empyema of the pleural cavity: outcome of 81 patients. *Interact Cardiovasc Thorac Surg.* 2010;10:565-7.
- Chen JS, Huang KC, Chen YC, et al. Pediatric empyema: outcome analysis of thoracoscopic management. *J Thorac Cardiovasc Surg.* 2009;137:1195-9.
- Light RW. A new classification of parapneumonic effusions and empyema. *Chest.* 1995;108:299-301.
- Pugh RN, Murray-Lyon IM, Dawson JL, et al. Transection of the oesophagus for bleeding oesophageal varices. *Br J Surg.* 1973;60:646-9.
- Chen YS, Lin JW, Yu HY, et al. Cardiopulmonary resuscitation with assisted extracorporeal life-support versus conventional cardiopulmonary resuscitation in adults with in-hospital cardiac arrest: an observational study and propensity analysis. *Lancet.* 2008;372:554-61.
- Chen DS. From hepatitis to hepatoma: lessons from type B viral hepatitis. *Science.* 1993;262:369-70.
- Chen YC, Chu CM, Yeh CT, et al. Natural course following the onset of cirrhosis in patients with chronic hepatitis B: a long-term follow-up study. *Hepatol Int.* 2007;1:267-73.
- Dai CY, Ho CK, Huang JF, et al. Hepatitis C virus viremia and low platelet count: a study in a hepatitis B & C endemic area in Taiwan. *J Hepatol.* 2010;52:160-6.
- Lu SN, Su WW, Yang SS, et al. Secular trends and geographic variations of hepatitis B virus and hepatitis C virus-associated hepatocellular carcinoma in Taiwan. *Int J Cancer.* 2006;119:1946-52.
- Fernandez-Esparrach G, Sanchez-Fueyo A, Gines P, et al. A prognostic model for predicting survival in cirrhosis with ascites. *J Hepatol.* 2001;34:46-52.
- Friedman LS. Surgery in the patient with liver disease. *Trans Am Clin Climatol Assoc.* 2010;121:192-204.
- Chen KY, Hsueh PR, Liaw YS, et al. A 10-year experience with bacteriology of acute thoracic empyema: emphasis on *Klebsiella pneumoniae* in patients with diabetes mellitus. *Chest.* 2000;117:1685-9.
- Lin YT, Chen TL, Siu LK, et al. Clinical and microbiological characteristics of community-acquired thoracic empyema or complicated parapneumonic effusion caused by *Klebsiella pneumoniae* in Taiwan. *Eur J Clin Microbiol Infect Dis.* 2010;29:1003-10.

19. Chen CH, Shih CM, Chou JW, et al. Outcome predictors of cirrhotic patients with spontaneous bacterial empyema. *Liver Int.* 2011;31:417-24.

20. Heffner JE, Klein JS, Hampson C. Interventional management of pleural infections. *Chest.* 2009;136:1148-59.

21. Cassina PC, Hauser M, Hillejan L, et al. Video-assisted thoracoscopy in the treatment of pleural empyema: stage-based management and outcome. *J Thorac Cardiovasc Surg.* 1999;117:234-8.

22. Novitsky YW, Litwin DE, Callery MP. The net immunologic advantage of laparoscopic surgery. *Surg Endosc.* 2004;18:1411-9.

23. Ng CS, Whelan RL, Lacy AM, et al. Is minimal access surgery for cancer associated with immunologic benefits? *World J Surg.* 2005;29:975-81.

24. Chen KC, Chen JS, Kuo SW, et al. Descending necrotizing mediastinitis: a 10-year surgical experience in a single institution. *J Thorac Cardiovasc Surg.* 2008;136:191-8.

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