ORIGINAL ARTICLE

Şimşek Index (Kocaeli Fournier's Gangrene Severity Index, KFGSI): Development and Prognostic Performance of an Admission-Based Mortality Prediction Model for Fournier's Gangrene

Gürkan Bozkurt, Turgay Şimşek, Mehmet Fatih Özsaray, Mehmet Furkan Avcı, Nuh Zafer Cantürk

Department of General Surgery, Kocaeli University Faculty of Medicine, Kocaeli-*Türkiye*

ABSTRACT

BACKGROUND: Fournier's gangrene (FG) is an aggressive form of necrotizing fasciitis associated with high mortality despite advances in critical care and surgical management. Early identification of high-risk patients is essential to enable timely intervention. This study aimed to evaluate established prognostic indices and to develop a novel model for mortality prediction.

METHODS: We retrospectively reviewed the medical records of 69 patients diagnosed with FG and treated at the General Surgery Clinic of Kocaeli University Hospital between January 2017 and January 2022. Demographic, clinical, laboratory, radiological, and treatment-related data were collected. Disease severity was assessed using the Fournier's Gangrene Severity Index (FGSI), Uludağ FGSI (UFGSI), and the American Society of Anesthesiologists (ASA) score. The UFGSI was calculated by combining the FGSI physiological score with additional age and dissemination scores derived from radiological extent grading. Logistic regression and receiver operating characteristic (ROC) curve analyses were performed to identify independent predictors of mortality and to develop the Kocaeli Fournier Gangrene Severity Index (KFGSI).

RESULTS: The mean age was 58.6±13.5 years (range: 36–89), with 52 (75.4%) males and 17 (24.6%) females. The overall in-hospital mortality rate was 40.6% (n=28). On univariate analysis, admission parameters significantly associated with mortality included pulse rate, respiratory rate, body mass index (BMI), serum lactate level, radiological extent grade, body temperature, and FGSI score (all $p<0.05$). Intensive care unit (ICU) length of stay was also associated with mortality in exploratory analyses, reflecting the downstream clinical course. ROC analysis demonstrated strong prognostic performance for pulse rate (area under the curve [AUC] 0.935; 95% confidence interval [CI] 0.848–0.980) and radiological extent grade (AUC 0.898; 95% CI 0.797–0.966), as illustrated in Figure 1. The UFGSI also showed good discrimination (AUC 0.858; 95% CI 0.748–0.967), with 96.4% sensitivity and 73.2% specificity at the Youden-derived cut-off (≥10). The newly developed admission-based KFGSI, incorporating five admission parameters (pulse rate, respiratory rate, body mass index, serum lactate level, and radiological extent grade), demonstrated superior discrimination compared with FGSI in this derivation cohort (AUC 0.943; 95% CI 0.860–0.985; sensitivity 92.9%; specificity 85.4% vs. FGSI AUC 0.860; 95% CI 0.755–0.932). ICU length of stay was not included in the admission-based KFGSI model.

CONCLUSION: The KFGSI demonstrated excellent prognostic accuracy for mortality prediction in FG and outperformed FGSI in this derivation cohort. However, external validation in multicenter populations is required. Early application of the KFGSI may enhance clinical risk stratification and support timely decision-making regarding triage and management. Prospective multicenter studies are needed to confirm its validity and establish its clinical utility.

Keywords: Fournier's gangrene; mortality; prognostic score; risk stratification; ROC analysis.

Cite this article as: Bozkurt G, Şimşek T, Özsaray MF, Avcı MF, Cantürk NZ. Şimşek Index (Kocaeli Fournier's Gangrene Severity Index, KFGSI): Development and Prognostic Performance of an Admission-Based Mortality Prediction Model for Fournier's Gangrene. Ulus Travma Acil Cerrahi Derg 2026;32:794-802.

Address for correspondence: Mehmet Fatih Özsaray
Department of General Surgery, Kocaeli University Faculty of Medicine, Kocaeli, Türkiye
E-mail: f_ozsaray@hotmail.com

Ulus Travma Acil Cerrahi Derg 2026;32(7):794-802 DOI: 10.14744/tjtes.2026.48209
Submitted: 29.09.2025 Revised: 19.01.2026 Accepted: 23.01.2026 Published: 07.07.2026

OPEN ACCESS This is an open access article under the CC BY-NC license (http://creativecommons.org/licenses/by-nc/4.0/).

INTRODUCTION

Fournier's gangrene (FG) is an acute, rapidly progressive, and life-threatening form of necrotizing fasciitis that primarily affects the perineal, genital, and perianal regions.[1,2] It is typically polymicrobial and may spread cephalad along contiguous fascial planes to the abdominal wall, driven by infectious and inflammatory processes; urgent recognition and management are therefore essential and often require prompt resuscitation and emergency surgical debridement.[1,3] Delays in diagnosis or treatment are associated with high mortality, underscoring the importance of maintaining clinical vigilance, particularly in cases with non-specific early symptoms.[3]

Fournier's gangrene has a multifactorial etiology with several well-established risk factors, including local trauma to the perineal, perianal, or genitourinary regions, diabetes mellitus, chronic alcohol use, general debilitation, medication exposure, immunosuppression, and underlying malignancy. These factors reflect the complex pathophysiology and severe clinical course of the disease.[1,2,4,5]

The clinical presentation of FG is often heterogeneous, which can delay diagnosis. Initial findings may be limited to localized cutaneous changes; however, the disease can rapidly progress to systemic toxicity with sepsis and multiorgan failure. As the condition advances, patients may develop ecchymosis, necrosis, edema, subcutaneous crepitus, marked tenderness, and purulent collections. In debilitated or comorbid patients, early physical signs may be subtle, necessitating a high index of suspicion.[1,3-5]

Given these diagnostic challenges and the need for early risk stratification, several prognostic indices have been proposed. The Fournier's Gangrene Severity Index (FGSI) and the Uludağ FGSI (UFGSI) are commonly used to estimate mortality risk and guide management decisions. These tools provide structured, bedside-applicable frameworks for assessing disease severity, particularly when clinical evaluation is inconclusive. However, their predictive accuracy and generalizability vary across different patient populations.[6-8]

The primary aim of this study was to identify factors associated with mortality in FG and to develop a novel, admission-based prediction model. We evaluated the predictive performance of established indices (FGSI and UFGSI) in our cohort and compared them with a newly derived model tailored to our dataset. By informing early triage and treatment strategies—particularly in the setting of diagnostic uncertainty—an effective prediction model may support timely clinical decision-making and optimize patient management.

In this context, the present study introduces the Kocaeli Fournier Gangrene Severity Index (KFGSI), a composite prognostic score designed to estimate in-hospital mortality in patients with Fournier's gangrene using clinically relevant physiological, laboratory, and radiological parameters available at initial presentation. For comparison, the original descriptions of the Fournier's Gangrene Severity Index and the Uludağ FGSI were referenced at their first mention.

The primary model, hereafter referred to as the admission-based KFGSI, incorporates pulse rate, respiratory rate, body mass index (BMI), serum lactate level, and radiological extent grade. An extended exploratory model including intensive care unit (ICU)–related variables was evaluated separately to assess prognostic performance over the clinical course; however, it was not considered suitable for early bedside risk stratification.

MATERIALS AND METHODS

Study Design and Setting

This retrospective study was conducted at the General Surgery Clinic of Kocaeli University Research and Application Hospital between January 2017 and January 2022. Patients diagnosed with Fournier's gangrene were included. The primary objectives were to evaluate the prognostic performance of established indices in predicting mortality and to develop a novel scoring system, the Kocaeli Fournier Gangrene Severity Index.

Ethical approval was obtained from the Non-Interventional Clinical Research Ethics Committee of Kocaeli University (Approval No: KU GOKAEK 2022/10.11). All patient data were anonymized, and the study was conducted in accordance with the Declaration of Helsinki.

Patient Selection and Data Collection

The medical records of 69 patients diagnosed with FG were reviewed. Collected data included demographic characteristics (age, sex), clinical variables (American Society of Anesthesiologists [ASA] score, body temperature, pulse rate, respiratory rate, height, weight, and BMI), and comorbidities (diabetes mellitus, hypertension, malignancy, chronic kidney disease, steroid use, and other chronic conditions).

Disease-specific variables included infection etiology, radiological grade based on computed tomography (CT) and/or magnetic resonance imaging (MRI), and the anatomical extent of involvement. Treatment-related data comprised wound culture results, identified microorganisms, antibiotic regimens, number of debridements, and diversion procedures such as ostomy creation. Diverting stoma formation was performed at the discretion of the attending surgical team, primarily in patients with severe anorectal involvement, including sphincter compromise, rectal perforation, gross fecal contamination, or extensive perineal defects where adequate wound control was not achievable. In this cohort, severe anorectal involvement was operationally defined as imaging and/or intraoperative evidence of anal sphincter complex involvement, rectal wall defect or perforation, or gross fecal contamination of the wound field. Hospitalization parameters, including total length of stay, ICU admission, and ICU length of stay, were also recorded.

Laboratory values at admission were documented, including C-reactive protein (CRP), sodium, potassium, creatinine, white blood cell (WBC) count, bicarbonate (HCO3), and lactate levels. Categorical variables were summarized as n (%), while continuous variables were reported as mean ± standard deviation (SD) for normally distributed data and median (interquartile range) for non-normally distributed data.

Scoring Systems

The FGSI and UFGSI were calculated at admission as previously described in the literature.[6,7] Perioperative risk was also assessed using the American Society of Anesthesiologists Physical Status Classification System, in accordance with the official guidelines.[9] For UFGSI calculation, the age and dissemination components were derived from admission data and radiological extent grading. The age score was assigned as 1 for patients aged ≥60 years and 0 otherwise. The dissemination score was mapped to the radiological extent grade as follows: grade 1 (anorectal involvement) = 1 point, grade 2 (pelvic involvement) = 2 points, and grade 3 (abdominal extension beyond the pelvis) = 6 points, consistent with the original UFGSI definitions. The total UFGSI was calculated as the sum of the FGSI physiological score, dissemination score, and age score.

Statistical Analysis

Statistical analyses were performed using SPSS software (IBM Corp., Armonk, NY, USA). Continuous variables were assessed for normality using visual inspection (histograms and Q–Q plots) and the Shapiro–Wilk test. Normally distributed continuous variables are presented as mean ± standard deviation, while non-normally distributed variables are reported as median (interquartile range). Comparisons between survivors and non-survivors were performed using the independent samples t-test for normally distributed variables and the Mann–Whitney U test for non-normally distributed variables. Categorical variables were compared using Fisher's exact test or the Fisher–Freeman–Halton test, as appropriate. Correlations were assessed using Spearman's rank correlation coefficient. Logistic regression analysis was performed to identify independent predictors of in-hospital mortality. Receiver operating characteristic (ROC) curve analysis was used to determine optimal cut-off values, and diagnostic performance was reported in terms of sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Optimal cut-off values were defined using the Youden index. A two-sided p value <0.05 was considered statistically significant. The primary multivariable logistic regression model was constructed using the enter method and restricted to five clinically plausible admission-time predictors (pulse rate, respiratory rate, BMI, serum lactate level, and radiological extent grade) to preserve interpretability and minimize overfitting, given the limited number of outcome events. Multicollinearity was assessed using variance inflation factors (VIF), with values >5 considered indicative of problematic collinearity; no significant multicollinearity was observed. Patients with incomplete admission data for key predictors were excluded during cohort selection; therefore, no imputation was performed.

Development of the Kocaeli Fournier Gangrene Severity Index

Candidate predictors of in-hospital mortality were initially identified through univariate analyses based on clinical relevance and statistical significance. Variables significantly associated with mortality (p<0.05) were subsequently entered into a multivariable logistic regression model, with careful consideration of model parsimony given the limited number of outcome events.

To ensure applicability at the time of initial clinical assessment, only variables available at hospital presentation were included in the primary (admission-based) KFGSI model. Variables reflecting the downstream clinical course, such as ICU admission or ICU length of stay, were intentionally excluded from the primary model to avoid time-dependent bias.

For each independent predictor retained in the admission-based model, ROC curve analysis was performed to determine optimal cut-off values using the Youden index. Variables exceeding their respective cut-off thresholds were assigned one point, and the cumulative score constituted the Kocaeli Fournier Gangrene Severity Index. To preserve bedside usability, an unweighted point-based approach was adopted; however, weighted scoring based on regression coefficients may be explored in future validation studies. Body temperature, although significant in univariate analysis, was excluded from the final model due to borderline cut-off stability and limited incremental prognostic value in multivariable analysis.

The total KFGSI score ranged from 0 to 5 points. An overall cut-off value was determined using ROC analysis to stratify patients into low- and high-risk mortality groups. The KFGSI was developed as a derivation model for exploratory risk stratification, with the understanding that external validation is required prior to clinical implementation.

RESULTS

Between January 2017 and January 2022, a total of 81 patients diagnosed with Fournier's gangrene were identified. Twelve patients were excluded from the analysis, including five who were transferred to external intensive care units and seven with incomplete medical records. Consequently, 69 patients comprised the final study cohort.

The demographic and clinical characteristics of the patients are summarized in Table 1. Of the included patients, 52 (75.4%) were male and 17 (24.6%) were female, with a median age of 58 years (range: 36–89). The mean length of hospital stay was 24.4±21.4 days (range: 1–130). According to the American Society of Anesthesiologists Physical Status Classification, 20 patients (29.0%) were classified as ASA II, 43 (62.3%) as ASA III, and six (8.7%) as ASA IV.

Comorbid conditions were common. Diabetes mellitus was

Table 1. Baseline demographic and clinical characteristics of the study cohort (n=69)

	Value
Age, years, mean±SD (range)	58.6±13.5 (36–89)
Sex, male, n (%)	52 (75.4)
Sex, female, n (%)	17 (24.6)
ASA II, n (%)	20 (29.0)
ASA III, n (%)	43 (62.3)
ASA IV, n (%)	6 (8.7)
Length of hospital stay, days, mean±SD (range)	24.4±21.4 (1–130)
Diabetes mellitus, n (%)	38 (55.1)
Hypertension, n (%)	20 (29.0)
Malignancy, n (%)	11 (15.9)
Chronic kidney disease, n (%)	10 (14.5)
Steroid use, n (%)	17 (24.6)
Bacterial infection, n (%)	29 (42.0)
Fungal infection, n (%)	3 (4.3)
Unknown etiology, n (%)	37 (53.6)
E. coli, n (%)	11 (15.9)
A. baumannii, n (%)	9 (13.0)
Radiological grade 1, n (%)	25 (36.2)
Radiological grade 2, n (%)	30 (43.5)
Radiological grade 3, n (%)	14 (20.3)
Scrotal extension, n (%)	35 (50.7)
Stoma required, n (%)	54 (78.3)
Debridement, mean±SD (range)	3.8±3.4 (1–18)
ICU admission, n (%)	45 (65.2)
In-hospital mortality, n (%)	28 (40.6)

SD: Standard deviation; ASA: American Society of Anesthesiologists Physical Status Classification; ICU: Intensive care unit; E. coli: Escherichia coli; A. baumannii: Acinetobacter baumannii.

present in 38 patients (55.1%), hypertension in 20 (29.0%), malignancy in 11 (15.9%), chronic kidney disease in 10 (14.5%), and a history of steroid use in 17 (24.6%). Microbiological evaluation demonstrated bacterial growth in 29 patients (42.0%) and fungal growth in three (4.3%), while no causative microorganism was identified in 37 cases (53.6%). The most frequently isolated organisms were Escherichia coli (15.9%) and Acinetobacter baumannii (13.0%). Radiological assessment showed anorectal involvement (grade 1) in 25 patients (36.2%), pelvic involvement (grade 2) in 30 (43.5%), and abdominal extension (grade 3) in 14 (20.3%). Scrotal extension was observed in 35 patients (50.7%). A diverting stoma was created in 54 patients (78.3%). The number of surgical debridement procedures ranged from 1 to 18, with a mean of 3.8±3.4 procedures. Forty-five patients (65.2%) required ICU admission during hospitalization. The overall in-hospital mortality rate was 40.6% (n=28), while 41 patients (59.4%) survived.

Univariate analysis identified several clinical and laboratory parameters significantly associated with in-hospital mortality, including body temperature (p=0.021), pulse rate (p<0.001), respiratory rate (p=0.003), BMI (p=0.007), FGSI score (p<0.001), serum lactate level (p=0.015), radiological extent grade (p=0.001), and ICU length of stay (p=0.003). Comparative outcomes and variables associated with mortality are presented in Table 2.

Receiver operating characteristic curve analysis was performed to assess the discriminative ability of significant predictors. Pulse rate demonstrated the highest individual predictive performance, with an area under the curve (AUC) of 0.935 (95% confidence interval [CI]: 0.848–0.980), sensitivity of 82.1%, and specificity of 97.6%. Radiological extent grade also showed strong prognostic performance, with an AUC of 0.898 (95% CI: 0.797–0.966), sensitivity of 89.3%, and specificity of 82.9%. ROC curves for the most significant predictors are presented in Figure 1.

Other parameters, including BMI, respiratory rate, serum lactate level, and body temperature, demonstrated moderate predictive performance. ICU length of stay showed prognostic relevance in exploratory analyses, reflecting disease severity during the clinical course; however, it was not incorporated into the primary admission-based prediction model. The diagnostic performance of significant predictors is summarized in Table 3.

Based on ROC-derived cut-off values, the admission-only KFGSI was developed using five parameters available at initial hospital presentation: pulse rate, respiratory rate, BMI, serum lactate level, and radiological extent grade. Body temperature, although statistically significant in univariate analysis, was excluded from the final model due to borderline cut-off stability and limited incremental prognostic value.

ROC analysis of the admission-based KFGSI demonstrated high discrimination, with an AUC of 0.943 (95% CI: 0.860–0.985), sensitivity of 92.9%, and specificity of 85.4% (p<0.001). A KFGSI score ≥4 was associated with a very high risk of in-hospital mortality and was identified as the optimal cut-off based on overall ROC curve analysis. The comparative predictive performance of FGSI and the admission-based KFGSI is presented in Table 4. One point was assigned for each of the following admission-time thresholds: pulse rate ≥120 bpm, respiratory rate ≥24/min, body mass index ≥30 kg/m², serum lactate level ≥3.5 mmol/L, and radiological extent grade ≥2. The UFGSI was also calculated at admission for all patients. ROC analysis demonstrated good discrimination for in-hospital mortality, with an AUC of 0.858 (95% CI: 0.748–0.967). Using the Youden index, the optimal cut-off was ≥10, yielding a sensitivity of 96.4% and specificity of 73.2%. Using the predefined threshold of ≥9 proposed in the original UFGSI study, sensitivity was 100.0% and specific-

Table 2. Univariate comparison between survivors and non-survivors

Parameter	Survivors (n=41)	Non-survivors (n=28)	p-value
Body temperature (°C)	37.3 (37.0–37.8)	38.2 (37.6–39.1)	0.021
Pulse rate (bpm)	100 (92–110)	122 (114–134)	<0.001
Respiratory rate (/min)	20 (18–22)	25 (22–28)	0.003
Body mass index (kg/m²)	27.1 (25.4–29.2)	30.0 (27.8–32.6)	0.007
FGSI score	6 (5–7)	9 (8–11)	<0.001
Serum lactate (mmol/L)	2.5 (2.0–3.1)	4.0 (3.3–4.9)	0.015
Radiological extent grade	2 (1–2)	3 (2–3)	0.001
ICU length of stay (days)†	3 (2–4)	10 (8–13)	0.003

Values are presented as median (interquartile range). †Intensive care unit (ICU) length of stay reflects downstream disease severity and was not included in the primary admission-based KFGSI model. Between-group comparisons were performed using the Mann–Whitney U test.

Table 3. Diagnostic performance of significant admission variables for in-hospital mortality (ROC analysis)

Parameter	AUC	95% CI	Sensitivity (%)	Specificity (%)	p-value
Pulse rate	0.935	0.848–0.980	82.1	97.6	<0.001
Respiratory rate	0.812	0.703–0.905	75.0	78.0	0.003
Body mass index (BMI)	0.789	0.672–0.886	71.4	76.2	0.007
Serum lactate level	0.821	0.713–0.912	78.6	80.5	0.015
Radiological extent grade	0.898	0.797–0.966	89.3	82.9	0.001
Body temperature	0.742	0.621–0.852	67.9	71.4	0.021

AUC: Area under the curve; CI: Confidence interval.

ity was 56.1%. The comparative discriminative performance of FGSI, UFGSI, and admission-based KFGSI is presented in Table 4.

In multivariable logistic regression analysis restricted to admission-time variables, pulse rate, respiratory rate, BMI, serum lactate level, and radiological extent grade remained independently associated with in-hospital mortality (Table 5). These findings underscore the prognostic importance of early systemic physiological response, metabolic derangement, and disease extent at presentation. The multivariable model was fitted using the enter method with the five predictors.

DISCUSSION

Fournier's gangrene is an aggressive and rapidly progressive necrotizing fasciitis associated with substantial morbidity and mortality despite advances in critical care and surgical management.[10] Early identification of patients at high risk of death is therefore essential, as it directly influences triage decisions, timing of imaging, surgical strategy, and the level of postoperative monitoring.

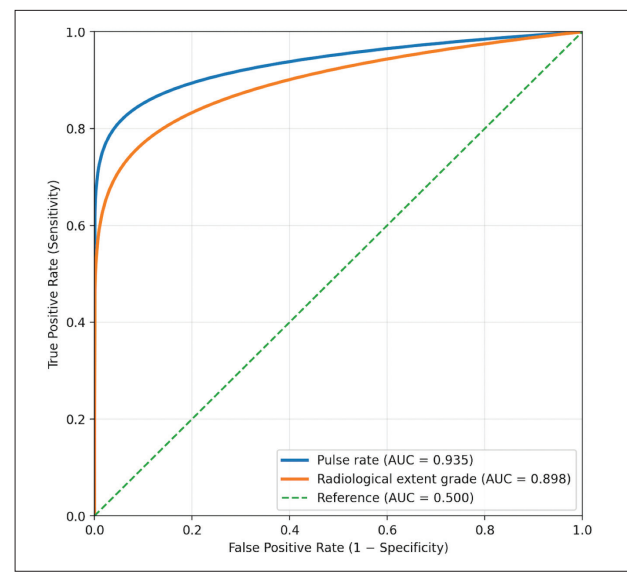


Figure 1. Receiver operating characteristic (ROC) curves illustrating the discriminative performance of pulse rate and radiological extent grade for predicting in-hospital mortality in patients with Fournier's gangrene.

Table 4. Comparative prognostic performance of FGSI, UFGSI, and admission-based KFGSI for predicting in-hospital mortality

Severity index	AUC	95% CI	Cut-off	Sensitivity (%)	Specificity (%)
FGSI	0.860	0.755–0.932	≥7	82.1	78.1
UFGSI (Youden)	0.858	0.748–0.967	≥10	96.4	73.2
UFGSI (predefined*)	0.858	0.748–0.967	≥9	100.0	56.1
Admission-based KFGSI	0.943	0.860–0.985	≥4	92.9	85.4

FGSI: Fournier's Gangrene Severity Index; UFGSI: Uludağ Fournier's Gangrene Severity Index; KFGSI: Kocaeli Fournier Gangrene Severity Index; AUC: Area under the receiver operating characteristic curve; CI: Confidence interval. *The predefined UFGSI threshold (≥9) was based on the original UFGSI description and validation studies.

Table 5. Multivariable logistic regression analysis of admission-time predictors of in-hospital mortality (n=69)

Predictor (admission variables)	Adjusted OR	95% CI	p-value
Pulse rate (per 1 bpm increase)	1.08	1.03–1.13	<0.001
Respiratory rate (per 1 /min increase)	1.29	1.10–1.53	0.002
Body mass index (per 1 kg/m² increase)	1.19	1.05–1.36	0.007
Serum lactate (per 1 mmol/L increase)	2.35	1.50–4.00	<0.001
Radiological extent grade (per 1-grade increase)	2.05	1.12–3.98	0.021

OR: Odds ratio; CI: Confidence interval; BMI: Body mass index. Note: Only admission-time variables were included in the multivariable model. Intensive care unit-related variables were excluded to avoid time-dependent bias.

Principal Findings

In this single-center cohort, several admission-time clinical and laboratory parameters—including pulse rate, respiratory rate, body mass index, serum lactate level, and radiological extent grade—were significantly associated with in-hospital mortality. Among these, pulse rate demonstrated the highest discriminative ability, followed by radiological extent grade, as reflected in the ROC curve analysis (Fig. 1). These findings underscore the prognostic importance of early systemic physiological response and disease extent at presentation.

Based on these results, we developed an admission-based composite prognostic model, the Kocaeli Fournier Gangrene Severity Index, incorporating the strongest predictors available at initial assessment. The admission-based KFGSI demonstrated higher apparent discrimination than the FGSI in this derivation cohort (AUC 0.943 vs. 0.860). Although this performance is encouraging, it should be interpreted with caution given the derivation nature of the model. Nevertheless, the findings suggest that integrating physiological derangement, metabolic stress, host-related factors, and radiological disease extent may provide more accurate early risk stratification than individual variables or traditional scoring systems alone.

Importantly, all five admission-time components of the KFGSI remained independent predictors of mortality in multivariable analysis, supporting their combined use as a practical bedside risk stratification tool.

Comparison with Existing Literature

Fournier's gangrene predominantly affects male patients; however, the impact of sex on mortality remains inconsistent across published studies. In our cohort, sex was not associated with mortality, consistent with the large review by Eke, which analyzed 1,726 cases.[10] In contrast, Czymek et al.[11] reported worse outcomes among female patients, potentially due to delayed presentation or more advanced disease at diagnosis. These discrepancies highlight the heterogeneity of FG populations and variations in healthcare settings.

Several prognostic scoring systems have been proposed to estimate mortality risk in FG. Established indices such as the FGSI and UFGSI provide structured bedside assessments; however, their predictive performance varies across different patient cohorts.[6,7,14] A recent systematic review and meta-analysis by Tufano et al.[14] confirmed the prognostic value of these tools, reporting pooled AUC values approaching 0.90–0.94, particularly for the UFGSI, while also highlighting methodological limitations and inter-study heterogeneity.

Our findings are broadly consistent with those of contemporary cohort studies. Garg et al.[15] reported substantial morbidity and persistent functional impairment among survivors, underscoring the importance of early and accurate risk strati-

fication. In contrast to smaller single-center series, Hauser et al.[16] demonstrated in a large consecutive cohort that higher FGSI scores and greater comorbidity burden independently predicted mortality, ICU admission, and hospital length of stay. Similarly, Hong et al.[17] identified key physiological and laboratory parameters as significant prognostic factors, further supporting the concept that composite risk assessment tools may outperform single-variable predictors.

In addition to established clinical indices, biomarker-based approaches have been explored to improve prognostic accuracy in necrotizing soft-tissue infections. Zil-E-Ali et al.[22] highlighted the potential utility of procalcitonin when combined with laboratory risk indicators. Although such biomarkers were not evaluated in the present study, they may represent valuable adjuncts for the future refinement of FG prognostic models.

Clinical Implications

The high apparent discriminative performance of the admission-based KFGSI suggests potential clinical utility for early risk stratification in patients with FG. Patients identified as high risk at presentation may be considered for early senior surgical review, aggressive resuscitation, prompt imaging to delineate disease extent, and closer postoperative monitoring. The strong prognostic contribution of radiological extent grade supports the role of early cross-sectional imaging in suspected FG, provided that it does not delay definitive surgical source control, in accordance with current emergency management principles.[10,12,14,17]

In the present cohort, the rate of diverting stoma creation was relatively high (78.3%). This finding should be interpreted in the context of disease severity and local surgical practice. A substantial proportion of patients presented with advanced disease, including extensive perineal involvement, anorectal spread, and pelvic or abdominal extension on imaging, which influenced intraoperative decision-making. Importantly, current evidence does not support routine fecal diversion in all patients with Fournier's gangrene, and its impact on mortality remains controversial. A systematic review and meta-analysis found no consistent association between diversion stoma and reduced mortality, suggesting that stoma formation should not be considered a universal mortality-reducing strategy.[18] Instead, diversion procedures are typically reserved for selected cases to facilitate wound care and reduce fecal contamination, particularly in patients with severe anorectal involvement, sphincter compromise, rectal perforation or gross fecal contamination, or extensive perineal defects where adequate wound control is not achievable.[19] Therefore, the high stoma rate observed in this study likely reflects a cautious institutional approach in advanced presentations rather than routine practice.

Strengths and Limitations

The strengths of this study include a well-defined cohort, comprehensive evaluation of clinical, laboratory, and radiological variables, and the development of a parsimonious, admission-based prognostic model using parameters readily available at initial hospital presentation. The use of ROC-based analyses enabled objective assessment of individual predictors and facilitated the construction of a clinically applicable composite score focused on early risk stratification.

Several limitations should be acknowledged. First, the retrospective, single-center design limits the generalizability of the findings and precludes causal inference. Second, external validation was not performed; therefore, the KFGSI should be considered a derivation model with potentially optimistic performance estimates. Third, the relatively small number of mortality events in relation to the number of candidate predictors may have increased the risk of overfitting, despite efforts to restrict the primary model to a limited set of clinically relevant variables.

The observed in-hospital mortality rate in our cohort (40.6%) was higher than that reported in large administrative and population-based database studies. For example, Sorensen et al.[20] reported substantially lower case-fatality rates in a population-based U.S. cohort. More recently, an analysis of the National Inpatient Sample (2016–2020), including 5,007 surgically debrided Fournier's gangrene hospitalizations, reported a crude in-hospital mortality rate of 5.8%, along with increased length of stay and healthcare costs compared with non-perineal necrotizing soft tissue infections.[21] This discrepancy likely reflects differences in case-mix and study setting, including referral bias to a tertiary care center, more advanced disease at presentation, delayed admission, and a higher burden of comorbidities in our cohort. Accordingly, comparisons with population-based datasets should be interpreted with caution.

Additionally, the rate of diverting stoma formation was relatively high in this cohort. This likely reflects institutional surgical practice and the advanced disease extent at presentation in a substantial proportion of patients, rather than a standardized mortality-reducing strategy. Current evidence does not consistently demonstrate a mortality benefit associated with diversion procedures in Fournier's gangrene, and decisions regarding stoma formation were made on a case-by-case basis. These factors may have influenced both treatment patterns and outcomes and should be considered when interpreting the study findings.

Calibration metrics (e.g., calibration plots or Hosmer–Lemeshow goodness-of-fit testing) were not formally assessed due to the limited sample size and number of events. In addition, internal validation techniques such as bootstrapping were not performed; therefore, the reported AUC values may reflect optimism inherent to a derivation cohort.

Future Directions

Prospective multicenter studies are required to externally validate the admission-based KFGSI, assess calibration, and benchmark its performance against established indices such

as FGSI and UFGSI. Further evaluation of additional biomarkers, including procalcitonin, as well as standardized radiological staging systems, may enhance the robustness and generalizability of FG mortality prediction models.[14,22]

CONCLUSION

This study identified several admission-time physiological, laboratory, and radiological parameters closely associated with in-hospital mortality in patients with Fournier's gangrene. Based on these findings, we developed the Kocaeli Fournier Gangrene Severity Index, an admission-based composite score designed to support early risk stratification using variables readily available at initial clinical assessment.

In our cohort, the KFGSI demonstrated higher apparent discriminative performance compared with the conventional FGSI, suggesting that integrating systemic physiological response, metabolic stress markers, and radiological disease extent may improve early prognostic assessment. Importantly, the model was constructed to exclude time-dependent variables, thereby preserving its applicability in the emergency setting.

However, these findings should be interpreted in light of the study's limitations, including its retrospective design, single-center setting, and lack of external validation. Accordingly, the KFGSI should be considered a derivation model, and its clinical utility requires confirmation in prospective, multicenter studies across diverse healthcare settings and patient populations.

Overall, this study highlights the need for refined, practical prognostic tools in Fournier's gangrene and supports further collaborative research aimed at improving early risk assessment, clinical decision-making, and patient outcomes.

Ethics Committee Approval: Ethical approval was obtained from the Non-Interventional Clinical Research Ethics Committee of Kocaeli University (Date: 09.06.2022, Decision No: KÜ GOKAEK-2022/10.11).

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: G.B., M.F.Ö., M.F.A., T.Ş., N.Z.C.; Design: G.B., M.F.Ö.; Supervision: M.F.Ö., N.Z.C., T.Ş.; Resource: M.F.A., G.B.; Materials: G.B., M.F.Ö., M.F.A.; Data collection and/or processing: M.F.Ö., G.B., T.Ş.; Analysis and/or interpretation: N.Z.C., T.Ş.; Literature review: M.F.Ö., M.F.A., G.B.; Writing: G.B., M.F.Ö., T.Ş.; Critical review: N.Z.C., T.Ş., M.F.Ö.

Informed Consent: Informed consent for treatment and publication was obtained or waived for all participants in this study.

Conflict of Interest: In accordance with the International Committee of Medical Journal Editors (ICMJE) Uniform Disclosure Form, all authors declare no conflicts of interest. No financial support was received from any organization for the submitted work. All authors further declare that there are no other relationships or activities that could have influenced the submitted work.

Financial Disclosure: The authors declare no financial relationships, either current or within the past three years, with any organizations that may have an interest in the submitted work.

REFERENCES

1. Montrief T, Long B, Koyfman A, Auerbach J. Fournier gangrene: a review for emergency clinicians. J Emerg Med 2019;57:488–500. [CrossRef]
2. Boughanmi F, Ennaceur F, Korbi I, Chaka A, Noomen F, Zouari K. Fournier's gangrene: its management remains a challenge. Pan Afr Med J 2021;38:23. [CrossRef]
3. Auerbach J, Bornstein K, Ramzy M, Cabrera J, Montrief T, Long B. Fournier Gangrene in the Emergency Department: Diagnostic Dilemmas, Treatments and Current Perspectives. Open Access Emerg Med 2020;12:353–64. [CrossRef]
4. Kuchinka J, Matykiewicz J, Wawrzycka I, Kot M, Karcz W, Głuszek S. Fournier gangrene - a challenge for the surgeon. Pol Przegl Chir 2019;93:55–60. [CrossRef]
5. Lewis GD, Majeed M, Olang CA, Patel A, Gorantla VR, Davis N, et al. Fournier's gangrene diagnosis and treatment: a systematic review. Cureus 2021;13:e18948. [CrossRef]
6. Noegroho BS, Siregar S, Mustafa A, Rivaldi MA. Validation of FGSI Scores in predicting fournier gangrene in tertiary hospital. Res Rep Urol 2021;13:341–6. [CrossRef]
7. Eğin S, Kamalı S, Hot S, Gökçek B, Yeşiltaş M, Duman MG, Alemdar A. The importance of the scoring system in Fournier's gangrene. Ulus Travma Acil Cerrahi Derg 2022;29:109–15. [CrossRef]
8. Charlson M, Szatrowski TP, Peterson J, Gold J. Validation of a combined comorbidity index. J Clin Epidemiol 1994;47:1245–51. [CrossRef]
9. Doyle DJ, Goyal A, Bansal P, Garmon EH. American Society of Anesthesiologists Classification. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2023.
10. Eke N. Fournier's gangrene: a review of 1726 cases. Br J Surg 2000;87:718–28. [CrossRef]
11. Czymek R, Frank P, Limmer S, Schmidt A, Jungbluth T, Roblick U, et al. Fournier's gangrene: is the female gender a risk factor? Langenbecks Arch Surg 2010;395:173–80. [CrossRef]
12. Korkut M, Içöz G, Dayangaç M, Akgün E, Yeniay L, Erdoğan O, Cal C. Outcome analysis in patients with Fournier's gangrene: report of 45 cases. Dis Colon Rectum 2003;46:649–52 [CrossRef]
13. Yang Z, Hu J, Qu Y, Sun F, Leng X, Li H, Zhan S. Interventions for treating gas gangrene. Cochrane Database Syst Rev 2015;2015:CD010577. [CrossRef]
14. Tufano A, Dipinto P, Passaro F, Anceschi U, Franco G, Flammia RS, et al. The value of fournier's gangrene scoring systems on admission to predict mortality: a systematic review and meta-analysis. J Pers Med 2023;13:1283. [CrossRef]
15. Garg G, Singh V, Sinha RJ, Sharma A, Pandey S, Aggarwal A. Outcomes of patients with Fournier's Gangrene: 12-year experience from a tertiary care referral center. Turk J Urol 2019;45(Supp. 1):S111–S6. [CrossRef]
16. Hauser N, Huang C, Vaidya G, Chrusciel T, Narayana Kumarasan K, et al. Fournier's gangrene severity index and charlson comorbidity index predict mortality, intensive care unit admission, and length of hospital stay in patients with fournier's gangrene: an analysis of 264 consecutive

patients. Cureus. 2024;16:e75281. [CrossRef]
17. Hong HB, Lee JW, Park CH. Prognostic factors and clinical outcomes in Fournier's Gangrene: a retrospective study of 35 patients. BMC Infect Dis 2024;24:958. [CrossRef]
18. Sarofim M, Di Re A, Descallar J, Toh JWT. Relationship between diversional stoma and mortality rate in Fournier's gangrene: a systematic review and meta-analysis. Langenbecks Arch Surg 2021;406:2581–90. [CrossRef]
19. Dupont M, Leal C, Tenreiro N, Marques R, Pinto-de-Sousa J. Fournier gangrene management: is a stoma mandatory? Cureus 2023;15:e39450. [CrossRef]
20. Sorensen MD, Krieger JN, Rivara FP, Broghammer JA, Klein MB, Mack CD, Wessells H. Fournier's Gangrene: population based epidemiology and outcomes. J Urol 2009;181:2120–6. [CrossRef]
21. Mitaka H, McQuerry K, Karnik K, Marra AR, Naito T, Ten Eyck P, et al. Fournier gangrene is associated with increased length of stay and higher healthcare costs compared to non-perineal necrotizing soft tissue infections: a retrospective analysis of the National Inpatient Sample (2016-2020). Antimicrob Steward Healthc Epidemiol 2025;5:e178. [CrossRef]
22. Zil-E-Ali A, Fayyaz M, Fatima A, Ahmed Z. Diagnosing Necrotizing Fasciitis Using Procalcitonin and a Laboratory Risk Indicator: Brief Overview. Cureus 2018;10:e2754. [CrossRef]

ORİJİNAL ÇALIŞMA - *ÖZ*

Şimşek İndeksi (Kocaeli Fournier Gangreni Şiddet İndeksi, KFGSI): Fournier gangreninde başvuru anına dayalı bir mortalite tahmin modelinin geliştirilmesi ve prognostik performansı

AMAÇ: Fournier gangreni (FG), yoğun bakım ve cerrahi alandaki gelişmelere rağmen yüksek mortalite oranına sahip agresif bir nekrotizan fasiittir. Yüksek riskli hastaların erken tanımlanması, zamanında müdahaleye rehberlik etmek açısından kritik öneme sahiptir. Bu çalışma, mevcut prognostik indeksleri değerlendirmeyi ve başvuru anında uygulanabilir yeni bir mortalite tahmin modeli geliştirmeyi amaçlamıştır.

GEREÇ VE YÖNTEM: Ocak 2017–Ocak 2022 tarihleri arasında Kocaeli Üniversitesi Hastanesi Genel Cerrahi Kliniği'nde FG tanısı alarak tedavi edilen 69 hastanın tıbbi kayıtları retrospektif olarak incelendi. Demografik, klinik, laboratuvar, radyolojik ve tedaviye ilişkin veriler toplandı. Hastalık şiddeti Fournier Gangren Şiddet İndeksi (FGSI), Uludağ FGSI (UFGSI) ve Amerikan Anesteziyologlar Derneği (ASA) skorları ile değerlendirildi. UFGSI, FGSI'nin fizyolojik skoruna yaş skoru ve radyolojik yaygınlık derecesinden türetilen diseminasyon skorunun eklenmesiyle hesaplandı. Bağımsız mortalite belirteçlerini saptamak ve Kocaeli Fournier Gangren Şiddet İndeksi'ni (KFGSI) oluşturmak için lojistik regresyon ve ROC eğrisi analizleri yapıldı. Birincil model olarak yalnızca hastaneye başvuru anında elde edilebilen değişkenler kullanıldı.

BULGULAR: Hastaların medyan yaşı 58 (36–89) idi; 52'si (%75.4) erkek, 17'si (%24.6) kadındı. Hastane içi mortalite oranı %40.6 (28 hasta) olarak saptandı. Tek değişkenli analizlerde mortalite ile anlamlı ilişkili başvuru-anı parametreleri; nabız hızı, solunum sayısı, vücut kitle indeksi (VKİ), serum laktat düzeyi, radyolojik yaygınlık derecesi, vücut ısısı ve Fournier Gangren Şiddet İndeksi (FGSI) skoru idi (tümü için $p<0.05$). Yoğun bakımda kalış süresi ise klinik seyri yansıtan keşifsel analizlerde mortalite ile ilişkili bulundu. ROC analizinde, nabız hızının (AUC 0.935; %95 GA 0.848–0.980) ve radyolojik yaygınlık derecesinin (AUC 0.898; %95 GA 0.797–0.966) bireysel prognostik performansının yüksek olduğu ve bu bulguların Şekil 1'de gösterildiği saptandı. UFGSI de mortaliteyi öngörmede iyi ayırt edicilik göstermiş olup ROC analizinde AUC 0.858 (%95 GA 0.748–0.967) saptandı; Youden indeksi ile belirlenen ≥10 eşik değerinde duyarlılık %96.4 ve özgüllük %73.2 idi. Başvuru anında elde edilebilen beş parametreden (nabız, solunum sayısı, VKİ, serum laktat düzeyi ve radyolojik yaygınlık derecesi) oluşturulan başvuru-anı Kocaeli Fournier Gangren Şiddet İndeksi (KFGSI), mortaliteyi öngörmede FGSI'ye kıyasla daha yüksek ayırt edici güce sahipti (AUC 0.943; %95 GA 0.860–0.985; duyarlılık %92.9; özgüllük %85.4; FGSI için AUC 0.860; %95 GA 0.755–0.932). Yoğun bakımda kalış süresi, başvuru anında elde edilemeyen zaman bağımlı bir değişken olması nedeniyle başvuru-anı KFGSI modeline dahil edilmemiştir.

SONUÇ: Başvuru anında uygulanabilir şekilde geliştirilen KFGSI, Fournier gangreninde hastane içi mortalite riskini erken dönemde sınıflandırmada yüksek ayırt edicilik göstermiştir. Bu türetim kohortunda FGSI ve UFGSI'ye kıyasla daha yüksek görünen ayırt edicilik saptanmakla birlikte, doğrulama yapılmadığından sonuçlar temkinli yorumlanmalı ve çok merkezli ileriye dönük dış doğrulama ile desteklenmelidir.

Anahtar sözcükler: Fournier gangreni; mortalite; prognostik skor; risk sınıflandırması; ROC analizi.

Ulus Travma Acil Cerrahi Derg 2026;32(7):794-802 DOI: 10.14744/tjtes.2026.48209