Original Article

# Fournier's gangrene: a modern analysis of predictors of outcomes

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**Background:** Fournier's gangrene (FG) is a rapidly progressing necrotizing fasciitis that carries a significant morbidity and mortality. The present study sought to identify the predisposing factors related to FG and validate the Fournier's Gangrene Severity Index (FGSI) score as a prognostic tool in the care of the Fournier's patient.

**Methods:** Medstar Washington Hospital Center records were searched from January 2003 to February 2015 for all patients with a diagnosis code of FG, n=42. Epidemiologic data was collected for patients and used to calculate an FGSI score.

**Results:** The average age was 53.45 yrs and M/F ratio was 39:1. Patients presented with an average 2.675 predisposing factors; the most common was diabetes mellitus (n=21) followed by hypertension (n=18). The most common etiology was periscrotal (n=25) next to perirectal (n=9). Streptococcus was the most common source of infection (n=14). Patients on average required three surgical interventions. The average and median hospitalization period was 19.625 and 11.5 days respectively. Eleven patients developed sepsis. Twenty-four (60%) patients experienced a complication. The overall mortality was 5% (n=2). The average FGSI on admission was 5.368. Multivariate analysis showed FGSI score correlates with more surgical intervention, longer hospitalization, sepsis, complication and mortality.

**Conclusions:** The FGSI score predicts a greater likelihood of more surgical interventions, longer hospitalization period, sepsis, complications and mortality within this patient population. Diabetes mellitus continues to be the most common predisposing factors in FG patients. The mortality rate of 5% is much less than the historically reported 20–30% and may reflect improved understanding and care of this aggressive disease.

**Keywords:** Fournier's gangrene (FG); morbidity; mortality; outcomes

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## Introduction

Fournier's gangrene (FG) is an aggressive, rapidly progressing, necrotizing fasciitis of the perineal and genital region. The disease initially described by Alfred Fournier in 1883 was a polymicrobial life threatening infection of unknown origin occurring in otherwise healthy young men (1). Mortality rates were initially reported in the range of 20–30%, which remains the accepted textbook mortality (2-6). However, this disease is now known to occur in a wide age range, frequently in older patients, and usually with an identifiable infectious source. Urinary extravasation, perirectal and periurethral skin infections serve as the common nidus of infection. Diabetes, immunosuppressed states and obesity often contribute to its rapid progression (7,8).

**Table 1** The patient demographics and pertinent clinical information of their hospitalization

| Patient demographics | Values |
|---|---|
| Sex | 41 male, 1 female |
| Age (range, SD) | 53 (24–98, 14.9) |
| Number of procedures (range, SD) | 3.2 (1–30, 2.3) |
| LOS (range, SD) | 19.6 (4–231, 36.1) |
| Mortality rate | 3/42 (7.5%) |
| Predisposing factors (range, SD) | 2.76 (0–6, 1.8) |
| FGSI (SD) | 5.3 (3.2) |

LOS, length of stay; SD, standard deviation; FGSI, Fournier's Gangrene Severity Index.

Despite the advantage of a known etiology, evidence-based management is still challenging. Because of wide variability in presentation, clinical course, and mortality rates, it can be difficult to predict which patients warrant the most aggressive approach.

In an effort to risk stratify these patients, Laor *et al.* devised the FG Severity Index Score (FGSI) to predict mortality in patients with FG. The FGSI is a scoring system that consists of 9 lab parameters and vital signs, measured at presentation, each assigned a score from 0 to 4 based on deviation from the normal range. Specifically, Laor *et al.* found a dramatic increase in mortality (from 22% to 75%) once the FGSI score rose above 9 (9). In the intervening 20 years, several case series have attempted to validate the predictive utility of this score with mixed results.

Based on an extensive review of the literature, there has not been a recent case series at a level 1 trauma center in the United States that has evaluated the validity of the FGSI. Our study aims to validate the FGSI as a prognostic tool for predicting patient morbidity and mortality in this environment.

## Methods

Hospital medical records were queried for diagnosis codes corresponding to FG and scrotal cellulitis. The medical records of 42 patients treated for FG at Washington Hospital Center in Washington, DC between 2001 and 2015 were identified and reviewed. Operative notes were reviewed for deliberate mention of necrotizing fasciitis or Fournier's to confirm FG. All patients received perioperative fluid resuscitation, as well as broad spectrum antibiotic coverage pending culture results. Standard initial antibiotics within our institution include vancomycin and piperacillin-tazobactam. Use of vasopressor support was based on shared decision of the critical care, urology, and anesthesia teams. Data tabulated from the medical records included vital signs at admission, serum sodium, potassium, creatinine, hematocrit, WBC, bicarbonate. An FGSI score as described by Laor *et al.* was calculated for 38 of the 42 patients. Four patients were excluded due to incomplete lab results (9). Additional data seen in *Table 1* including length of stay (LOS), number of operations performed during the single admission, mortality, and number of comorbidities were collected as additional prognostic factors to test.

Logistic regression analysis was performed using SAS statistical software (SAS, NC, USA) to investigate whether FGSI predicts mortality. Pearson correlation coefficients were calculated to analyze the relationship between individual variables (e.g., serum Cr, hematocrit, LOS, number of operations, comorbidities) and FGSI score. Receiver operating characteristic (ROC) curve was calculated based on Mann-Whitney testing of the relationship between mortality and FGSI. Odds ratio estimates were calculated to assess risk of mortality with each FGSI score.

## Results

Of the 42 patients with confirmed FG, 3 patients died during the original admission (7.5%), and 39 survived until discharge (92.5%). Mean patient age was 53 years old, and mean LOS was 19.6 days. FGSI scores ranged from 1 to 13. All patients were treated at MedStar Washington Hospital Center, and underwent an average of 3.2 surgical procedures prior to discharge. Etiologies of FG were varied and included scrotal cellulitis, scrotal abscess, perirectal/perianal abscess, persistent urethral catheterization, hidradenitis, infected Bartholin cyst, and decubitus ulceration.

Documented comorbidities included mellitus (DM), HIV, alcohol abuse, iv drug abuse, coronary artery disease, peripheral vascular disease, chronic kidney disease, obesity, neurologic disease, hypertension, chronic obstructive pulmonary disease (COPD), congestive heart failure, malignancy, and immunosuppression.

The average number of patient comorbidities at presentation was 2.76, with the most common condition being Diabetes, which occurred in 24 of 42 (57.1%) of patients. The number of comorbidities was not associated with patient mortality.

 

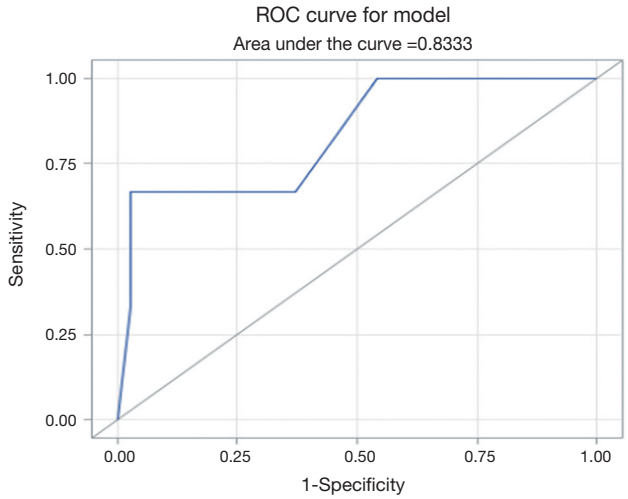


**Figure 1** ROC analysis demonstrating the strong association between FGSI score and patient mortality. Area under the ROC curve equal to 0.8333. ROC, receiver operating characteristic; FGSI, Fournier's Gangrene Severity Index.

**Table 2** The Pearson coefficient and P value associated between FGSI and each of its 9 variables

| Lab/vital sign parameters | Pearson coefficient (R) | P value |
|---|---|---|
| BUN | 0.72 | <0.0001 |
| Creatinine | 0.66 | <0.0001 |
| Hematocrit | –0.21 | 0.21 |
| WBC count | 0.53 | 0.0007 |
| Na | –0.23 | 0.17 |
| K | 0.33 | 0.045 |
| Bicarbonate | –0.63 | <0.0001 |
| Temperature (F) | 0.006 | 0.97 |
| Heart rate | –0.011 | 0.95 |
| Respiratory rate | 0.29 | 0.081 |

Of note, BUN is not one of the 9 variables but did show a strong association. FGSI, Fournier's Gangrene Severity Index; BUN, blood urea nitrogen; WBC, white blood cell.

FGSI was calculated for 38 of the 42 patients. The average FGSI score was 5.2. Patients that died had an average FGSI of 10.0, where patients who survived had a mean FGSI score of 5.0. Logarithmic regression analysis showed the relationship between FGSI and mortality was statistically significant, with a Pearson correlation coefficient of 1.63 (CI: 1.04–2.49, P=0.0313) for each interval increase in FGSI score. ROC analysis showed a strong association between FGSI score and patient mortality, with area under the ROC curve equal to 0.8333 (*Figure 1*). There was a statistically significant relationship between FGSI and length of hospital stay (R=0.40, P=0.0121). FGSI score showed no significant relationship to number of comorbidities or to number of surgical procedures.

In addition to the association of comorbidities and FGSI to mortality, we measured the association between FGSI and each of its nine individual components (*Table 2*). There was a statistically significant association between FGSI and 4 of its 9 variables: Creatinine (R=0.66), Bicarbonate (R=–0.63), white blood cell (WBC) count (R=0.53), and Potassium (R=0.33). There was also a strong relationship between blood urea nitrogen (BUN) (not part of the FGSI score) and FGSI, with R=0.72. Increases in 5 of the 9 constituent variables were not associated with increases in FGSI.

## Discussion

FG is a rare, life threatening disease with a clinical course that remains challenging to predict. Early identification of patients at high risk for mortality allows rapid advancement of care and may provide survival benefit. While many institutions including our own use computed tomography (CT) scans to detect free air within the soft tissues, ultrasound has been reported to be of benefit for bedside detection of free air when CT is not readily available (10). The FGSI score is the most widely used prognostic tool in the management of FG. *Table S1* lists the single center studies that have attempted to validate the prognostic value of the FGSI (2-5,7,11-19).

In addition, more recently, two larges database-based studies were published in the United States showing substantially lower mortality rates of 7.5% and 10% (20,21). The mortality rate reported in this study is in line with these recent publications suggesting improved outcomes for FG patients compared to the higher mortality rates often cited in textbooks.

Based on the previous decade of experience presented here, the mortality rates of FG have improved over the past twenty years and more closely resemble the lower rates sited above of 7–10%. It is also worth noting that the FGSI is predictive of mortality and LOS in the setting of a low mortality rate. Possible reasons for a lower mortality rate include the early use of broad-spectrum antibiotics, ICU care involvement, better recognition of the disease on the primary care provider level and shorter time to

debridement. A recent study compared early debridement versus conservative management of early FG (equivocal cases) and confirmed early debridement led to shorter hospital stays and better clinical outcomes (22). No studies directly attempt to identify causes of a lower mortality rate but the above study shows that clinical care is likely responsible and not that the pathophysiology of the disease has changed.

In addition to validation of the FGSI as a predictor of morbidity and mortality, our results also showed a surprising lack of association between FGSI and 5 of its 9 constituent variables. This implies that changes in these 5 variables do not correspond to an overall increase in mortality, and therefore may not add value to the scoring system. This allows for the possibility that a modified FGSI with fewer variables may yield similar, or even superior, prognostic results. A simpler evaluation system could presumably improve utilization or implementation in the clinical setting.

A recent 2014 study by Lin *et al.* found that a simplified scoring system using only 3 clinical variables was non-inferior to FGSI in predicting patient mortality in an 85-patient series (21). If a reliable, simplified scoring system can be developed that is easier for clinicians to calculate, the likelihood of clinical use increases. The findings of this paper further support that such a system may offer improved predictions of clinical outcomes.

Our study is not without its limitations. The small number of mortalities (3), represent a statistical limitation to the study. In addition, the retrospective nature of the study limits the possible prognostic variables to those that were recorded accurately at the time of hospitalization. Other studies have shown several other clinical factors to be associated with increased mortality. Variables such as increased surface area, delayed treatment onset, advanced age, cirrhosis, anorectal *vs.* penoscrotal source, and immunocompromised status have all been shown to result in increased incidence of death (11,17,23,24). Incorporating these factors into the FGSI or a newly designed scoring system may improve prognostic accuracy.

## Conclusions

The overall mortality rate of 7.5% in this series is similar to more recent studies of FG and substantially lower than historical case series. FGSI score was significantly associated with patient mortality, and length of hospital stay. This scoring tool holds utility in stratifying risks and outcomes. Only 4 of 9 constituent variables of the FGSI were associated with the overall FGSI score, indicating that a simpler FGSI score may prove equally valid and easier to use.

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## Footnote

*Conflicts of Interest*: The authors have no conflicts of interest to declare.

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## Supplementary

**Table S1** This table lists the single center studies that have attempted to validate the prognostic value of the FGSI

| Study | Sample size | Mortality rate (%) | FGSI validated? |
|---|---|---|---|
| Bozkurt *et al.* 2015 | 33 | 9 | Y |
| García Marín *et al.* 2015 | 59 | 26 | Y |
| Tuncel *et al.* 2014 | 50 | 14 | N |
| Yilmazlar *et al.* 2014 | 80 | 21 | N |
| Vyas *et al.* 2013 | 30 | 20 | Y |
| Aridogan *et al.* 2012 | 71 | 30 | N |
| Roghmann *et al.* 2012 | 44 | 30 | Y |
| Altarac *et al.* 2012 | 41 | 37 | Y |
| Yilmazlar *et al.* 2010 | 80 | 21 | Y |
| Luján Marco *et al.* 2010 | 51 | 16 | N |
| Erol *et al.* 2010 | 20 | 30 | N |
| Sorensen *et al.* 2009 | 1,641 | 6–8 | N/A |
| Corcoran *et al.* 2008 | 68 | 10 | Y |
| Unalp *et al.* 2008 | 68 | 10 | Y |

FGSI, Fournier's Gangrene Severity Index.