



## Original article

## The role of hyperbaric oxygen therapy in treating extensive Fournier's gangrene

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## ARTICLE INFO

## Article history:

Received 18 March 2015

Received in revised form

17 June 2015

Accepted 25 June 2015

Available online 11 September 2015

## Keywords:

fasciotomy

Fournier's gangrene

hyperbaric oxygen therapy

necrotizing fasciitis

## ABSTRACT

**Background:** Fournier's gangrene (FG) is a rapidly progressive necrotizing infection of the perineal and genital fascia. The disease is always associated with high morbidity and mortality if diagnosed late and treated improperly.

**Purpose:** This paper analyzed the epidemiology of FG, and clarified the treatment strategy of FG of different origins and prognosis.

**Methods:** From January 2007 to December 2015, 60 patients with FG were treated at the Chi Mei Medical Center (Tainan, Taiwan). Their medical records were reviewed and analyzed.

**Results:** Sixty patients were identified: 50 (83.33%) men and 10 (16.66%) women who were aged 29–90 years (mean  $59.6 \pm 14.5$  years). The most frequent systemic illness was diabetes mellitus (73.33%). The location of FG was in the anorectal region in 21 (35.00%) patients, urogenital region in 25 (41.66%) patients, and dermatological region in 14 (23.33%) patients. The patients underwent from zero to nine surgical debridements with an average of 3.1 surgical debridements. Septic shock was observed in 25 patients. All 14 patients who expired died of sepsis. The survival rates were better for patients who underwent an early colostomy than for patients who underwent a delayed colostomy [20/21 (95.2%) patients vs. 2/7 (22.2%) patients, respectively;  $p < 0.001$ ]. Patients with septic shock who received hyperbaric oxygen therapy (HBO) had better survival rates than patients who did not have HBO [7/7 (100%) vs. 4/18 (22.22%), respectively;  $p = 0.0007$ ].

**Conclusion:** Bacteremia and sepsis are major indicators of the mortality rate for FG. The cornerstones of treatment are early diagnosis, aggressive resuscitation, broad-spectrum antibiotic therapy, early colostomy, and prompt and repeated surgical intervention. Adjuvant HBO therapy led to higher survival rates.

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## 1. Introduction

Fournier's gangrene (FG) is a rare necrotizing fasciitis with rapid progression. It involves the genitals and perineum and is associated with high morbidity and mortality.<sup>1</sup> It often originates in the genitals and quickly spreads from Buck's fascia to subcutaneous tissues such as the scrotum, penis, perineum, and anterior abdominal

fascia.<sup>1,2</sup> The most common bacteria are Enterobacteriaceae and anaerobic bacteria such as *Bacillus fragilis*. Early clinical symptoms include redness, swelling, heat, and pain, followed by progressive pain, fever, and other symptoms of systemic toxicity (e.g., septic shock).<sup>1,3</sup>

In 1992, the American College of Chest Physicians/Society of Critical Care Medicine Consensus Conference defined septic shock as severe sepsis plus persistently low blood pressure after the administration of intravenous fluids.<sup>4</sup> Septic shock can cause organ dysfunction and death.<sup>5</sup> The literature indicates that the mortality rate of FG is high—up to 14–45%—with higher mortality for the diffuse type than for the local type.<sup>6</sup> Early colostomy for FG of the

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anorectal region decreases wound infection and reduces the mortality rate.<sup>7,8</sup> Delayed colostomy is defined as a colostomy that is created 2 days after the first debridement.<sup>9</sup>

Fournier's gangrene usually causes local tissue hypoxia. The infectious agents include aerobic and anaerobic gram-negative bacilli. Hyperbaric oxygen (HBO) therapy has a bactericidal effect on anaerobic infection caused by aerobic or anaerobic bacteria. Hyperbaric oxygen therapy is widely and successfully used to treat mixed infections by improving tissue perfusion, promoting angiogenesis, increasing the oxygen level in tissues, and inhibiting the production of toxins. These factors inhibit the growth of anaerobic bacteria. It has an adjuvant role in the management of severe Fournier's gangrene.<sup>10</sup>

## 2. Materials and methods

### 2.1. Study objective

The aim of the study was to investigate the epidemiology of FG, effectiveness of treatment, and prognosis. The study provides information on the effectiveness of early diagnosis, aggressive surgical debridement, and adjuvant HBO therapy on FG.

### 2.2. Methods

This study is a retrospective analysis of 60 patients diagnosed with FG (ICD-9 codes 603.83 for men and 728.86 for women) in Chi Mei Medical Center (Tainan, Taiwan) from January 2007 to December 2012. We analyzed sex, age, comorbidities, clinical symptoms, lab testing results, wound culture data, timing of debridement, antibiotics use, treatment outcome, and prognosis. The study was approved by the Institutional Review Board (IRB) of Chi Mei Medical Center (IRB number, 10203-010). In 1995, Laor and colleagues<sup>11</sup> created the Fournier's gangrene severity index (FGSI). It is composed of nine parameters: temperature, heart rate, respiratory rate, serum sodium level, potassium level, creatinine level, bicarbonate level, hematocrit, and leukocyte count. On admission, the nine parameters were scored with values of 0–4, as described in Table 1.

### 2.3. Statistical analysis

The data were stratified by the outcome of whether the patient died or survived. Continuous data were presented as the mean with standard deviation, and were compared between groups by using the two-sample *t* test. Categorical data were presented by the count and percentage, and were compared by using the Chi-square test or Fisher's exact test, as appropriate. To identify the predictors of

survival, multivariable binary logistic regression analyses were conducted. A difference was statistically significant at  $p < 0.05$ . Data analyses were performed by using SPSS version 17.0 software (SPSS Inc., Chicago, IL, USA).

## 3. Results

### 3.1. Sex and age

Fournier's gangrene affects all ages and primarily men with a male:female ratio of 10:1. The current study had 60 patients, which included 50 men and 10 women. Their age ranged from 29 years to 90 years (mean age,  $59.6 \pm 14.5$  years).

### 3.2. Clinical symptoms, complications, and laboratory results

Early clinical symptoms include redness, swelling, heat, pain (100%), symptoms similar to cellulitis, and systemic reactions such as high fever (i.e., body temperature  $> 38^\circ\text{C}$ ). Fifty-seven (95%) patients had a comorbidity. The most common comorbid diseases were diabetes mellitus [44 (73.33%) patients], hypertension [25 (41.66%) patients], liver cirrhosis [4 (6.66%) patients], and end-stage renal disease [ESRD; 7 (11.66%) patients].

### 3.3. The location and extent of injury

The primary origins of injury are summarized in Table 2, as follows: dermatological [14 (23.33%) patients], anorectal [21 (35%) patients], and urogenital [25 (41.66%) patients]. Fournier's gangrene progressed to the groin, lower abdomen, and thigh in 12 patients. Necrotizing fasciitis can occur in any part of the body; however, the limbs, abdominal wall and perineum are the most common sites. Fournier's gangrene is an infection involving the perineal region (Figures 1 and 2).

### 3.4. Bacteriology

Necrotic tissue or pus obtained from the wound during surgery or at the bedside was sent for microbial culture and antibiotic testing. For each of the 60 patients, the wounds were cultured, and the species were cultured. The most commonly isolated organisms were *Escherichia coli* in 21 patients, *Enterococcus* species in 16 patients, *Viridans streptococcus* in 15 patients, *Klebsiella pneumoniae* in 14 patients, and *Staphylococcus* species in eight patients; *Proteus* species in seven patients; oxacillin-resistant *Staphylococcus aureus* (ORSA) in six patients; and anaerobic bacteria such as *Bacteroides* species in four patients, *Clostridium perfringens* in four patients, *Peptoniphilus* species in four patients, and *Fusobacterium* species in

**Table 1**  
Fournier's gangrene severity index.

Physiological variables	High abnormal values			Normal values			Low abnormal values		
	4+	3+	2+	1+	0	1+	2+	3+	4+
Point assignment									
Body temperature ( $^\circ\text{C}$ )	>41	39–40.9	—	38.5–38.9	36–38.4	34–35.9	32–33.9	30–31.9	<29.9
Heart rate	>180	140–179	110–139	—	70–109	—	56–69	40–54	<39
Respiratory rate	>50	35–49	—	25–34	12–24	10–11	6–9	—	<5
Serum sodium (mmol/L)	>180	160–179	155–159	150–154	130–149	—	120–129	111–119	<110
Serum potassium (mmol/L)	>7	6–6.9	—	5.5–5.9	3.5–5.4	3–3.4	2.5–2.9	—	<2.5
Serum creatinine (mg/100 mL)	>3.5	2–3.4	1.5–1.9	—	0.6–1.4	—	<0.6	—	—
Hematocrit (%)	>60	—	50–59.9	46–49.9	30–45.9	—	20–29.9	—	<20
Leukocytes (total/mm <sup>3</sup> × 1000)	>40	—	20–39.9	15–19.9	3–14.9	—	1–2.9	—	<1
Serum bicarbonate	>52	41–51.9	—	32–40.9	22–31.9	—	18–21.9	15–17.9	<15

FGSI = Fournier's gangrene severity index.

**Table 2**  
Location of Fournier's gangrene.

Location	No. of patient
Dermatological	14 (23.33%)
Anorectal	21 (35.00%)
Anal abscess	16
Ischioanal abscess	5
Urogenital	25 (41.66%)
Scrotum	24
Penis	1

The data are based on 60 patients.

**Table 3**  
Results of the bacteriologic culture (N = 122).<sup>a</sup>

Microorganism	Survived/died	Total	p
<b>Aerobic culture</b>			
<i>Enterococcus</i> species	12/4	16	1.000
<i>Enterobacter aerogenes</i>	1/4	5	0.015*
<i>Escherichia coli</i>	15/6	21	1.000
<i>Viridans streptococcus</i>	10/5	15	
<i>Klebsiella pneumoniae</i>	9/5	14	
<i>Proteus</i> species	2/5	7	0.012*
<i>Staphylococcus</i> species	8/0	8	0.095
ORSA	2/4	6	0.038*
<i>Pseudomonas aeruginosa</i>	1/0	1	1.000
<i>Acinetobacter baumannii</i>	2/5	7	
<i>Morganella morganii</i>	2/1	4	1.000
<b>Anaerobic culture</b>			
<i>Bacteroides</i> species	3/1	4	
<i>Clostridium perfringens</i>	4/0	4	
<i>Peptoniphilus</i> species	4/0	4	
<i>Fusobacterium</i> species	1/0	1	
<i>Candida</i>	1/4	5	0.05*

\*The p value is based on the Pearson's Chi-square test and Fisher's exact test.  
ORSA = oxacillin-resistant *Staphylococcus aureus*.

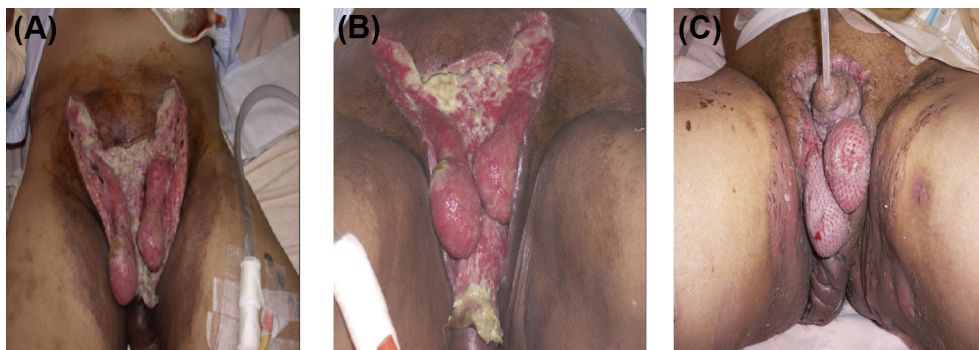
<sup>a</sup> The data are based on 122 cultures.

four patients. Pearson's Chi-square test and Fisher's exact test revealed that mortality was significantly correlated with the isolation of *Enterobacter aerogenes*, *Proteus* species, ORSA, and *Candida* ( $p < 0.05$ ; Table 3).

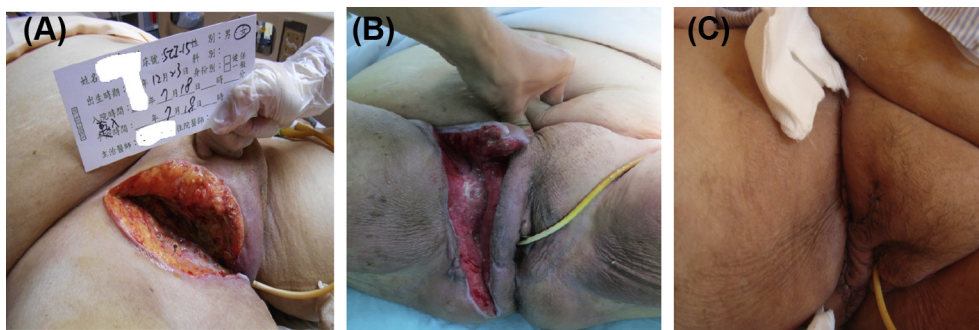
### 3.5. Treatment and outcomes

All patients in this study were first treated with broad-spectrum antibiotics. The treatment was then adjusted according to the patient's clinical condition and culture results. Many studies prove that early and sufficient surgical debridement and fasciotomy improve the survival rate. Complete surgical intervention includes fasciotomy, drainage, and debridement of all necrotic tissue until reaching healthy tissue. In the current study, 57 (95%) patients received fasciotomy within 24 hours after admission. However, fasciotomy alone is an insufficient treatment. Repeated debridement may be necessary. The number of surgical debridements the patients underwent in this study varied from zero to nine

debridements with an average of 3.1 debridements. Fournier's gangrene requires different management strategies, depending on the severity of the disease. Among the 44 survivors, eight patients had a skin flap, three patients had a skin graft, 19 patients underwent wound closure surgery, and the remaining 14 patients healed with dressing changes. The mortality rate was 26.7% (16/60 patients).



**Figure 1.** Necrotizing fasciitis of the scrotum and perineum after serial debridement and hyperbaric oxygen therapy. The wound was reconstructed with a skin flap. The patient's hospital stay was 58 days. A: Necrotizing fasciitis of the scrotum and perineum after serial debridement. B: secondary debridement. C: Final appearance of the perianal region after reconstructive surgery.



**Figure 2.** Fournier's gangrene extends to the right inguinal area with substantial necrotic tissue on the fascia and muscle layer status postextensive debridement and hyperbaric oxygen therapy. A: Necrosis extends to the right inguinal region with substantial necrotic tissue on the fascia and muscle layer. B: good granulation after hyperbaric oxygen therapy. C: Final appearance of right inguinal region after suture.

**Table 4**  
Factors related to the mortality of Fournier's gangrene.<sup>a</sup>

Factor	No. of patients (%)	Alive n (%)	Mortality n (%)	p	OR (95%CI)
Age (y)					
>55	39	25 (64.1)	14 (35.9)	0.034*	1.00
<55	21	19 (90.5)	2 (9.5)		5.32 (1.08–26.28)*
DM					
Yes	44	32 (72.7)	12 (27.3)	1.000	1.13 (0.30–4.18)
No	16	12 (75.0)	4 (25.0)		1.00
HTN					
Yes	25	16 (64.0)	9 (36.0)	0.167	2.25 (0.70–7.20)
No	35	28 (80.0)	7 (20.0)		1.00
LC					
Yes	4	1 (25.0)	3 (75.0)	0.054*	9.92 (0.95–103.64)
No	56	43 (76.8)	13 (23.2)		1.00
ESRD					
Yes	7	3 (42.9)	4 (57.1)	0.074	4.56 (0.89–23.24)
No	53	41 (77.4)	12 (22.6)		1.00
Septic shock					
Present	25	11 (44.0)	14 (56.0)	<0.001*	18.00 (2.18–148.38)*
Absent	35	33 (94.3)	2 (5.7)		1.0
Colostomy					
Early	21	20 (95.2)	1 (4.8)	<0.001*	0.14 (0.02–1.20)
Delayed	9	2 (22.2)	7 (77.8)		9.63 (1.64–56.37)*
No	30	22 (73.3)	8 (26.7)		1.00
HBO					
Yes	12	12 (100.0)	0 (0.0)	0.025*	—
No	48	32 (66.7)	16 (33.3)		1.00
Severity					
Mild	46	37 (80.4)	9 (19.6)	0.024*	1.00 (ref.)
Severe	14	7 (50.0)	7 (50.0)		4.11 (1.15–14.73)
Location					
Dermatological	14	10 (71.4)	4 (28.6)	0.6026	1.00 (ref.)
Anorectal	21	17 (80.9)	4 (19.1)		1.18 (0.28–4.93)
Urogenital	25	17 (68.0)	8 (32.0)		0.59 (0.12–2.89)

\*The p value is based on the Pearson's Chi-square test and Fisher's exact test.

ARF = acute renal failure; DM = diabetes mellitus; ESRD = end-stage renal disease; HBO = hyperbaric oxygen; HTN = hypertension; LC = liver cirrhosis.

<sup>a</sup> The data are based on 60 cases. In the Fournier's gangrene severity index (FGSI), a FGSI score < 9 is mild and FGSI score ≥ 9 is severe.

### 3.6. Bowel diversion

Thirty patients in the study had a diverting colostomy. Twenty-one patients in the study who had an early colostomy had a survival rate of 95.2% (20/21 patients), compared to 22.2% (2/9 patients) for patients who did not have a colostomy (Table 4). The number of surgical debridement procedures and the need for diverting colostomy did not have an effect on postoperative mortality. However, delayed formation of a colostomy (>48 hours) increased the mortality of patients with FG that required a stoma ( $p < 0.001$ ).

### 3.7. Complications

Complications were septic shock in 25 (41.66%) patients, disturbed consciousness in six (10%) patients, upper

gastrointestinal (UGI) bleeding in two (3.33%) patients, and skin necrosis in 14 (23.33%) patients.

### 3.8. Hyperbaric oxygen therapy

Hyperbaric oxygen therapy has been used as adjuvant treatment for infectious diseases. Twelve (20%) patients who had HBO therapy in the study had a survival rate of 100% (12/12 patients), compared to 66.7% for 32 of 48 patients who did not have HBO therapy (Table 4). The survival difference between the HBO patients and non-HBO patients in each subgroup such as age, location, and severity are listed in Table 5. The septic shock survival rates were better for patients who underwent HBO therapy than for patients who did not undergo HBO therapy: 100% survival rate (7/7 patients)

**Table 5**  
Analysis of the distribution of patient survival, based on age, severity, and location.

	No. of patients	HBO		Non-HBO		p*	Relative ratio of survival
		Survival n (%)	Mortality n (%)	Survival n (%)	Mortality n (%)		
Age (y)							
<55	21	8 (100.00)	0 (0.00)	11 (84.62)	2 (15.38)	0.5048	1.18 (0.94–1.49)
>55	39	4 (100.00)	0 (0.00)	21 (60.00)	14 (40.00)	0.2766	1.67 (1.27–2.18)
Severity							
Mild	46	9 (100.00)	0 (0.00)	28 (75.68)	9 (24.32)	0.1709	1.32 (1.10–1.59)
Severe	14	3 (100.00)	0 (0.00)	4 (36.36)	7 (63.64)	0.1923	2.75 (1.26–6.01)
Location							
Dermatological	14	4 (100.00)	0 (0.00)	6 (60.00)	4 (40.00)	0.2507	1.67 (1.00–2.76)
Anorectal	21	4 (100.00)	0 (0.00)	13 (76.47)	4 (23.53)	0.5455	1.31 (1.00–1.70)
Urogenital	25	4 (100.00)	0 (0.00)	13 (61.90)	8 (38.10)	0.2689	1.62 (1.16–2.26)

HBO = hyperbaric oxygen.

versus 22.22% survival rate (4/18 patients), respectively ( $p = 0.0007$ , Table 6).

#### 4. Discussion

Patients with FG usually present with sudden onset and rapid progression. It quickly spreads through the fascia to the skin and muscle, and causes infection and necrosis of the subcutaneous tissue. In agreement with the literature, the patients in our study presented with redness, swelling, heat, pain (100%), and cellulitis-like symptoms, accompanied by fever (50%) and leukocytosis (84%). Fournier's gangrene infectious agents include mixed aerobic and anaerobic bacteria.<sup>12</sup> However, some patients are infected by just one microorganism (i.e., aerobic, anaerobe, or fungus).<sup>13</sup> Aerobes and anaerobes are invariably present, but anaerobes are less frequently isolated. This low anaerobic isolation rate may be because of a delay in the processing of specimens or because of imprecise isolation and culture technique.<sup>13</sup> The bacteriology showed *Enterobacter aerogenes*, *Proteus* species, and *Candida* infection and mortality were highly positively correlated (Table 3). Six of our patients had ORSA. Drug resistance can admittedly lead to a lethal outcome and is a serious problem that must be addressed.

In most studies, FG has a high mortality rate because of the small number of patients and the different treatments for various types of disease.<sup>6</sup> Patients with FG often have one or more comorbid conditions. Older age, trauma, diabetes mellitus, immunosuppression, and chronic systemic diseases (e.g., hypertension, atherosclerosis, and liver cirrhosis) are predisposing factors that reduce immunity and result in uncontrolled sepsis and death.<sup>14</sup> A poor prognosis is associated with some risk factors such as aged older than 55 years, diabetes, peripheral vascular disease, coronary artery disease, ESRD, and poor nutritional status.<sup>15</sup> In our study, mortality, comorbidity, and infection were highly positively correlated (Table 4). There are significant differences in the mortality rates in our study among patients older than 55 years, or patients who had renal disease, liver cirrhosis, complicating sepsis, and ESRD. The mortality rates are not significantly different between patients with diabetes and hypertension; however, they were positively correlated (Table 4).

According to a previous literature review, the mortality rate is higher in patients with diffuse FG than in patients with the focal type, especially in the lower abdomen, groin, and perineum (~28% mortality).<sup>16</sup> However, some studies found no relationship between mortality and the site of infection.

The most common complications of FG include respiratory failure, septicemia, multiple organ failure, UGI bleeding, hepatic failure, and renal failure. In our study, 16 patients died (i.e., a mortality rate of 26.7%). Among these patients, 14 patients died of septicemia that led to septic shock and multiple organ failure, which was the major cause of death; one patient died of coronary artery disease, and one patient died of UGI bleeding that resulted from liver cirrhosis. Fournier's gangrene is a surgical emergency. Early diagnosis and prompt surgical debridement are the keys to successful treatment.<sup>17,18</sup>

**Table 6**  
Analysis of the survival of septic shock.

Treatment	No. of patients (n = 25)	Survival n (%)	Mortality n (%)	p
HBO	7	7 (100.0)	0 (0.00)	0.0007*
Non-HBO	18	4 (22.22)	14 (77.78)	

\*The p is from the Pearson's Chi-square test and Fisher's exact test.  
HBO = hyperbaric oxygen.

If FG is highly suspected, surgical exploration should be performed and adequate debridement is necessary. Some surgeons suggest that routine wound management in the first 24 hours after debridement is necessary. If fascia necrosis spreads extensively, re-debridement should be performed immediately.<sup>19</sup> Complicated debridement and reconstruction of the skin defect have important roles in treating FG. These factors present a challenge to general surgeons, urologists, and plastic surgeons.

In this study, the patients underwent from zero to nine surgical debridements with an average of 3.1 surgical debridements. Three patients did not have surgical debridement because of advanced age, rapid progress of violations, unstable condition, and malignancy. After the debridement, skin and soft tissue defects may exist that involve the penis, scrotum, perineum, lower abdomen, buttocks, and bilateral thighs. If the wound is too wide to stitch, reconstruction with skin grafts and skin flaps is necessary. Treatment methods depend on the severity of the disease. Among the 44 survivors, eight patients received skin flaps; three patients, skin grafts; 19 patients, wound closure; and 14 patients healed with dressing changes.

In the postoperative period, colostomy very effectively prevents contamination of the wound with fecal matter and enhances wound care. The need for fecal diversion in patients with FG is covered extensively in the published literature; however, the timing of diversion has not been widely addressed. The reports of factors that influence the survival of patients with FG show that the formation of a colostomy improves the condition of the individual.<sup>20</sup> In our study, 30 patients underwent colostomy to prevent contamination of the wound. The survival analysis (Table 4) shows that patients with an early colostomy had a better prognosis than patients without a colostomy. The difference was significant ( $p < 0.001$ ). Colostomy combined with a first-time debridement was reserved for patients with involvement of the anorectal region and sphincter. Of these patients, 70.0% of patients received a colostomy within 48 hours after admission and 30.0% of patients received a delayed colostomy (i.e., >48 hours). There was a significant percentage of delayed colostomy formation in the non-survivor group ( $p < 0.001$ ). This delay appears to be primarily associated with the presence of more extensive disease, and mortality is high in this situation. Diversion colostomy decreases the difficulty in nursing care, particularly in the intensive care unit setting. With diversion colostomy, the patients could receive nutrition via nasogastric feeding as soon as possible. Previous research has shown the advantages of early enteral feeding.<sup>21</sup>

Our results revealed that diversion stoma plus HBO therapy has a survival benefit for patients with FG in a shock status. In addition to the treatment regimens previously described, we also propose the importance of adjuvant hyperbaric oxygen therapy to promote the bactericidal effect.

Hyperbaric oxygen therapy can improve tissue perfusion, promote angiogenesis and fibroblast proliferation, and increase collagen synthesis and the oxygen level in tissues. Table 4 shows that the patients who received HBO therapy had a significant improvement in survival (100%), compared to 66.7% survival for patients who did not have HBO therapy ( $p = 0.025$ , based on Fisher's exact test).

Fournier's gangrene is a rare but rapidly progressive soft tissue infection and is a fulminant fatal necrotizing fasciitis. It usually occurs in combination with severe systemic toxicity. Early diagnosis, aggressive surgical debridement, and the use of broad-spectrum antibiotics would reduce mortality that results from septic shock or multiple organ failure. Bacteremia and sepsis are major factors of mortality. In the survival analysis of septic shock (Table 6), patients with septic shock who had HBO therapy had better survival (100%), compared to patients who did not have HBO

therapy (22.22% survival;  $p = 0.0007$ , based on Fisher's exact test). A scoring system (i.e., FGSI) has been developed to determine the severity of the infection and prognosis of patients with FG, based on vital signs and laboratory data.<sup>11</sup> In this system, the mortality rate is 75% if the FGSI score is  $> 9$ , whereas the survival rate is 78% if the FGSI score is  $< 9$ .<sup>22</sup> In our study, we compared the survival difference between the HBO patients and non-HBO patients in each subgroup (i.e., age, location, and severity; Table 5). Based on the results, there was no survival difference between the HBO and non-HBO groups, although patients who were treated with HBO had a higher survival rate.

This study was limited by its retrospective design, insufficiency of some data within the registry, and inability to access all data. In particular, when calculating the FGSI, some patients did not have daily blood gas analyses data. Therefore, our FGSI values were less than the values reported in other studies in the literature.

The results of this study showed that aggressive surgical debridement, early colostomy, and the use of broad-spectrum antibiotics can prevent substantial tissue damage and reduce inflammation. If complicated by septic shock, treatment with adjuvant hyperbaric oxygen therapy can help reduce inflammation, manage sepsis, and increase survival.

## 5. Conclusion

Fournier's gangrene requires emergency surgery. In our case series of 60 patients, older than 55 years and the presence of underlying diseases such as liver cirrhosis and ESRD were all highly correlated with mortality. The treatment strategy includes intensive hemodynamic stabilization, early diagnosis, broad-spectrum antibiotic treatment, and aggressive extensive debridement. Furthermore, adjuvant hyperbaric oxygen therapy can help stop the progression of FG, prevent septic shock, and increase survival rates.

## Conflicts of interest

The authors declare that they have no financial or non-financial conflicts of interest related to the subject matter or materials discussed in the manuscript.

## Sources of funding

No funding was received for the work described in this article.

## Acknowledgments

The authors thank Dr. Jinn- Rung Kuo for critical comments on the manuscript.

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