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ORIGINAL RESEARCH

Outcome of Pleural Empyema Treated With Video-Assisted Thoracoscopic Surgery in Patients With Severe Co-Morbidities: An Observational Study

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Background: Empyema patients with poor physical condition and severe comorbidities face a significant challenge, with difficulties in choosing appropriate treatment methods, limited treatment outcomes, and a high rate of complications and mortality.

Objective: To comment on the indications and to evaluate the treatment outcomes of pleural empyema in patients with poor physical condition and severe comorbidities by thoracoscopic surgery.

Methods: An observational study on 12 patients treated at the Department of Thoracic Surgery – Military Hospital 103, from January 2017 to December 2022.

Results: The mean of age was 63.4 ± 12.4 years old, with a male/female ratio of 5/1. In this study, 83.3% of cases were presented with stage II empyema. The mean Karnofsky score was 50.0 ± 6.1. Some comorbidities contained chronic obstructive pulmonary disease (COPD) (25.0%), spontaneous esophageal perforation (16.7%), liver cancer, cirrhosis, esophageal cancer, end-stage renal failure – chronic dialysis (8.7%). The surgery procedures were efficient with a short duration (65.6 ± 9.4 minutes), low incidence of blood transfusion (8.3%), and lower rate of postoperative complications (surgical wound infection 8.3%). The length of postoperative stay was 16.8 ± 9.9 days. Pleural drainage was removed in 11 out of 12 cases after an average of 60.1 ± 8.5 days, while one patient had their drainage retained due to esophageal cancer. The total recovery rate at the 1-year follow-up was 91.7%.

Conclusion: Video-Assisted Thoracoscopic Surgery (VATS) exhibits positive outcomes in treating stage I and II pleural empyema patients who incurred severe comorbidities.

Keywords: pleural empyema, video-assisted thoracoscopic surgery, pus drainage

Introduction

Empyema is a common disease, with approximately 80,000 cases reported annually in the United Kingdom and the United States.[1] In the early 20th century, the mortality from empyema in camps that used open drainage as the standard treatment method ranged from 20.0% to 30.2%, with some instances exceeding 70.0%. This high mortality was probably attributed to respiratory failure prompted by the large pneumothorax resulting from open drainage.[2] The disease is common in the elderly or people with immunosuppression or comorbidities.[3–6]

Along with antibiotic therapy, many methods are currently applied in treating pleural empyema, including drainage, video-assisted thoracoscopic surgery (VATS), open surgery, or open window thoracostomy.[6] The selection of a treatment

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method must be based on various factors such as the patient's overall condition, disease stage, age, and concurrent pathologies.

Treatment of patients with empyema in poor health conditions and severe comorbidities remains a challenge. The rate of complications and mortality after intervention and treatment is high, with the rate of complications being 70.5%, and mortality ranging from 7.6% to 38.2%. The mortality rate can even be up to 75% to 100% in the group of empyema resulting from complications of spontaneous esophageal rupture (Boerhaave syndrome) depending on the treatment method applied.

The limited success in the use of current methods raises the need for further research to improve the effectiveness of treatment approaches. Thus, we conducted this study with the following objectives: to comment on the indications and to evaluate the results of VATS to clean the pleural cavity, chest tube gradually withdrawn for treating pleural empyema in patients with severe comorbidities.

Study Population and Methodology

Study Population

Pleural empyema patients with poor physical condition and severe comorbidities who were indicated for VATS at the Department of Thoracic Surgery – Military Hospital 103, from January 2017 to December 2022.

Inclusion Criteria

Patients with an established diagnosis of pleural empyema are classified as stages I and II according to the British Thoracic Society (BTS) 2010 and American Association for Thoracic Surgery (AATS) 2017.[7,8]

Patients with at least one severe comorbidity, namely heart failure grade III, IV; advanced stage of cancer; Child-Pugh B or C cirrhosis; hemodynamic disorders, prothrombin time <60%; chronic renal failure with dialysis; chronic obstructive pulmonary disease (COPD); empyema due to complications of spontaneous esophageal perforation (Boerhaave syndrome).

Exclusion Criteria

Patients who have contraindications to anesthesia due to drug allergies, acute heart failure, or advanced COPD.

Patients who disagree to participate in the study.

Methodology

This was an observational study.

The Thoracoscopic Surgical Procedure

Surgical instruments: using general endoscopic instruments (Figure 1).

Anesthesia: general anesthesia, single or double-lumen endotracheal tube.

The patient was put in lateral decubitus position (Figure 2).

Steps of Thoracoscopic Surgical Procedure

Inserting troca:

1st Troca was placed at the 6th, 7th or 8th intercostal spaces on anterior, middle, or posterior axillary line: channel for scope.

2nd Troca was placed at the 4th or 5th intercostal spaces on the anterior axillary line (in case the pleural cavity was adherent, Troca holes will be expanded into a supporting thoracotomy line 3 cm–5 cm long)

In some cases, Troca 3 can be placed, the location depends on the purpose and ensures the "pyramid" principle.

Implementation: assessing pleural cavity (Figure 3A); Using a tampon or metal suction: lung liberation from adhesions, early lung peeling (removing the pseudomembrane), or true peeling (separating the fibrin layer on the visceral pleura); Washing and removing maximum pus and necrotic tissue from the pleural cavity with 0.9% NaCL; treating air leaks, bleeding (Figure 3B); Place 1 or 2 chest tube to drainage air leaks and fluid; close the incision.

Postoperative care, monitoring and treatment: Postoperative antibiotics were given, combined with oral and intravenous nutrition supplements. Drainage of the pleural space was continuously suctioned under a pressure of −10 to −20 cm H_2O until no air is released. After that, in cases where 2 drainage tubes are placed, 1 tube will be removed.

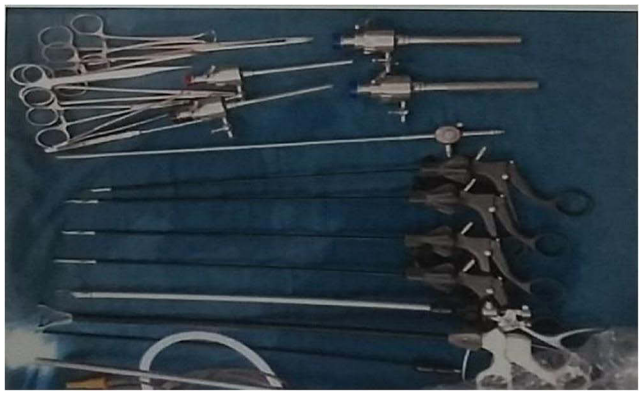

Figure 1 Surgical instruments.

Figure 2 Patient position during surgery.

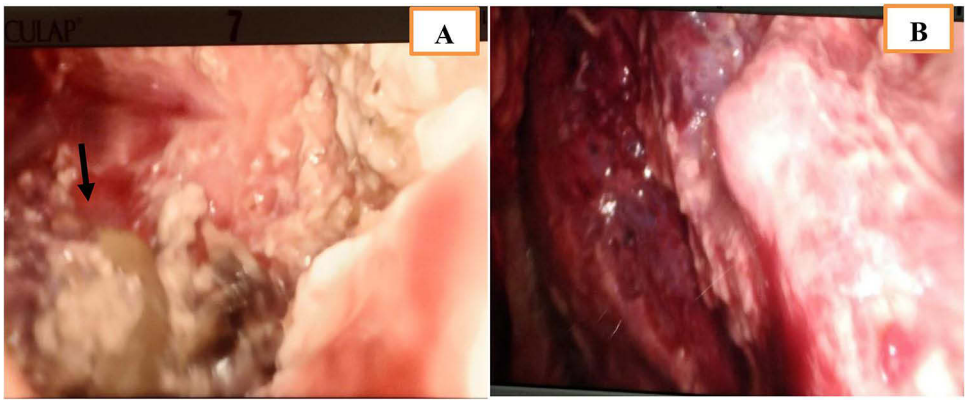

Figure 3 Pleural cavity. (**A**) Before intervention: Image of foreign bodies (Piece of Food) in the pleural cavity in a patient with pleural empyema due to complications of primary esophageal perforation (black arrow). (**B**) After intervention: The pleural cavity is cleared.

Enhanced recovery after surgery (ERAS) protocol was applied: early nutrition, early mobilization 12 to 24 hours after surgery; breathing and blowing exercises, restoring respiratory function early after surgery: cough, expectorate, vibrate, abdominal breathing practice (diaphragm movement) and using a spirometer 3 to 5 times per day (Figure 4).

The drainage tube would be tied with a nylon bag (Figure 5) when the drainage fluid was less than 50 mL/24 hours. Patients could mobilize and exercise conveniently. The drainage bags were renewed every 24 hours.

The patients were discharged when their overall clinical condition improved (Karnofsky ≥ 60%), the fever was gone, and spontaneous breathing was satisfactory. They were given instructions for home care and physical therapy.

Figure 4 Postoperative breathing practice with equipment.

Figure 5 Bandages and pus bag changes.

Monitoring and treatment patients after discharging from the hospital: Follow-up examination was implemented every 2–4 weeks. Chest tube drainage was removed when the fluid was clear and the amount was less than 20 mL/24 hours with decent lung expansion on CT-scan imaging (Figures 6 and 7). This follow-up activity ended 12 months after surgery.

Study Parameters

The Population's Characteristics

+ Demographic parameters: age, sex, comorbidities, Karnofsky score, and BMI.
+ Paraclinical parameters:

Blood test results before surgery and 1 month after surgery: Hematological indices (the number of red blood cells, white blood cells, platelets), biochemical (protein, albumin, urea, creatinine).

- CT-scan imaging: pleural empyema position.

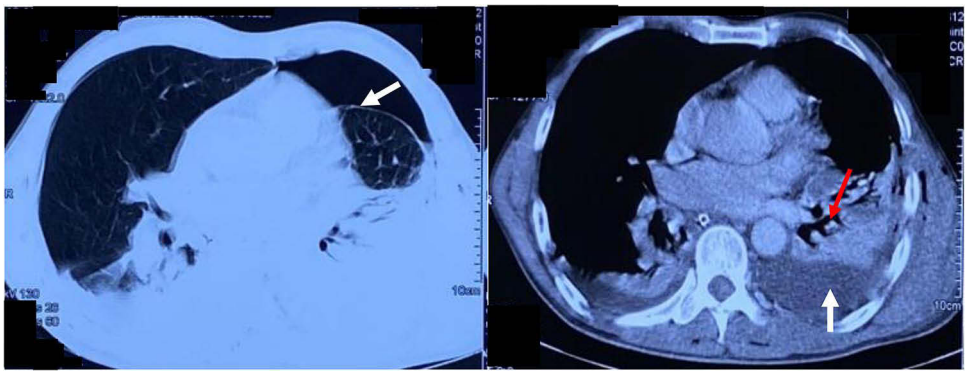

Figure 6 Preoperative CT-scan imaging (54 year old patient): Left pneumothorax and pleural effusion (white arrow), consolidation of the lower lobe of the left lung (red arrow); small right pleural effusion.

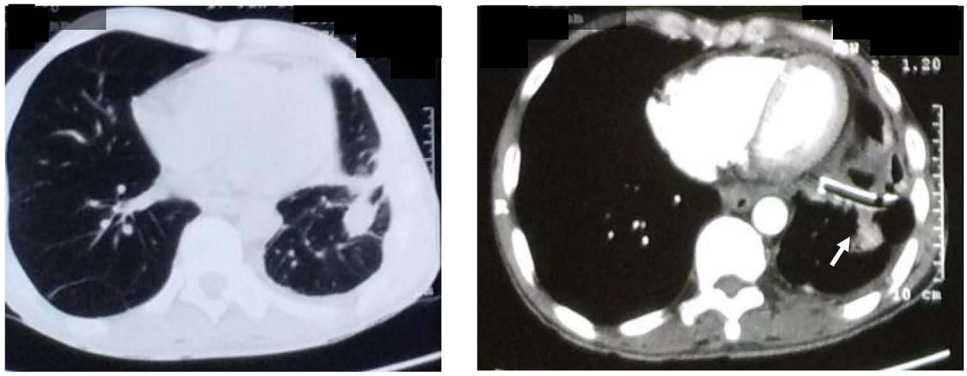

Figure 7 CT-scan imaging 02 months postoperative (54 year old patient): Reduced left lung volume, chest tube in the left side (white arrow).

- Pleural empyema cultures.
- Diagnosis of disease stages (according to BTS 2010), including stage I – acute, stage II – subacute, and stage III – chronic.[7]

Surgical Outcomes Assessments

+ Intraoperative results: anesthesia method, surgical time, complications, blood transfusion.
+ Post-operative outcomes: post-operative complications, length of hospital stay, lung expansion, duration of wearing drains, cured disease.

Data Analyze

Data were processed using SPSS 20.0 statistical software. Quantitative variables displaying standard normal distribution are expressed as mean and standard deviation. Ordinal and discrete variables are presented as percentages.

Results

Patients' Characteristics

There were 02 cases in the acute stage that developed empyema after thoracic esophageal rupture, with complicated injuries: one had drainage placed at a lower-level hospital, and the other had drainage placed immediately upon admission. One patient had an esophageal stent placed one day undergoing endoscopic surgery to clear the pleural cavity. In another patient, the esophageal tear near the cardia was simultaneously sutured through laparotomy and VATS to treat empyema (Table 1).

Table 1 Study Population's Characteristics

Parameters		n	%
Age (years)		63.4 ± 12.4 (38–77)	
Karnofsky (points)		50.0 ± 6.1 (40–60)	
BMI (kg/m^2)		17.9 ± 2.1 (16.0–22.3)	
Gender	Male	10	83.3
	Female	2	16.7
Pleural empyema position	Right	5	41.7
	Left	6	8.3
	Both	1	50.0
Pleural empyema stages	I	2	16.7
	II	10	83.3
Comorbidities	Boerhaave syndrome	2	16.7
	COPD	3	25.0
	Child-Pugh C cirrhosis	1	8.3
	Liver cancer	1	8.3
	Arthritis, Cushing syndrome	2	16.7
	Chronic kidney failure, dialysis	1	8.3
	Heart failure NYHA class 3	1	8.3
	Esophageal cancer	1	8.3
	Diabetes	4	33.3
	Hypertension	4	33.3
Interventions before scopic surgery	Pleural cavity drainage	2	16.7
	Esophageal stenting	1	8.3
Combined surgery	Surgery to suture esophageal perforation and open gastrostomy	1	8.3
	Jejunostomy	1	8.3
	Naïve	10	83.3

Abbreviations: BMI, body mass index; COPD, chronic obstructive pulmonary disease; NYHA, New York heart association.

There were 06 patients with positive bacterial cultures, including the following bacteria: *Streptococcus intermedius, Pseudomonas aeruginosa, Streptococcus viridans, Streptococcus iridians, Staphylococcus aureus*. Especially, 01 case of coinfections with *Pseudomonas aeruginosa and Streptococcus viridans* (Table 2).

Surgery Outcomes

There was 01 patient with empyema due to primary esophageal rupture had two surgeries performed simultaneously, including VATS to clean the pleural cavity and suturing the esophageal tear through laparotomy. The time for VATS to treat pleural empyema was calculated separately (Table 3).

Postoperative red blood cell indexes, hemoglobin, albumin, and protein were improved compared to preoperative. Similarly, the number of white blood cells and the neutrophil ratio decreased (Table 4).

Table 2 Bacteriology of Culture of Pleural Fluid

Bacterial Species	Positive	%
Streptococcus intermedius	1	8.3
Pseudomonas aeruginosa + *Streptococcus viridans*	1	8.3
Pseudomonas aeruginosa	1	8.3
Streptococcus iridians	1	8.3
Staphylococcus aureus	1	8.3
Streptococcus pneumoniae	1	8.3
Total	6	50.0

Table 3 Early Outcomes

Parameters		n	%
Surgery duration (minutes)		65.6 ± 9.4 (48–82)	
Blood transfusion		1	8.3
Complications	Hemorrhage	0	0.0
	Local infection	1	8.3
Postoperative stay (day)		16.8 ± 9.9 (8–42)	
CT-scan one day before discharge	Lungs fully expand	0	0.0
	Lungs partly expand	12	100.0

Table 4 Changes in Hematological Parameters Over Time

Parameters	Preoperative (Mean ± SD)	One Month Postoperative (Mean ± SD)
Red blood cell (T/L)	3.53 ± 0.48	3.77 ± 0.34
Hemoglobin (g/L)	96.7 ± 17.9	110.3 ± 10.3
White blood cell (G/L)	15.45 ± 2.74	7.50 ± 1.33
Neut (%)	84.7 ± 4.1	75.6 ± 4.1
Platelet (G/L)	204 ± 139	211 ± 100
Urea (mmol/L)	6.96 ± 1.92	6.99 ± 1.99
Creatinin (μmol/L)	115.7 ± 35.8	116.4 ± 36.9
Albumin (g/L)	28.6 ± 2.5	33.8 ± 3.1
Protein (g/L)	58.3 ± 4.2	66.2 ± 5.3

The reason for being unable to remove the drainage in one case due to the combination of pleural empyema and esophageal cancer. In one case, drainage could not be removed due to the combination of pleural empyema and esophageal cancer. The drainage tube was maintained, and the fluid bag discharges was changed every 2 days. The patient could perform daily activities (Table 5).

Table 5 One-year Follow-up Outcomes

Parameters	n (%)	Duration (day)	Totally Recover	Remain Stably
Drainage tube removed	11 (91.7)	60.1 ± 8.5 (47–75)	11 (91.7)	0
The drain cannot be removed	1 (8.3)		0	1 (8.3)

Discussion

Treatment methods for pleural empyema have been improved and developed over time. However, the goals and principles of treatment remain unchanged: cleaning the pleural cavity, freeing the lungs, and creating conditions for the lungs to expand close to the chest wall. Up to now, antibiotic therapy still plays a leading role in the treatment of pleural empyema. Additionally, many interventions have been applied and have achieved positive results. Recent reports have shown positive outcomes in the treatment of this disease. Treatment with medical thoracoscopy or tube thoracostomy with intrapleural instillation of tissue plasminogen activator and human recombinant deoxyribonuclease is considered a safe and effective treatment method, with a fairly high success rate of 75.0%–81.25%.[9] Uniportal VATS exhibited outstanding effectiveness, with a success rate of up to 100% in the treatment of stage II pleural empyema.[10]

Despite various interventions, the treatment of pleural empyema in patients with poor physical condition and severe comorbidities is still challenging. The treatment outcomes in patients with Karnofsky ≤50 and comorbidities such as severe COPD, lung cancer, right ventricular dysfunction, coupled with a high rate of complications and mortality. According to previous reports, the mortality rate was approximately 7.6%.[11] Patients with COPD had a higher risk of developing empyema (15.80 vs 4.34 per 10,000 people/year), the hazard ratio of developing empyema is 3.25 (95% CI = 2.73–3.87).[12] However, research on treatment outcomes in this particular group of patients was rarely discussed. As the results of a meta-analysis of the American Association of Thoracic Surgeons' database (2018), the rate of mortality and complications were 3.1%, 39.3%, respectively.[13] Chen et al (2012) studied empyema treatment outcomes in a cohort of cirrhotic patients, finding a mortality rate of 30.0%. Child-Pugh C cirrhosis and negative blood cultures were risk factors for increased mortality (p = 0.016 and 0.027).[14] Among patients who had chronic kidney disease, with a glomerular filtration rate below 60 mL/minute/1.73 m^2, the complication rate was up to 70.5%, and the mortality was 38.2%. Besides, the operations were complicated with a long surgical duration (304 minutes) and severe hemorrhage (average 562 mL).[11] Empyema resulting from complications of spontaneous esophageal rupture (Boerhaave syndrome) was complex and severe. While patients can be treated with conservative, endoscopic, or surgical methods, the outcomes remain very limited, with reported mortality rates of 75%, 100%, and 81%, respectively, for each one.[15]

Due to the high risks of complications of anesthesia or surgery, choosing the appropriate treatment method for the patients is also a real challenge. It requires both good cleaning of the pleural cavity, maximum lung clearance and minimal invasiveness. Therefore, it is necessary to continue researching and proposing highly effective treatment methods, minimizing the rate of complications and mortality.[10,16]

For this group, conservative treatment is often indicated as a first step, but its results are limited. Bar et al (2010) reported using fibrinolytic therapy, where the success rate reached 79.3%, and 20.7% failed treatment and underwent surgery. The author recorded a mortality rate of 2.7% and complications of 6.3%.[17]

Sziklavari et al (2011), applied open window thoracostomy combined with continuous negative pressure suction technique. The success rate of this method reached at 87.7%. The average hospital stay is 22.7 days. After the first surgery 97.5 ± 66.5 days, 62.5% of cases had the window closed by plastic surgery to fill the residual cavity with autologous muscle flap transfer and 25.0% of cases did not need plastic surgery to fill the residual cavity due to the maximum contracts of the pleural cavity. However, local care of the surgical wound was complicated, the first dressing changes needed to be done in the operating room under anesthesia (an average of 2.1 times), and the mortality rate was up to 12.3%.[18]

In a study by Biswas et al (2016), patients with chronic empyema were assessed as unable to expand their lungs (based on chest computed tomography) who failed in responding to fibrinolytic therapy. Chest tubes were placed and maintained for these patients as they were receiving outpatient treatment. The "Empyema tubes" gradually shortened over time. All the patients fully recovered, with the drain successfully removed after an average of 73.62 ± 49.73 days;

the longest duration for drain removal was 240 days.[19] However, this method had some limitations: the ability to completely debride and remove all pus, adhesions, and septa. As a result, the thoroughness is compromised and might extend the treatment time.

For patients with a nonexpandable lung who had been failure of treated with antibiotics, tube thoracostomy and intrapleural fibrinolytic therapy. In case of invasive treatment, options that include surgical decortication are not feasible or not desired. Majid et al (2019) applied tunneled pleural catheters. The catheter had been removed within a median of 36 days for 63.6% cases. One patient had worse pleural space infection which originated from soft tissue infection at the site of catheter insertion, so had to undergo open window thoracostomy.[20]

Currently, VATS has been commonly applied in the treatment of pleural empyema thanks to its outstanding advantage of minimizing invasiveness and of performing the technique under the guidance of camera images. We have applicated the advantages of this surgical method, using metal tube suction and tampons for removing maximum pseudomembranes, necrotic tissue, and foreign bodies to liberate pulmonary and drain the pus, maximally cleaning the pleural cavity but not completely remove pseudomembranes of the lung, which may pose a high risk of heavy bleeding, prolonging the surgery time. We also actively applied the ERAS protocol early, strengthened measures to restore respiratory function, increased lung expansion ability, and maintained chest tube to maximize drainage of remaining pus after surgery. Therefore, the treatment results for patients with empyema who are in poor physical condition (Karnofsky = 50.0 ± 6.1%; BMI = 17.9 ± 2.1%) and have severe comorbidities were positive with average chest tube drainage time of 60.1 ± 8.5 days. No deaths were recorded during the follow-up.

The study had some limitations. First, its population was relatively small. Second, the postoperative respiratory function has not been evaluated. Finally, the treatment method also has limitations: the patient must carry a chest tube for a long duration (60.1 ± 8.5 days), causing inconvenience in daily routine and aesthetic features.

Conclusion

The application of VATS to clean the pleural cavity combined with tube gradually withdrawn to treat sub-acute and acute stages of empyema in patients with severe combined diseases has yielded positive results. The approach has shown a high recovery rate, safety and mild complications with a low frequency (8.3%).

Abbreviations

BMI, body mass index; BTS, British Thoracic Society; COPD, chronic obstructive pulmonary disease; NYHA, New York heart association; ERAS, Enhanced recovery after surgery; VATS, Video-Assisted Thoracoscopic Surgery.

Ethical Approval

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethical Review Committee of Military Hospital 103 (Reference 399B/2022/HĐĐĐ, date August 20th, 2022). Written informed consent was obtained from all the patients or from a legal representative before the study. The patients in Figures 4 and 5 provided written informed consent for the images to be published.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors declared no potential conflicts of interest to this article's research, authorship, and/or publication.

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