Fournier’s Gangrene: Epidemiology and Outcomes in the General US Population

Key Words
Fournier’s gangrene · Mortality · Necrotizing infection · Epidemiology · Outcomes · Management

Abstract

Purpose: Case series reported 20–40% mortality rates for patients with Fournier’s gangrene with some series as high as 88%. This literature comes almost exclusively from referral centers. Materials and Methods: We identified and analyzed inpatients with Fournier’s gangrene who had a surgical debridement or died in the US State Inpatient Databases. Results: One thousand six hundred and forty one males and 39 females with Fournier’s gangrene represented <0.02% of hospital admissions. Overall, the incidence was 1.6 cases per 100,000 males and case fatality was 7.5%. Sixty six percent of hospitals cared for no cases per year, 17% cared for 1 case per year, 10% cared for 2 cases per year, 4% cared for 3 cases per year, 1% cared for 4 cases per year, and only 1% cared for ≥5 cases per year. Teaching hospitals had higher mortality (adjusted OR 1.9) due primarily to more acutely ill patients. Hospitals treating more than 1 Fournier’s gangrene case per year had an adjusted 42–84% lower mortality (p < 0.0001). Conclusions: Most hospitals rarely care for Fournier’s gangrene patients. The population-based mortality rate (7.5%) was substantially lower than the case series from tertiary care centers. Hospitals that treated more number of Fournier’s gangrene patients had lower mortality rates, thereby supporting the rationale that regionalized care worked well for patients with this rare disease.

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Introduction

In 1883 Jean Alfred Fournier described idiopathic gangrene in previously healthy young men with acute onset and rapid progression [1]. Over the years, this definition has changed substantially. Today, an etiology can almost always be identified, and the disease is not limited to young males [2, 3]. Fournier’s gangrene is a urologic emergency characterized by progressive necrotizing infection of the external genitalia or perineum [1]. Standard teaching is that management depends on early recognition, broad-spectrum antibiotics, resuscitation and aggressive debridement [1–5].

Literature reports 20–40% mortality rates, with some studies reporting mortality as high as 88% (table 1) [6]. These reports tend to be from tertiary referral centers with most studies dealing with less than 100 patients [7]. It is difficult to generalize these findings to other practice settings. Previous reports also reflect differences in referral patterns, surgical management, clinical volumes, and institutional differences. For example, authors diverge widely in their recommendations for urinary and fecal diversion, use of hyperbaric oxygen, and early skin grafting [7–11]. Because previous reports do not include data from community hospitals, there are no population-based data on incidence, regional trends, or case fatality rates. There have been efforts to predict mortality such as the Fournier’s Gangrene Severity Index that uses vital signs and laboratory tests to calculate a score [12, 13]. This index was based on data gathered from only 30 pa-
Table 1. Contemporary listing of Fournier’s gangrene case series

| Primary author | Year | Journal                                      | Mortality rate, % | Number of Fournier’s cases |
|----------------|------|----------------------------------------------|-------------------|---------------------------|
| Chalya         | 2015 | BMC Res Notes                                | 29                | 84                        |
| Erdogan        | 2015 | Eur J Trauma Emerg Surg                      | 12                | 84                        |
| McCormack      | 2015 | Can Urol Assoc J                             | 20                | 26                        |
| Ngugi          | 2014 | Afr Health Sci                               | 21                | 146                       |
| Li             | 2015 | Urol Int                                     | 21                | 28                        |
| Garcia         | 2015 | Cir Esp                                      | 26                | 59                        |
| Yilmazlar      | 2014 | Ulus Travma Acil Cerrahi Derg               | 21                | 120                       |
| Eskitascioglu   | 2014 | Ulus Travma Acil Cerrahi Derg               | 4                 | 80                        |
| Lin            | 2014 | Int J Urol                                   | 19                | 85                        |
| Tuncel         | 2014 | Scand J Urol                                 | 14                | 50                        |
| Vyas           | 2013 | Ind J Urol                                   | 20                | 30                        |
| Czymek         | 2013 | Colorectal Dis                               | 16                | 86                        |
| Aliyu          | 2013 | ISRN Urol                                    | 16                | 38                        |
| Benjelloun      | 2013 | World J Emerg Surg                           | 24                | 50                        |
| Bjurlin        | 2013 | Urology                                     | 5                 | 41                        |
| Katib          | 2013 | Cent European J Urol                         | 0                 | 20                        |
| Verma          | 2012 | J Cutan Aesthet Surg                         | 27                | 95                        |
| Aridogan       | 2012 | Urol Int                                    | 30                | 71                        |
| Ersoz          | 2012 | Signapore Med J                              | 23                | 52                        |
| Sugihara       | 2012 | BJU Int                                     | 17                | 379                       |
| Altarac        | 2012 | Urol Int                                    | 37                | 41                        |
| Goktas         | 2012 | Ulus Travma Acil Cerrahi Derg               | 11                | 36                        |
| Vargas         | 2012 | Arch Esp Urol                               | 17                | 42                        |
| Koukouras      | 2011 | Urol Int                                    | 16                | 45                        |
| Mehl           | 2010 | Rev Col Bras Cir                            | 20                | 40                        |
| Malik          | 2010 | J Pak Med Assoc                              | 18                | 73                        |
| Lujan Marco    | 2010 | BJU Int                                     | 16                | 51                        |
| Morua          | 2009 | Arch Esp Urol                               | 12                | 50                        |
| Czymek         | 2009 | Infection                                  | 18                | 33                        |
| Sorensen       | 2009 | J Urol                                      | 7.5               | 1,641                     |
| Medina         | 2008 | Actas Urol Esp                              | 34                | 90                        |
| Corcoran       | 2008 | J Urol                                      | 10                | 68                        |
| Basoglu        | 2007 | Surg Today                                  | 8.8               | 45                        |
| Carvalho       | 2007 | Int Braz J Urol                             | 16                | 80                        |
| Dje            | 2006 | African J Urology                           | 18                | 78                        |
| Ayan           | 2005 | Anz J Surg                                  | 22                | 41                        |
| Edino          | 2005 | African J Urology                           | 13                | 24                        |
| Yeniyol        | 2004 | Urology                                    | 24                | 25                        |
| Daali          | 2002 | African J Urology                           | 17                | 60                        |
| Norton         | 2002 | Am Surg                                    | 9                 | 33                        |
| Eke            | 2000 | Br J Surg                                  | 16                | 1,726*                    |
| Eke            | 2000 | Int Surg                                   | 10                | 21                        |
| Yaghan         | 2000 | Dis Colon Rectum                           | 20                | 10                        |
| Corman         | 1999 | BJU Int                                    | 4                 | 23                        |
| Brissaud       | 1998 | Chirurgie                                   | 34                | 44                        |
| Kouadio        | 1998 | Med Trop                                   | 27                | 30                        |
| Benchekroun    | 1997 | J Urol                                      | 9                 | 55                        |
| Pizzorno       | 1997 | J Urol                                      | 0                 | 11                        |
| Laor           | 1995 | J Urol                                      | 43                | 30                        |
| Palmer         | 1995 | Br J Urol                                  | 43                | 30                        |
| Picramenos     | 1995 | Prog Urol                                  | 30                | 10                        |
| Attah          | 1992 | Br J Urol                                  | 0                 | 13                        |
| Baskin         | 1990 | J Urol                                      | 21                | 29                        |
| Clayton        | 1990 | Surg Gynecol Obstet                         | 18                | 57                        |
| Wolach         | 1989 | Br J Urol                                  | 20                | 10                        |
| Fahal          | 1988 | Br J Urol                                  | 25                | 9                         |
| Enriquez       | 1987 | Dis Colon Rectum                           | 25                | 28                        |
| Spirkak         | 1984 | J Urol                                     | 45                | 20                        |
| Stone and Martin | 1972 | Ann Surg                                  | 88                | 33                        |

* Review article
tients presenting to a referral center over a 15-year period. Other investigators reported variable accuracy using the Fournier’s Gangrene Severity Index to predict mortality [13–18].

We used a large population-based database to better understand the epidemiology and outcomes of Fournier’s gangrene. Our initial goals were to determine the incidence, patient characteristics, and hospital experience with Fournier’s gangrene. We hypothesized that case series from tertiary referral centers do not accurately reflect the clinical spectrum and outcomes in the general population. The database was then used to examine differences in case severity and management between teaching and non-teaching hospitals, and to determine predictors of mortality in Fournier’s gangrene.

**Materials and Methods**

**Study Population**

The US State Inpatient Databases (SID) was established by the Healthcare Cost and Utilization Project (HCUP). The SID includes data from 100% of admissions and discharges from all US civilian hospitals in participating states [19]. The SID is the largest US hospital care dataset.

We analyzed data from 13 states for 2001 and from 21 states for 2004. In 2001, data were purchased from Colorado, Florida, Iowa, Massachusetts, Maryland, Maine, North Carolina, New Jersey, New York, Oregon, Utah, Washington, and West Virginia. In 2004, we also purchased data from Arizona, Kentucky, Michigan, Nebraska, Nevada, Rhode Island, South Carolina, Vermont, and Wisconsin; but data from Maine were unavailable.

**Case Definition and Data Abstraction Strategy**

The International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9) code for Fournier’s gangrene (608.83) is listed under ‘Diseases of the Male Genital Organs’. There is no Fournier’s gangrene code for females. To identify female cases, we searched for patients with diagnosis codes for gangrene (785.4) and either vulvovaginal gland abscess (616.3) or vulvar abscess (616.4). Overall, 3 cases were excluded, as they were discharged alive without a surgical debridement, leaving 39 total females with Fournier’s gangrene. Due to the differential identification and the low yield, analyses of female Fournier’s gangrene cases were restricted by demographic and descriptive factors.

To evaluate the potential role of comorbidities on outcome, the Charlson comorbidity index was calculated for each patient. This represents the most extensively studied index for risk adjustment and mortality prediction [22–25]. To more specifically examine the effect of specific comorbidities individual covariates were analyzed including preexisting obesity, diabetes, congestive heart failure, peripheral vascular disease, chronic pulmonary disease, hypertension, renal failure, liver disease, AIDS, coagulopathy, peptic ulcer disease, and anemia.

**Data Analyses**

Population-based incidence rates were calculated using US Census Bureau [26] data. Incidence and mortality rates were determined for the four US Census Bureau-defined regions (Northeast, South, Midwest, and West) [27]. Trends were compared to the 2005 Behavioral Risk Factor Surveillance System prevalence rates for diabetes and obesity using linear regression analyses [28].

Although most patient and hospital demographic variables were obtained from the SID, some variables were obtained by linking hospital identification numbers with the National Inpatient Sample, a separate database also operated by the HCUP. Because age was not linearly associated with mortality, age was categorized as <40, 40–49, 50–59, 60–69, and ≥70. Fournier’s gangrene cases treated at an institution was categorized as 0, 1, 2–4, 5–9, or ≥10 cases per year due to a non-normal case distribution. The chi-square test was used to evaluate binary variables, Student’s t test allowing for unequal variance was used to evaluate continuous variables, and the Wilcoxon rank-sum was used to compare medians. Multivariate logistic regression analyses with robust SEs were used to determine patient and hospital factors that predicted mortality adjusted for confounding variables.

**Results**

**Patient and Hospital Demographics**

We identified 1,641 males with Fournier’s gangrene. The overall case fatality rate was 7.5% (124 deaths/1,641 cases). Male cases had a mean age of 50.9 ± 18.6, were most commonly white, and many had comorbidities (table 2). Fournier’s gangrene patients were more likely to have diabetes (OR 3.3, 95% CI 2.9–3.7) and obesity (OR 3.7, 95% CI 3.1–4.3) than other males in the SID after adjustment.
for age (table 2). Males with Fournier’s gangrene had similar rates of hypertension (OR 0.9, 95% CI 0.8–1.0), tobacco and alcohol use (OR 1.0, 95% CI 0.8–1.2) and were less likely to use illicit drugs (OR 0.5, 95% CI 0.3–0.8).

Only 39 women were identified who met our case definition for Fournier’s gangrene. Females with Fournier’s gangrene were similar to male cases in age, ethnicity, comorbidities, number of surgical debridements, and discharge needs. Female cases were more acutely ill at presentation, as they had double the requirement for mechanical ventilation and dialysis, longer mean and median length of stay, greater total hospital charges and higher case fatality (12.8%, 5/39 cases) than the male cases, although none of these factors met statistical significance.

Admissions for Fournier’s gangrene were rare, representing less than 0.02% of all SID hospital admissions. The 1,764 hospitals analyzed cared for an average of 0.6 ± 1.2 Fournier’s gangrene cases per year (median 0, range 0–23), while 66% cared for no Fournier’s gangrene cases during the 2 study years (fig. 1). Results were similar when 2001 and 2004 data were analyzed individually.

### Table 2. Patient and hospital characteristics of male patients with Fournier’s gangrene

| Patient demographics | Male Fournier’s cases (n = 1,641) | All other males in SID (n = 11.2 million) | p value |
|----------------------|-----------------------------------|------------------------------------------|---------|
| **Age, years, n (%)**|                                   |                                          |         |
| <40                  | 379 (23)                          | 3,606,816 (32)                           | <0.0001 |
| 40–49                | 341 (21)                          | 1,286,656 (12)                           |         |
| 50–59                | 407 (25)                          | 1,481,863 (13)                           |         |
| 60–69                | 250 (15)                          | 1,584,606 (14)                           |         |
| ≥70                  | 264 (16)                          | 3,224,827 (29)                           |         |
| **Age, years, mean ± SD** | 50.9±18.6                      | 48.5±28.3                                |         |
| **Race/ethnicity, n (%)** |                                  |                                          | <0.0001 |
| White                | 836 (51)                          | 6,042,041 (54)                           |         |
| Black                | 307 (19)                          | 1,316,227 (12)                           |         |
| Hispanic             | 109 (7)                           | 801,713 (7)                              |         |
| Other                | 49 (3)                            | 477,827 (4)                              |         |
| **Charlson comorbidity index, mean ± SD** | 1.2±1.4                          |                                          |         |
| **Comorbidities, %** |                                   |                                          | <0.0001 |
| Diabetes             | 37                                | 14                                       |         |
| Obesity              | 11                                | 4                                        | <0.0001 |
| Hypertension         | 31                                | 31                                       | 0.64    |
| Alcohol abuse        | 5                                 | 3                                        | <0.0001 |
| Tobacco smoker       | 15                                | 15                                       | 0.69    |
| Illicit drug abuse   | 1.5                               | 2.3                                      | 0.0007  |
| **Admission source** |                                   |                                          | <0.0001 |
| Transferred from outside hospital, n (%) | 110 (7)                             | 451,481 (4)                              |         |
| Case fatality rate, n (%) | 124 (7.5)                         | 298,313 (2.7)                            | <0.0001 |

* Numbers may not add to 100% due to missing values.

![Fig. 1. Distribution of annual cases per hospital.](image)

**Epidemiology and Regional Trends**

The overall incidence was 1.6 Fournier’s gangrene cases per 100,000 males annually (table 3). The incidence peaked and remained steady after age 50 at 3.3 cases per 100,000 males.
The incidence of Fournier’s gangrene was highest in the South and the lowest in the West and Midwest US (table 4). Fournier’s gangrene incidence increased 0.2 per 100,000 males for each 1% increase in the regional prevalence of diabetes (p = 0.02). The incidence was not related to the regional prevalence of obesity (p = 0.95). The regional mortality rate was not related to the regional prevalence of diabetes (p = 1.00) or obesity (p = 0.35). Similar findings were observed when individual states were analyzed, rather than US regions.

Transferred patients were similar in age, ethnicity, surgical procedures, length of stay, total hospital charges, and discharge needs to patients who were not transferred. There was a higher case fatality rate among transferred cases (12.7%) than cases that were not transferred (7.1%, p = 0.09). The 633 patients with a diagnosis of Fournier’s gangrene that did not undergo debridement prior to discharge had lower mortality (5%), were less likely to require ICU care, mechanical ventilation, or dialysis, had an average length of stay almost half as long (7 vs. 13 days), and many patients were observed overnight and discharged the following day. These observations led us to conclude that the survivors from this group were unlikely to truly have a necrotizing soft tissue infection and, thus, were appropriately excluded.

**Hospital Demographics**

The 1,641 male Fournier’s gangrene cases were treated at 593 hospitals. Patients were more likely to be treated at large, urban hospitals (table 5). Only 18% of the 1,720 hospitals in the SID were designated as teaching hospitals but they treated more than half of the Fournier’s gangrene cases. Overall, 71% of the teaching hospitals treated at least one Fournier’s gangrene case compared to only 30% of the non-teaching hospitals.

**Clinical Management**

Patients required multiple surgeries (average of 2.2 ± 1.6, range 0–11), and multiple debridements (average of 1.5 ± 1.0, range 0–8) per admission. Many patients required additional procedures (e.g. suprapubic tube, colostomy, orchietomy, penectomy, etc.), while 10% re-

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**Table 3.** Age-stratified incidence rates of male Fournier’s gangrene cases

| Age   | Fournier’s cases | Total male population in SID | Incidence rate per 100,000 males |
|-------|------------------|------------------------------|---------------------------------|
| 0–9   | 36               | 14,050,384                   | 0.3                             |
| 10–19 | 83               | 14,864,893                   | 0.6                             |
| 20–29 | 85               | 14,187,958                   | 0.6                             |
| 30–39 | 175              | 15,238,114                   | 1.1                             |
| 40–49 | 341              | 15,905,127                   | 2.1                             |
| 50–59 | 407              | 12,363,771                   | 3.3                             |
| 60–69 | 250              | 7,685,933                    | 3.3                             |
| ≥70   | 264              | 8,093,712                    | 3.2                             |
| Total | 1,641            | 102,389,892                  | 1.6 per 100,000 males           |

**Table 4.** Incidence rates of Fournier’s gangrene by region and comparison to 2005 Behavioral Risk Factor Surveillance System prevalence rates of diabetes and obesity diagnoses

| US region | Male cases (n = 1,641) | Total male population in SID (n = 102,389,892) | Male incidence per 100,000 | Mortality rate, % | Estimated diabetes prevalence*, % | Estimated obesity prevalence*, % |
|-----------|------------------------|-----------------------------------------------|---------------------------|------------------|----------------------------------|----------------------------------|
| Northeast | 651                    | 39,850,544                                   | 1.6                       | 8.8              | 7.1                              | 22.3                             |
| Midwest   | 150                    | 11,451,728                                   | 1.3                       | 6.7              | 7.4                              | 26.5                             |
| South     | 567                    | 30,532,528                                   | 1.9                       | 6.2              | 9.1                              | 27.1                             |
| West      | 273                    | 20,555,092                                   | 1.3                       | 8.1              | 6.3                              | 22.9                             |

* 2005 Behavioral Risk Factors Surveillance System prevalence rates by region.
quired mechanical ventilation, and 1.4% underwent dialysis. Overall, 7% of patients underwent reconstruction of their wound (with or without skin grafting) during their hospitalizations. The median hospital stay was 8 days. Hospital charges were more than 50% higher for those who died than for those who survived (median $40,871 vs. $26,574, p = 0.0001). After discharge, 30% of Fournier’s gangrene cases required home health care or a skilled nursing facility stay.

**Teaching Hospitals vs. Non-Teaching Hospitals**

Most Fournier’s gangrene cases were treated at teaching hospitals and these patients were younger, more likely to be nonwhites, and more often admitted via transfer (table 6). Patients treated at teaching hospitals had a more severe form of the disease. They underwent more surgeries (especially genital/perineal debridements), mechanical ventilation, had longer lengths of stay, and higher total hospital charges. The case fatality rate at teaching hospitals was 8.9% compared to 6.4% at non-teaching hospitals (p = 0.06, unadjusted).

**Mortality Predictors**

In univariate analyses, increasing age (OR 4.0–18.8) was associated with increased mortality (table 7). Mortality increased 50% for each one-point increase in Charlson comorbidity index (aOR 1.20 per point), and admission via transfer (aOR 1.9), after adjusting for hospital location, size, ownership, US region, teaching center status and number of Fournier’s gangrene cases treated annually (table 8). When comorbidities were analyzed separately, specific risks associated with increased mortality included: heart failure (aOR 2.1), renal failure (aOR 3.2), and coagulopathy (aOR 3.4). Race and number of surgeries did not predict mortality.

On multivariate analyses, patient factors that independently predicted mortality included: increasing age category (adjusted OR, aOR 4.0–15.0), Charlson comorbidity index (aOR 1.20 per point), and admission via transfer (aOR 1.9), after adjusting for hospital location, size, ownership, US region, teaching center status and number of Fournier’s gangrene cases treated annually (table 7). When comorbidities were analyzed separately, specific risks associated with increased mortality included: heart failure (aOR 2.1), renal failure (aOR 3.2), and coagulopathy (aOR 3.4). Race and number of surgeries did not predict mortality.

In a separate model evaluating hospital-associated predictors, mortality was 42–84% lower at hospitals treating more than 1 Fournier’s gangrene case per year (p < 0.0001), after adjustments for patient age, race, Charlson comorbidity index, and admission via transfer. Patients at teaching hospitals had higher mortality (aOR 1.9) than those at non-teaching hospitals. However, when the model was adjusted for the number of surgeries, teaching hospital status was not an independent predictor of mortality.

**Discussion**

These population-based epidemiological studies provide a broader perspective than previous studies of Fournier’s gangrene. The major advantage of our population-based approach was the ability to identify a large number of Fournier’s gangrene cases managed at multiple centers, including tertiary care referral hospitals and non-referral hospitals, limiting case-selection and publication biases.
Table 6. Demographic characteristics of hospitals treating Fournier’s gangrene cases

|                                    | Teaching hospitals (n = 215) | Non-teaching hospitals (n = 362) | p value |
|------------------------------------|-----------------------------|---------------------------------|---------|
| Fournier’s gangrene cases, n (%)†  | 820 (50)                    | 710 (43)                        |         |
| **Case demographic characteristics** |                             |                                 |         |
| Age, years, mean ± SD              | 49.7±18.8                   | 52.1±18.7                       | 0.05    |
| Race/ethnicity, %                  |                             |                                 | <0.001  |
| White                              | 59                          | 72                              |         |
| Black                              | 28                          | 17                              |         |
| Hispanic                           | 8                           | 9                               |         |
| Other                              | 5                           | 2                               |         |
| Admission source, %                |                             |                                 | <0.001  |
| Transferred from another hospital  | 11                          | 2                               |         |
| **Hospital demographic characteristics, %** |                             |                                 |         |
| Hospital location                   |                             |                                 | <0.001  |
| Urban                              | 98                          | 85                              |         |
| Rural                              | 2                           | 15                              |         |
| Hospital bed size                   |                             |                                 | 0.03    |
| Small                              | 7.7                         | 9.2                             |         |
| Medium                             | 21.5                        | 26.5                            |         |
| Large                              | 70.9                        | 64.4                            |         |
| Hospital ownership                  |                             |                                 | <0.001  |
| Non-profit                         | 26                          | 45                              |         |
| Private                            | 0.4                         | 23                              |         |
| Public                             | 7                           | 9                               |         |
| Government/other                    | 67                          | 24                              |         |
| Number of annual Fournier’s gangrene cases |                             |                                 | <0.001  |
| 1                                  | 9                           | 26                              |         |
| 2–4                                | 53                          | 71                              |         |
| 5–9                                | 26                          | 4                               |         |
| ≥10                                | 12                          | 0                               |         |
| Mean ± SD                          | 2.4±2.1                     | 1.5±0.8                         |         |
| **Management factors during each admission** |                             |                                 |         |
| Total surgeries, mean ± SD*        | 2.3±1.7                     | 1.9±1.3                         | <0.001  |
| Genital/perineal debridements, mean ± SD* | 1.6±1.0                    | 1.4±0.9                         | 0.001   |
| Additional surgical procedures, %  |                             |                                 |         |
| Suprapubic tube placement          | 7                           | 8                               | 0.49    |
| Colostomy                          | 10                          | 8                               | 0.09    |
| Orchietomy                         | 24                          | 30                              | <0.01   |
| Penectomy                          | 1                           | 1                               | 0.98    |
| Surgical wound closure             | 11                          | 4                               | <0.001  |
| Supportive care, %                 |                             |                                 |         |
| Mechanical ventilation             | 13                          | 8                               | <0.01   |
| Dialysis                           | 0.7                         | 1.8                             | 0.06    |
| Median length of stay, days        | 10                          | 7                               | <0.0001 |
| Median total hospital charges       | $31,900                     | $22,862                         | <0.0001 |
| Case fatality rate, %              | 8.9                         | 6.4                             | 0.06    |

† No information on teaching hospital status was available for 16 hospitals (3%) treating 111 (7%) of the Fournier’s gangrene cases.

* Mean ± SD number of surgeries and debridements were calculated based on the 61% cases where the dates of surgical intervention were reported.
### Table 7. Unadjusted in-hospital mortality risk for 1,641 Fournier’s gangrene cases

| OR (95% CI) | p value |
|-------------|---------|
| **Patient-associated factors** | | |
| Age, years | | <0.001 |
| <40 | Ref. |
| 40–49 | 4.0 (1.3–12.3) |
| 50–59 | 7.5 (2.6–21.4) |
| 60–69 | 13.8 (4.8–39.4) |
| ≥70 | 18.8 (6.7–53.1) |
| Race/ethnicity | | 0.60 |
| White | Ref. |
| Black | 0.70 (0.41–1.20) |
| Hispanic | 1.01 (0.49–2.10) |
| Other | 0.73 (0.22–2.43) |
| Charlson comorbidity index (per 1 point increased index) | | 1.5 (1.3–1.6) | <0.001 |
| Specific comorbidities |
| Diabetes | 0.94 (0.64–1.37) | 0.74 |
| Obesity | 0.64 (0.32–1.30) | 0.22 |
| Hypertension | 1.5 (1.0–2.1) | 0.05 |
| Congestive heart failure | 3.7 (2.3–5.8) | <0.001 |
| Renal failure | 5.3 (3.2–8.7) | <0.001 |
| Coagulopathy | 4.4 (2.4–8.1) | <0.001 |
| **Hospital-associated factors** | | 0.88 |
| Bedsize | | |
| Small | Ref. |
| Medium | 1.19 (0.55–2.58) |
| Large | 1.09 (0.53–2.23) |
| Urban hospital | 2.68 (0.97–7.38) | 0.06 |
| Hospital ownership | | 0.02 |
| Private, non-profit | Ref. |
| Private for profit | 1.7 (0.8–3.4) |
| Public | 1.4 (0.6–3.2) |
| Government/other | 2.1 (1.3–3.4) |

### Table 8. Multivariate predictors of Fournier’s gangrene mortality

| aOR (95% CI) | p value |
|-------------|---------|
| **Patient-related** | | <0.0001 |
| Age, years | | |
| <40 | Ref. |
| 40–49 | 4.0 (1.1–14.1) |
| 50–59 | 7.3 (2.2–24.7) |
| 60–69 | 11.0 (3.1–38.9) |
| ≥70 | 15.0 (4.5–49.7) |
| Charlson comorbidity index (per point) | | 1.20 (1.0–1.4) | 0.04 |
| Comorbidities |
| Congestive heart failure | 2.1 (1.1–3.8) | 0.02 |
| Renal failure | 3.2 (1.6–6.4) | 0.001 |
| Coagulopathy | 3.4 (1.6–7.4) | 0.002 |
| Admission via transfer | 1.9 (1.0–3.7) | 0.048 |

* Additional comorbid conditions were evaluated and were not significant including: preexisting peripheral vascular disease, chronic pulmonary disease, liver disease, AIDS, peptic ulcer disease, and anemia.

### Management variables

| OR (95% CI) | p value |
|-------------|---------|
| Teaching hospital | 1.4 (0.98–2.12) | 0.06 |
| Admission source |
| Transferred from another hospital | 1.9 (1.1–3.4) | 0.04 |
| Cases Fournier’s gangrene (per year) | | |
| 1 | Ref. |
| 2–4 | 0.8 (0.5–1.3) |
| 5–9 | 1.1 (0.6–1.9) |
| ≥10 | 0.6 (0.2–1.8) |
| Length of stay (each day) | | 1.6 (0.7–2.5) | 0.001 |

* Patient-related predictors were adjusted for hospital location, US region, hospital bed size, hospital ownership, teaching center status, and cases of Fournier’s gangrene per year. Patient race and number of surgeries did not predict mortality risk.

† Hospital-related predictors were adjusted for patient age, race, Charlson comorbidity index, and patient admission via transfer. Hospital location, bed size, ownership and US region did not predict mortality risk.
We confirmed that Fournier’s gangrene is indeed rare, representing less than 0.02% of hospital admissions in the United States with an overall incidence of 1.6 cases per 100,000 males per year. Most hospitals (66% overall) cared for no patients with Fournier’s gangrene during a given year, and only 1% of hospitals cared for ≥5 cases per year. Thus, even high-volume centers cared for a patient with Fournier’s gangrene every few months. As practitioners at a high-volume, teaching-center in the United States, our perspective on the management, mortality, morbidity and risk factors might differ from what is seen in the general US community.

Overall mortality was 7.5% in our population-based study. This was substantially lower than rates reported in the literature (table 1). The highest mortality was reported in 1972 by Stone and Martin (88% mortality among 33 patients). More contemporary series report fatality rates in the 20–40% range. In our studies, mortality was highest for transferred patients (12.7%) possibly representing the most acutely ill cases. What is projected in our study is a lower rate than that revealed by most prior studies and is less than the Centers for Disease Control and Prevention population-based mortality rate for Group A streptococcal necrotizing soft tissue infections (24%), suggesting that Fournier’s gangrene is less lethal than other necrotizing soft tissue infections [29].

Increased patient age (aOR 4.0–15.0, p < 0.0001) proved the strongest independent predictor of mortality. Patients in hospitals that treated more Fournier’s gangrene cases had 42–84% lower mortality (p < 0.0001) than hospitals treating only 1 case per year. This may reflect more aggressive diagnosis, management, and treatment at more experienced hospitals. Patients admitted via transfer also had a higher independent risk of mortality (aOR 1.9). This may reflect a more severe form of the illness among transferred patients, lack of critical care facilities at the transferring hospitals, or delays in management and/or treatment. These findings support the need to increase regionalization of care for patients with Fournier’s gangrene. Because management often requires care from urologic surgeons, general surgeons, intensivists and plastic surgeons, a multidisciplinary approach at facilities with greater experience might improve patient outcomes.

Teaching hospitals cared for a majority of Fournier’s gangrene cases while 30% of non-teaching hospitals treated patients with Fournier’s gangrene (p < 0.0001). Patients at teaching hospitals were more acutely ill, required more surgical procedures (especially genital/perineal debridements), more mechanical ventilation and other supportive care. These factors likely account for longer lengths of stay, higher hospital charges, and higher case fatality at teaching hospitals. Patients in teaching hospitals had nearly double the unadjusted mortality rate. We hypothesized that this might reflect differences in the severity, management or supportive care, or that diagnostic criteria for Fournier’s gangrene at teaching hospitals might differ from those followed at non-teaching hospitals. After adjusting for the number of surgeries a patient required during admission, which is a marker of disease severity, the teaching center status was not an independent predictor of mortality. These observations suggest that higher mortality at teaching hospitals likely reflects a more severely ill population. Patient race and other hospital-related factors assessed (location, size, ownership and US region) did not independently predict mortality.

Deaths tended to occur late during hospitalization. Patients who died had longer lengths of stay and greater hospital. These findings may reflect a more indolent course of Fournier’s gangrene following initial therapy. Deaths might reflect in-hospital complications, but we have no data to substantiate these events.

Morbidity from Fournier’s gangrene was high. Similar to other reports, cases in this series often required many operations, especially genital/perineal debridements, orchietomy, cystostomy and/or colostomy [30–33]. Overall, 30% of survivors required ongoing care after hospital discharge. Given the rarity (7%) of surgical reconstruction of wounds during the initial hospitalizations, we suspect this ongoing care was necessary to facilitate closure of many patients’ open wounds.

This study has certain crucial limitations. Our approach was retrospective using administrative data and subject to the inherent biases of retrospective designs. The database provided no clinical or microbiologic variables to support the diagnosis, determine the degree/severity of infection or percent surface area of skin involvement, or calculate a Fournier’s Gangrene Severity Index [12–14]. We were unable to examine urethral stricture as comorbidity because this information was not in the dataset. We could not determine if differential coding of comorbidities occurred, with comorbidities more likely to be captured in the more severely ill patients and in those who died. We may have excluded patients managed with antibiotics only because our case definition required a surgical debridement. However, our subgroup analysis revealed that patients who did not receive a debridement did not merit a diagnosis of...
Fournier’s gangrene. It is also possible that case fatality was inflated slightly because we included all subjects who died with a Fournier’s gangrene diagnosis code, but required survivors to have both a Fournier’s gangrene diagnosis code and a genital/perineal debridement. The number of distinct visits to the operating room could be determined for 61% of cases, potentially limiting this variable as a marker of disease severity. Also, we have limited information on women in this regard.

Conclusions

This is the largest study of Fournier’s gangrene and the first population-based study allowing accurate estimation of incidence and case fatality. Our study provides the required data on the management of this complex condition in the United States. We are aware of no other comparable data from other areas. We provide new insights into the rarity and hospital experience with Fournier’s gangrene, regional trends and comorbidities. Our findings agree with those of prior literature on the age of onset and comorbid risk factors. However, we found substantially lower mortality than case-series from referral centers. We provide the first comparison of outcomes for patients treated at different hospital types and the first population-based study evaluating predictors of mortality. Our findings support earlier observations from tertiary care referral centers documenting the frequent need for surgical procedures and supportive care.

The large number of cases identified provided a unique opportunity to identify patient-associated and hospital-associated factors predictors or mortality. Fournier’s gangrene patients treated at teaching hospitals required more surgical procedures, more supportive care, longer lengths of stay, greater hospital charges and higher mortality rates, reflecting a more severely ill patient population. Hospitals that treated more number of Fournier’s gangrene patients had lower mortality rates supporting the need to regionalize care for patients with this rare disease.

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