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# CLINICAL-EPIDEMIOLOGICAL PROFILE AND OUTCOMES OF PATIENTS WITH FOURNIER'S GANGRENE IN A REFERRAL HOSPITAL IN THE FEDERAL DISTRICT BETWEEN MARCH 2020 AND SEPTEMBER 2025

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**Abstract:** Fournier's gangrene is a rare and severe necrotizing infection associated with high morbidity and mortality and significant consumption of hospital resources. This study aimed to analyze the clinical-epidemiological profile and outcomes of patients with Fournier's gangrene undergoing surgical treatment at a referral hospital in the Federal District, as well as to estimate the potential economic impact of incorporating adjuvant therapies. This is an observational, retrospective, and descriptive study, with analysis of medical records of patients treated between March 2020 and September 2025. Demographic data, comorbidities, clinical manifestations, need for ICU admission, length of hospital stay, number of surgical procedures, and mortality were evaluated. The economic analysis was performed using estimates, with length of stay as a proxy for cost, based on official sources and scientific literature. Thirty-seven patients were included, with a mean age of 54 years, a predominance of males, and a high prevalence of comorbidities, especially diabetes mellitus, systemic arterial hypertension, and obesity. The observed mortality rate was 21.6%, with a high rate of ICU admission and prolonged hospitalization. No patient had access to adjuvant therapies such as negative pressure therapy or hyperbaric oxygen therapy. It is concluded that Fournier's gangrene remains associated with serious outcomes and high healthcare impact, and that the protocolized adoption of adjuvant therapies in selected patients has the potential to reduce hospitalization time, improve clinical outcomes, and rationalize costs in the public health system.

**Keywords:** Fournier's gangrene; necrotizing fasciitis; clinical-epidemiological profile; outcomes; hospital costs.

## INTRODUCTION

Fournier's gangrene (FG) is a rare but devastating necrotizing infection that affects the soft tissues of the perineal, genital, and/or anal region. Characterized by its rapid progression and high mortality, this condition represents a significant challenge for healthcare professionals, requiring early diagnosis and immediate multidisciplinary intervention. Despite advances in modern medicine, FG continues to have mortality rates ranging from 15% to 50%, depending on the population studied and associated clinical conditions. (Stevens et al., 2014)

FG is considered a urological and surgical emergency, with an estimated incidence of 0.3 to 1.6 cases per 100,000 inhabitants, predominantly in men (a ratio of 10:1 compared to women). However, cases in women, children, and neonates are also documented, as evidenced in studies by Salihu et al. (2024) and dos-Santos et al. (2018). The condition is often associated with comorbidities such as diabetes mellitus (DM), hypertension, immunosuppression, and chronic kidney disease, factors that worsen the prognosis.

Retrospective studies in different regions (Nigeria, Brazil, South Korea, Portugal) show variations in mortality rates, reflecting disparities in access to healthcare and early diagnosis. For example, Salihu et al. (2024) reported a mortality rate of 36% in Nigerian patients, while Louro et al. (2019) observed a mortality rate of 0% in a Portuguese cohort, possibly due to early interventions and specialized management.

GF is a polymicrobial infection involving aerobic bacteria (*Escherichia coli*, *Staphylococcus aureus*) and anaerobic bacteria (*Bacteroides fragilis*), which act syner-

gistically to produce toxins and tissue-destroying enzymes. Ischemia resulting from microvascular thrombosis accelerates fascial necrosis and the spread of infection. (Cen et al. (2022)

Early diagnosis is crucial but often hampered by nonspecific presentation (pain, edema, erythema) and confusion with less serious infections. Delays in treatment are associated with significantly higher mortality rates. (Cen et al. (2022)

GF is not only life-threatening, but also causes profound physical and psychological sequelae, such as genital disfigurement, sexual dysfunction, and social stigma. Hospital costs are high due to long hospital stays, multiple surgeries, and intensive care. (Louro et al., 2019)

Therefore, given that GF is a paradigm of necrotizing infection that requires urgent and multidisciplinary attention, its study not only saves lives but also highlights global health inequalities. The integration of local and international evidence, as will be analyzed, is vital to advance the management of this devastating condition, and the survey of the prevalence of diagnoses of cases at the Regional Hospital of Taguatinga-DF can provide a better assessment of the number of cases diagnosed with this condition in the region and correlate it with national and international data.

## Pathophysiology

The pathophysiology of GF involves thrombosis of the subcutaneous arterioles and venules, caused both by the direct action of bacterial toxins and by the host's inflammatory response. Endotoxins released by gram-negative bacteria, such as lipopoly-

saccharide (LPS), and exotoxins from microorganisms such as *Clostridium*, induce severe vascular inflammation (El-Qushayri et al., 2020). This inflammatory response promotes endothelial damage, complement activation, release of pro-inflammatory cytokines such as TNF-alpha, IL-1, and IL-6, and formation of microthrombi that obstruct local blood flow. This results in ischemia and subsequent tissue necrosis, especially of the superficial and deep fascia, with relative initial preservation of the musculature (Stevens et al., 2014). The overlying skin, upon losing its perfusion, initially becomes erythematous and edematous, progressing to cyanosis, darkening, hemorrhagic blisters, and finally, sloughing and gangrenous necrosis with a characteristic foul odor.

The local condition worsens rapidly and is accompanied by an intense systemic inflammatory response. The release of large amounts of inflammatory mediators and bacterial toxins into the circulation leads to the development of systemic inflammatory response syndrome (SIRS), which manifests clinically as high fever (or hypothermia), tachycardia, tachypnea, and hematological changes such as leukocytosis or leukopenia. As the condition progresses, sepsis and, often, septic shock set in, characterized by refractory hypotension, lactic metabolic acidosis, tissue hypoperfusion, and multiple organ dysfunction. (Cen et al. (2022)

Laboratory findings reflect the intensity of the infectious and destructive process: marked leukocytosis with left shift, elevated inflammatory markers such as C-reactive protein and procalcitonin, hyponatremia, metabolic acidosis, elevated creatine phosphokinase (CPK), lactate dehydrogenase (LDH), and other muscle enzymes, indi-

cative of tissue necrosis. Arterial blood gas analysis reveals acidosis with increased lactate, signaling hypoperfusion and shock. (Cen et al. (2022) The clinical progression of Fournier's gangrene is extremely rapid, often occurring within a few hours. Furthermore, intense pain disproportionate to physical examination is one of the first clinical signs, followed by edema, erythema, and crepitus on palpation. As the disease progresses, skin signs of necrosis, blistering, darkening, and a putrid odor appear. Thus, the infection spreads along the fascial planes, which justifies the need for extensive and successive surgical debridement. (Cen et al. (2022)

## Diagnosis

The diagnosis of Fournier's gangrene is eminently clinical, based on early suspicion from the patient's history, present risk factors, and careful physical evaluation. It is a rapidly progressing medical emergency in which immediate recognition is essential to reduce morbidity and mortality. Patients usually present with severe pain in the perineal, scrotal, or genital region, often disproportionate to the initial physical findings. This pain may radiate to the lower abdomen, buttocks, or lower limbs and tends to worsen rapidly within a few hours, accompanied by systemic signs such as fever, malaise, tachycardia, hypotension, and mental confusion in more advanced cases. (Stevens et al., 2014)

On physical examination, local signs may initially be subtle, such as edema, erythema, or increased sensitivity in the genital or perineal region. However, as the disease progresses, more specific and severe changes appear, including subcutaneous crepitus, hemorrhagic blisters, skin detachment, skin

necrosis with dark or purplish discoloration, and a characteristic foul odor resulting from the activity of anaerobic bacteria. Purulent or serosanguineous discharge, spontaneous drainage of gas or necrotic tissue, and signs of systemic distress, such as hypotension, decreased level of consciousness, and signs of septic shock, are common. (Stevens et al., 2014)

A targeted medical history is essential to identify important risk factors, such as diabetes mellitus (present in up to 60% of cases), alcoholism, illicit drug use, neoplasms, immunosuppression (including HIV/AIDS or use of corticosteroids and chemotherapy drugs), obesity, and poor hygiene. Recent urological or anorectal interventions, such as biopsies, catheterizations, or surgeries, which may have been the point of entry for the infection, are also investigated. (Seong et al. (2023)

After clinical evaluation, laboratory tests are useful both to support the diagnosis and to stratify severity and monitor progression. The complete blood count often shows severe leukocytosis with a left shift; however, in severe cases or with immunosuppression, leukopenia may be present. Inflammatory tests such as C-reactive protein (CRP) and procalcitonin are usually quite elevated. Arterial blood gas analysis may reveal metabolic acidosis, reflecting hypoperfusion and septic state. Hyponatremia, elevated creatine phosphokinase (CPK), elevated urea and creatinine due to acute renal failure, and coagulation disorders such as disseminated intravascular coagulation (DIC) in advanced stages are also common. (Seong et al. (2023)

A useful laboratory score called LRINEC (Laboratory Risk Indicator for Necrotizing Fasciitis) can be applied to aid in the differentiation between common skin infections and necrotizing fasciitis, using

**Summary of the original study by Wong et al. (2004):**

- A single center, retrospective chart review of 89 patients admitted with NF and 225 patients admitted with severe cellulitis or abscess.
- Six criteria (CRP, Hgb, WBC, Na<sup>+</sup>, Cr, Glucose) were identified as independent predictors for NF and assigned a numerical value of 0-4.
- LRINEC cut-off of  $\geq 6$  was established for NF; and patients were then classified into 3 risk groups based on their point score:
  - **Low risk (<6) = <50% risk for NF.**
  - **Intermediate risk (6-7) = 50-75% NF.**
  - **High risk ( $\geq 8$ ) =  $\geq 75\%$  risk NF**

**LRINEC Score**

Variables		Points
<b>CRP</b>	<150 mg/L	0
	$\geq 150$ mg/L	4
<b>WBC</b>	<15 x 10 <sup>9</sup> /L	0
	15-25 x 10 <sup>9</sup> /L	1
	>25 x 10 <sup>9</sup> /L	2
<b>Hgb</b>	>135 g/L	0
	110-135 g/L	1
	<110 g/L	2
<b>Sodium</b>	$\geq 135$ mmol/L	0
	<135 mmol/L	2
<b>Creatinine</b>	$\leq 141$ umol/L	0
	>141 umol/L	2
<b>Glucose</b>	$\leq 10$ mmol/L	0
	>10 mmol/L	1

Accessed at <https://l1nq.com/MECvF> 04/11/2025

parameters such as CRP, sodium, creatinine, leukogram, and blood glucose; although useful, this score does not replace clinical judgment. (Seong et al. (2023)

Imaging tests, in turn, play a complementary role, especially in early cases where the clinical picture is not so evident. A simple X-ray of the pelvis or perineal region can show the presence of gas in the soft tissues, a highly suggestive but not very sensitive finding. Ultrasound can reveal fluid collections, thickening of the fascia, and subcutaneous gas, and is also useful in unstable patients who cannot undergo more time-consuming imaging exams. However, the method of choice is computed tomography (CT), which allows accurate assessment of the extent of infection, presence of gas, collections, and involvement of adjacent structures such as the testicles, bladder, or rectum. Magnetic resonance imaging provides excellent detail of soft tissues, but is rarely used in practice due to the time required and the clinical instability of patients. (Seong et al. (2023)

In some cases, especially when the diagnosis is uncertain, it may be necessary to proceed with immediate surgical exploration, which becomes both a diagnostic and therapeutic act. During the procedure, there is no bleeding in the fascial planes, extensive necrosis, friable fascia, and a putrid odor. These findings confirm the diagnosis of necrotizing fasciitis, regardless of laboratory or imaging results. (Seong et al. (2023)

## Treatment

According to (Louro et al., 2019), Fournier's gangrene (FG) is a medical emergency that requires immediate and aggressive intervention to control the necrotizing

infection, reduce mortality, and minimize functional and aesthetic sequelae. Treatment is based on four main pillars

1. Clinical stabilization,
2. Empirical antibiotic therapy,
3. Early surgical debridement, and
4. Tissue reconstruction

### Clinical Stabilization and Advanced Support

Before surgical intervention, it is essential to stabilize the patient, especially if there is sepsis or septic shock: Aggressive volume replacement: Crystalloids (0.9% saline or Ringer's lactate) to correct hypotension and perfusion deficit.

- Vasopressor support: Norepinephrine in cases of refractory shock.
- Hemodynamic monitoring: Central venous access, bladder catheterization (for urinary output), and, if necessary, ventilatory support.
- Correction of comorbidities: Strict glycemic control in diabetics, adjustment of immunosuppressants, and correction of electrolyte disturbances.

## Empirical Antibiotic Therapy

GF is typically polymicrobial, involving aerobic bacteria, anaerobic bacteria, and, in some cases, fungi. The initial regimen should cover: Gram-negative (*Escherichia coli*, *Klebsiella*, *Proteus*), Gram-positive (*Staphylococcus aureus*, *Streptococcus pyogenes*, *Enterococcus*), and anaerobic (*Bacteroides fragilis*, *Clostridium*) organisms. (El-Qushayri et al., 2020)

Triple combination: Piperacillin-tazobactam (4.5 g IV every 6 hours) or carbapenems (meropenem 1 g IV every 8 hours). Clindamycin (600 mg IV every 8 hours) – inhibits bacterial toxins and covers anaerobes. Aminoglycoside (gentamicin 5 mg/kg/day) or ciprofloxacin (400 mg IV every 12 hours) for Gram-negative bacteria. Also, in case of penicillin allergy: Third-generation cephalosporin (ceftriaxone) + metronidazole + vancomycin (if MRSA is suspected). (Stevens et al., 2014)

Adjust after culture:

- If fungi (*Candida*) are present, add fluconazole or amphotericin B.
- For multidrug-resistant bacteria, adjust according to antibiogram (e.g., linezolid for VRE, polymyxin for resistant *Pseudomonas*).

## Early and Radical Surgical Debridement

Urgent debridement is the most critical step in treatment. It should be performed within the first 6-12 hours after diagnosis.

Extent of surgery:

- Removal of all necrotic skin, subcutaneous tissue, and compromised fascia to viable margins (active bleeding).
- Exploration of the perineal, scrotal, and abdominal regions (if there is extension).
- Associated procedures:
  - Colostomy/ileostomy: Indicated if there is severe fecal contamination or anal/sphincter injury.

- Suprapubic cystostomy: If there is urethral involvement or a need for urinary diversion.

- Orchiectomy: Rarely necessary (the testicle is spared due to its independent vascularization).

- Reapproaches:

- Multiple surgeries (average of 2-4 debridements) may be necessary until complete removal of necrotic tissue.

## Adjuvant Therapies

Negative pressure wound therapy (NPWT) accelerates granulation and reduces bacterial contamination. It can also be used between debridements and before reconstruction. (Seong et al. (2023))

In addition, Hyperbaric Oxygen Therapy (HBOT) improves tissue oxygenation and bactericidal activity. However, the evidence is controversial, but it may be useful in selected cases. (Seong et al. (2023))

## Surgical Reconstruction

After infection control (usually 5-10 days after the last debridement), reconstruction is performed: Total or partial skin; skin graft (more common for superficial defects); local flaps (pudendal, medial femoral, ALT flap) to cover testicular exposure or deep defects; scrotal reconstruction—if the testicles are exposed, they can be sutured to the residual skin or covered with fasciocutaneous flaps. (Seong et al. (2023))

Poor prognostic factors: FGSI > 9, sepsis, advanced age, comorbidities (diabetes, CRF), delayed treatment.

## Prognosis

The prognosis of Fournier's syndrome is strongly influenced by a complex interaction of clinical, temporal, and socioeconomic factors. Although advances in management have reduced mortality rates in recent decades, this condition still carries a high risk of fatal outcomes, particularly in populations with limited access to health services. A study conducted in Nigeria (Salihu et al., 2024), which analyzed 47 cases over 13 years, revealed a mortality rate of 36%, highlighting regional disparities in addressing this medical emergency.

One of the most critical elements for prognosis is the interval between the onset of symptoms and medical intervention. Data from the Nigerian study show that patients who died had an average symptom progression time of two weeks before hospitalization, while survivors sought care an average of five days after the onset of symptoms. This delay allows not only the progression of tissue necrosis but also the establishment of severe sepsis, which was present in 62.5% of fatal cases in the series analyzed. Sepsis, in turn, triggers a cascade of organ dysfunctions that amplify the risk of death, especially when associated with pre-existing comorbidities. (Seong et al. (2023)

Among the clinical conditions that negatively impact prognosis, diabetes mellitus emerges as a predominant factor. Present in 55% of patients in the African study and in virtually all fatal cases (except one newborn), diabetes contributes to worse outcomes through multiple mechanisms. Diabetic microangiopathy compromises local tissue perfusion, hindering the response to infection and healing. Simultaneously, the relative immunosuppression characteristic of

diabetes favors uncontrolled bacterial proliferation (Salihu et al., 2024). Other conditions that worsen the prognosis include chronic kidney disease (especially patients on hemodialysis, who have marked immune dysfunction), advanced liver disease, and malignant neoplasms.

Objective assessment of severity using the Fournier's Gangrene Severity Index (FGSI) provides valuable parameters for predicting outcomes. This score, which incorporates clinical variables (such as temperature and heart rate) and laboratory variables (including sodium, creatinine, and complete blood count), shows that values above 9 are associated with a 75% mortality rate. In the context of the Nigerian study, the combination of hyponatremia, metabolic acidosis, and marked leukocytosis was a frequent finding in fatal cases, reflecting the intensity of the systemic inflammatory response.

In addition to clinical aspects, the anatomical extent of necrosis directly influences prognosis. While cases limited to the scrotal or perineal region respond better to treatment, spread to the abdominal wall or retroperitoneum is associated with higher mortality. The literature highlights that patients with extensive necrosis often required multiple surgical debridements (an average of 3.3 procedures), and those with deep structure involvement were indicated for diversion ostomies—although no patients in the series underwent colostomy, six required suprapubic cystostomy for urinary diversion (Stevens et al., 2014).

Despite therapeutic advances, sequelae in survivors represent a significant challenge. Genital deformities, perineal fibrosis, and urethral strictures can lead to permanent sexual dysfunction and impaired quali-

ty of life. In the study by Salihu et al., 2024, although functional sequelae were not detailed, the world literature reports that up to 30% of survivors require complex reconstructive procedures, such as fasciocutaneous flaps or skin grafts.

The scenario in low- and middle-income countries, such as Nigeria, Brazil, and India, introduces additional layers of complexity to the prognosis. Factors such as initial dependence on traditional medicine, transportation difficulties to specialized centers, and limitations in the availability of intensive care beds contributed to the higher mortality rates observed in the study (36%) compared to series from developed countries (15-20%). This disparity emphasizes the need for strategies that combine community education for early recognition of symptoms with strengthening hospital infrastructure.

In summary, the prognosis for Fournier's syndrome remains serious but can be modified through timely interventions. The combination of early diagnosis (based on clinical suspicion of progressive perineal pain and systemic signs), radical surgical debridement within the first 24 hours, and broad-spectrum antibiotic therapy constitutes the essential triad for improving outcomes. At the same time, aggressive management of comorbidities, particularly strict glycemic control in diabetics, and access to intensive care units are indispensable components for reducing mortality. In resource-limited settings, investments in multidisciplinary team training and emergency referral protocols can mean the difference between survival and preventable death in this devastating condition.

## JUSTIFICATION

From an epidemiological point of view, FG has been relevant over the last few decades. In this logic, preventive actions, especially those directed at populations and epidemiological data, can bring benefits and improve the treatment of this pathology.

This study was conducted with all patients diagnosed with Fournier's gangrene who underwent surgical treatment during a predetermined period (March 2020 to September 2025). Consequently, it will be possible to better assess the need to improve primary care for patients with common symptoms of this pathology and also increase attention to risk factors, aiming to change the population's lifestyle habits and make early diagnoses of the disease.

In addition, the study aims to analyze the clinical profile of patients who would have benefited from surgical approaches, as well as hyperbaric chamber treatments, saving public resources and avoiding prolonged hospitalizations.

## OBJECTIVES

### General Objective

To conduct a survey of the clinical and epidemiological characteristics of patients diagnosed with Fournier's gangrene who underwent surgery at the Regional Hospital of Taguatinga, Brasília-DF, and to quantify how much the health system would save by partnering with clinics that offer hyperbaric chamber treatment.

## Specific Objectives

To describe the epidemiological profile of patients diagnosed with Fournier's gangrene who underwent surgical debridement: age, sex, risk factors, extent of the lesion, size of the surgical debridement margins, bacterial culture, resistance, need for new surgical approaches, type of surgical treatment performed, intraoperative complications, outpatient follow-up, and survival.

Identify the main signs and symptoms present in patients with Fournier's gangrene before undergoing the proposed surgical treatment: sepsis, crepitus, and soft tissue necrosis.

Analyze the clinical profile of patients who could have benefited from limited treatments, such as vacuum dressings or hyperbaric chambers, aiming at early discharge, as well as plastic surgery approaches.

## METHODOLOGY

This is an observational, retrospective, descriptive study with a cross-sectional design.

Initially, data was collected from the "Surgery Book" maintained by residents in General Surgery of the Medical Residency Program at the Regional Hospital of Taguatinga (HRT), Federal District, which contains the following data: name, date of birth, registration number with the Federal District Health Secretariat, diagnosis and surgical procedure performed, as well as the date on which the surgery was performed. Next, a group of patients of both sexes who underwent surgical debridement of the perineal region between March 2020 and September 2025, as recorded in the "Surgery Book," was selected, comprising 37 patients.

Finally, a standard questionnaire was constructed based on the electronic medical records available at the Taguatinga Regional Hospital, accessed through the Trackcare system, seeking data on medical history, with an emphasis on comorbidities, risk factors, clinical condition at diagnosis, and physical examinations performed, complementary tests, results of cultures and antibiotic therapies used, and patient evolution in the postoperative period.

## Inclusion and exclusion criteria

### INCLUSION CRITERIA

Patients of both sexes who underwent surgical debridement for GF at the Taguatinga Regional Hospital between March 2020 and September 2025 were selected and recorded in the "Surgery Book" maintained by residents in General Surgery of the HRT Medical Residency Program.

### EXCLUSION CRITERIA:

Patients who underwent surgical debridement of other parts of the body that did not characterize necrotizing fasciitis of the perineal region, approached by general surgery, were excluded from the study. In addition, patients who had outcomes in other units will be excluded from the study.

## ECONOMIC ANALYSIS METHODOLOGY

First, this is not a formal cost-effectiveness study. The economic analysis developed in this study is descriptive and estimative in nature, conducted from the perspective

of the public health system, specifically the Unified Health System in the Federal District. Considering the retrospective nature of the study and the unavailability of individualized accounting data per patient, we opted to use indirect cost estimates, which are widely accepted in the literature on economic evaluations in health.

To estimate hospital costs, we used length of stay as the main cost reference, a strategy often employed in observational studies when there is no access to detailed hospital cost centers. This approach is based on the assumption that hospital stay, especially in intensive care units, is the main determinant of healthcare resource consumption in patients with Fournier's syndrome.

The reference values for hospital daily rates were obtained from official sources, including the Infosaúde Panel of the Federal District Health Secretariat, the SES-DF Hospital Care Cost Management Manual, as well as public reference tables from the Federal District Integrated Legal Standards System (SINJ-DF) and the SUS Hospital Information System (SIH/SUS). Based on these sources, the estimated average daily cost of a hospital bed in a ward was set at R\$ 300.00, and the estimated average daily cost of a bed in an intensive care unit (ICU) was set at R\$ 819.08. (See Appendix B)

To estimate the costs related to high-cost special dressings, including negative pressure wound therapy (NPWT) systems, data from technical reports by the National Commission for the Incorporation of Technologies in the SUS (CONITEC) were considered, as well as economic models published in the international literature. Recognizing the heterogeneity of costs associated with these devices, three distinct

economic scenarios were constructed: conservative, realistic, and high cost.

In the moderate scenario, a daily dressing cost of R\$ 77.10 was considered, according to the lowest cost estimates described in economic evaluations of health technologies. In the realistic scenario, an average operating cost of R\$ 300.00 per day was adopted, including supplies, nursing staff time, and hospital logistics, a value considered more compatible with everyday care practices in public hospitals. In the high-cost scenario, commercial kits with a higher unit value were considered, estimating a cost of R\$ 900.00 per application, with two changes per day, totaling R\$ 1,800.00 per day.

Based on these values, the daily costs per patient in a ward bed and in an intensive care unit were estimated, with and without the incorporation of special dressings, allowing for comparison between different scenarios of postoperative management of Fournier's syndrome. The results were presented comparatively, using tables and graphs, with the aim of demonstrating the potential impact of adopting adjuvant therapies on daily healthcare costs.

It should be noted that this analysis is not a formal cost-effectiveness study, nor is it a cost-minimization analysis, since there was no comparator group undergoing adjuvant therapies in the institutional context analyzed. The results should therefore be interpreted as exploratory estimates, useful for supporting discussion and the formulation of institutional proposals, but not as absolute values of actual cost.

Finally, the absence of direct cost data per patient is recognized as an inherent limitation of the method, and it is recommended that future studies adopt prospective

designs, with systematic collection of hospital accounting data and formal economic evaluation, in order to validate locally the economic impacts suggested in this study.

## Data analysis

The information collected was compiled in a Microsoft Excel 2022 Office spreadsheet, and an initial analysis was performed to identify typing and classification errors, making corrections when necessary.

The statistical analysis included inferential analysis procedures based on frequency distribution and percentages. To assess associations between variables, the Chi-square test was applied, considering a value of  $p \leq 0.05$  as statistically significant, with a 95% confidence level. In cases where associations involved non-dichotomous categorical variables and had low frequency in some categories, Fisher's exact test was used as a more robust alternative.

In the comparative analysis of size, represented by radius, Student's t-test was applied for variables with parametric distribution and the Mann-Whitney test for those that did not meet the assumptions of normality.

All analyses were conducted using Statistical Package for the Social Sciences (SPSS) software, version 26.0. It is worth noting that, considering the small sample size, the statistical analyses were exploratory in nature.

## RESULTS

Thirty-seven patients diagnosed with GF who underwent surgical debridement were analyzed. The mean age of the patients was  $54 \pm 13$ , ranging from 27 to 81 years.

There was a predominance of males, with 27 male patients and 10 female patients.

Regarding the risk factors most associated with Fournier's gangrene in the present study, 16 patients (44.44%) were diagnosed with type 2 diabetes mellitus (DM2), 12 of whom were insulin-dependent, with a mean glycosylated hemoglobin (Hb1AC) of 9.8%; 13 patients (36.11%) were diagnosed with systemic arterial hypertension and used at least three antihypertensive drugs; 10 patients (27.78%) were obese, with a BMI  $>33$ ; four patients (11.11%) had a history of paraplegia; three (8.3%) had a psychiatric diagnosis; 1 patient (2.7%) had a diagnosis of retrovirus, 1 patient (2.7%) was a chronic user of corticosteroids, 4 patients (11.11%) used an indwelling urinary catheter, and 4 patients (11.11%), approached at the time of the pandemic, were diagnosed with SARS-CoV-2. Sixty-nine percent of patients had comorbidities, the most prevalent being diabetes mellitus (44.4%), hypertension (36.1%), and obesity (27.78%). The average time between symptom onset and seeking care, based on data collected in the medical history, was 6 days, with the HRT surgically treating the patient within the first 24 hours of admission.

The most commonly described clinical picture concerns nodules in the perianal region, with hyperemia and inflammatory signs, characterizing perianal abscesses. In the study, it was also possible to identify other predisposing causes, which were, in descending order: sacral ulcers (8.3%), Mechanical trauma (2.7%), Furuncle (2.7%), Infected hematocele (2.7%), Post-indwelling urinary catheter injury (2.7%), and Testicular abscess (2.7%).

Regarding the surgical technique, all 37 patients (100%) underwent aggressive

surgical debridement, and of these, 10 patients (27.7%) underwent further debridement during the same hospitalization, on average 72 hours after the first procedure. Furthermore, 7 patients underwent diversion surgery, including 6 colostomies and 1 ileostomy. Regarding protective colostomies, 5 were loop colostomies and 1 was a terminal colostomy. Also, in the sample studied, 2 patients underwent cystostomy and 1 patient underwent hydrocele correction at the time. However, according to medical records, no patients underwent adjuvant therapies such as negative pressure wound therapy (NPWT) or hyperbaric oxygen therapy (HBOT) due to lack of access in the single health system/SES-DF, as well as the high costs of treatment.

In addition, it was found that 8 patients (22.2%) underwent plastic surgery to correct areas with tissue loss, 3 during the same hospitalization, and 5 patients with an average of 32 weeks after the first surgery.

The analysis of complications shows that 12 patients (32.4%) required admission to an intensive care unit; 8 patients (21.6%) died after prolonged admission to the ICU, and other cases presented some type of complication, the most prevalent being septic shock requiring the use of vasoactive amines (26.7%); acute respiratory failure (13.8%) - including patients treated during the SARS-COVID-19 pandemic with a diagnosis during hospitalization for COVID-19, empyema requiring thoracostomy with water seal (2.7%), tracheostomy due to prolonged mechanical ventilation (22.2%), evisceration (5.5%), ostomy collapse (5.5%); appearance of anal fistulas or new perianal abscesses requiring drainage in the operating room in the first 5 years (11.1%).

Patients who underwent follow-up with general surgery in the postoperative period accounted for 88.8% of the total, with urology, plastic surgery, and proctology sharing the remaining 11.11%.

## DISCUSSION

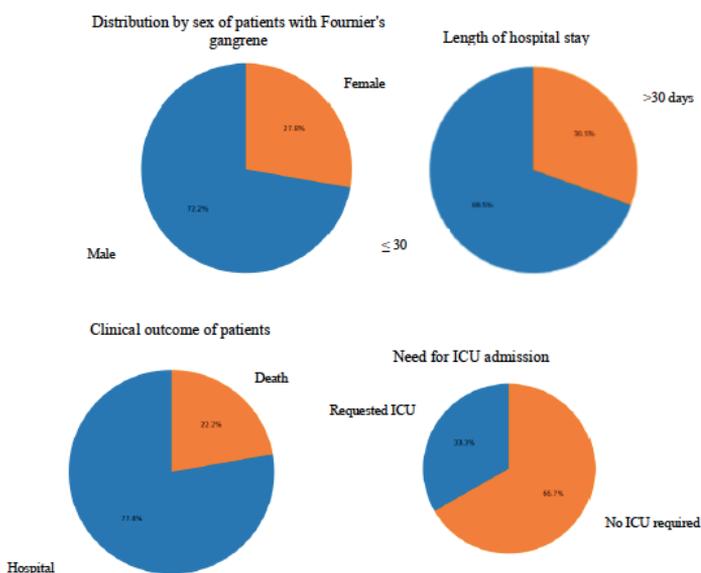
The results of this study show that the clinical and epidemiological profile of patients with Fournier's syndrome treated at the hospital analyzed is similar to that described in the national and international literature, with a predominance of males, middle to advanced age, and a high prevalence of comorbidities, especially diabetes mellitus and systemic arterial hypertension. These findings reinforce the role of chronic diseases as predisposing and aggravating factors for prognosis.

The observed mortality rate is within the range described in centers in developing countries, reflecting both the intrinsic severity of the disease and possible structural and care limitations of the public health system. The significant percentage of patients who required admission to an intensive care unit, as well as the prolonged hospitalization time, highlight the impact of Fournier's syndrome on healthcare, with direct repercussions on bed occupancy and hospital costs.

In the present study, no patient had access to advanced adjuvant therapies, such as negative pressure therapy or hyperbaric oxygen therapy, a fact that reflects the unavailability of these technologies in the context analyzed. This limitation prevents a direct comparison between groups treated with and without such therapies, but allows for a critical analysis based on external evidence.

Demographic/Clinical Data	Percentage (approximate)
Male	72.2
Female	27.7
Length of stay > 30 days	30.5
Admission to intensive care unit	33.3
Need for further debridement	27.7
Traffic diversion	19.4
Cystostomy	5
Death	21.6
Approach by plastic surgery	22.2
Septic shock	26.7

Table 1 - Demographic and clinical data



Comorbidities	Percentage (approximate)
Diabetes Mellitus	44.4
Systemic arterial hypertension	36.1
Obesity	27.78
Paraplegia	11.11
Retrovirus	2.7
Chronic alcoholism	2.7
Leprosy	2.7
COVID-19	11.11

Smoking	11.11
Myelomeningocele	2.7
Liver cirrhosis	2.7
Neoplasia	8.3
Osteomyelitis	8.3

Table 2 – Associated comorbidities, with the same patient having more than one.

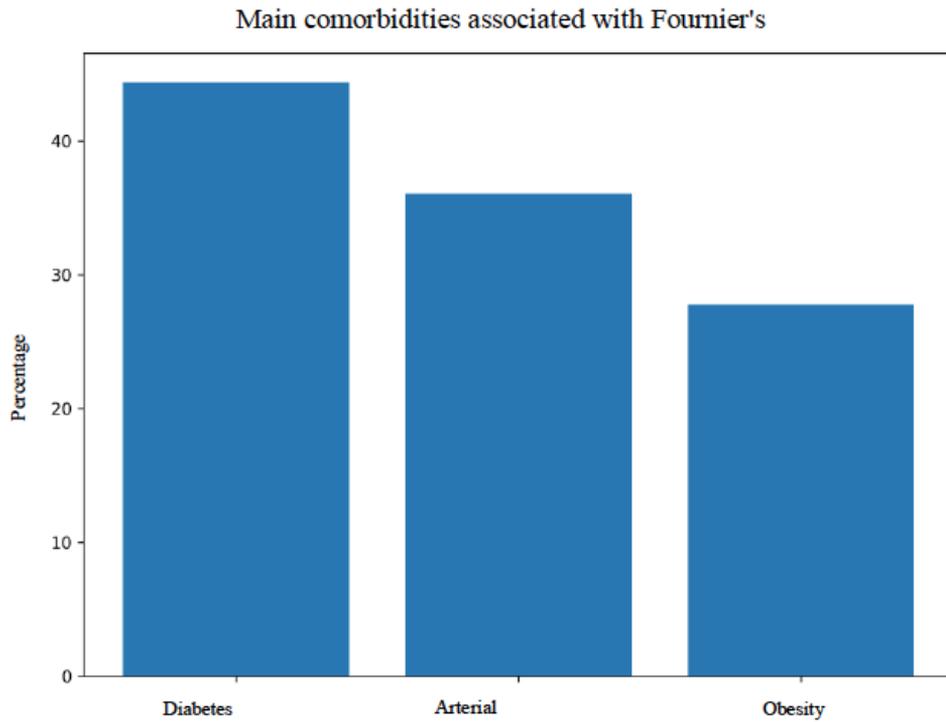
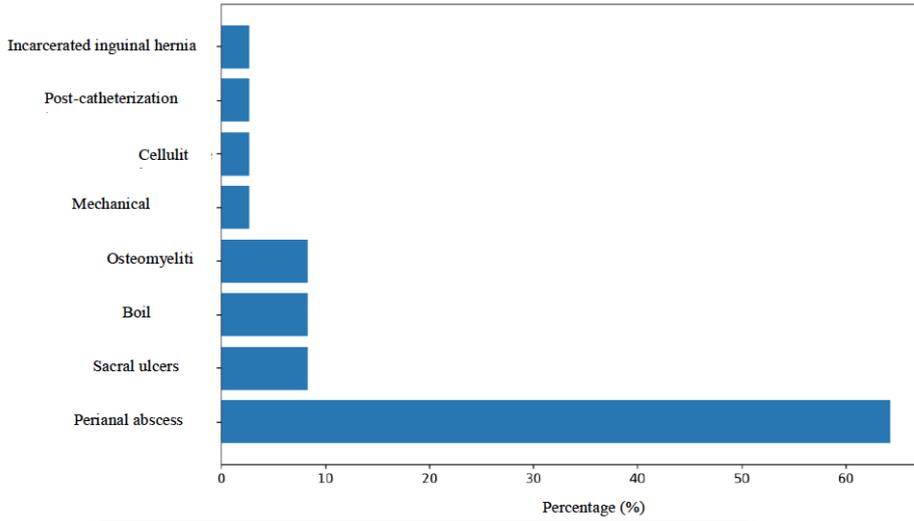


Figure 1 – Associated comorbidities.

<b>Initial Cause</b>	<b>Percentage (approximate)</b>
Perianal abscess	64.3%
Sacral ulcers	8.3
Furunculosis	8.3
Osteomyelitis	8.3
Mechanical trauma (depilation/nail)	2.7
Cellulitis	2.7
Post-bladder catheterization trauma	2.7
Incarcerated inguinal hernia	2.7

Table 3 – Propensity factors

Initial cause of Fournier's gangrene

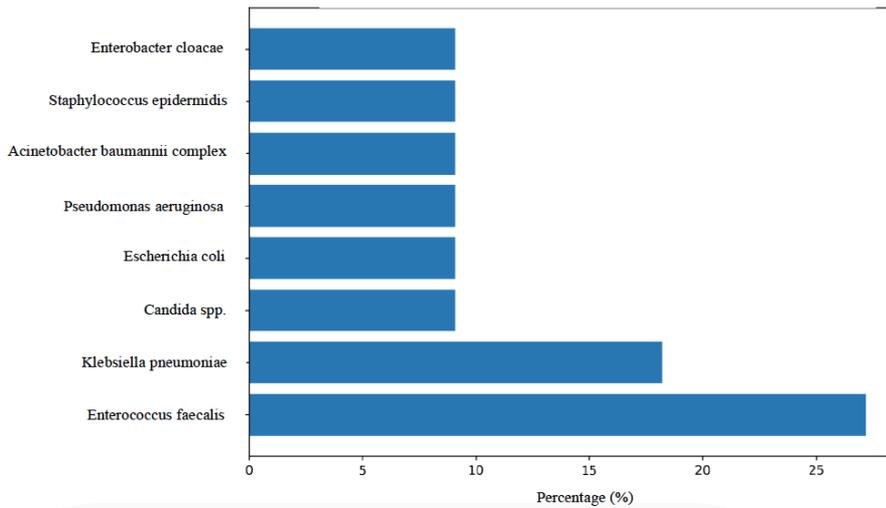


2 Figure - Table 3

Isolated bacteria	Number of occurrences	Percentage (approximate)
<i>Candida</i> spp.	1	9.1
<i>Enterococcus faecalis</i>	3	27.2
<i>Klebsiella pneumoniae</i>	2	18.2
<i>Escherichia coli</i>	1	9.1
<i>Pseudomonas aeruginosa</i>	1	9.1
<i>Acinetobacter baumannii</i> complex	1	9.1
<i>Staphylococcus epidermidis</i>	1	9.1
<i>Enterobacter cloacae</i>	1	9.1

Table 4 – Culture results from patient samples

Bacteria isolated in cultures – Fournier's gangrene



3 Figure - Table

Observational studies and systematic reviews indicate that the use of NPWT after surgical debridement can accelerate the healing process, reduce the number of dressing changes, decrease the need for reoperations, and contribute to a reduction in hospital stay. Similarly, hyperbaric oxygen therapy has been associated with reduced mortality and improved clinical outcomes in selected patients with Fournier’s syndrome, especially when used as early adjuvant therapy.

From an economic perspective, analytical models published in the literature suggest that the reduction in hospitalization time and complications may offset the initial costs associated with implementing these therapies. However, it is essential to highlight that, in the present study, the economic impact was estimated indirectly, using hospitalization time as a cost proxy, with no direct analysis of institutional costs.

The estimated daily cost of a postoperative patient within the Federal District’s Unified Health System can be constructed from official sources and technical literature. Considering reference values from the

Infosaúde Panel and the SES-DF Cost Management Manual, an average daily ward rate of R\$ 300.00 and an average daily ICU rate of R\$ 819.08 were adopted for this study (SES-DF, 2023; SINJ-DF, 2025). For costs related to high-cost dressings, such as the use of negative pressure wound therapy (NPWT) systems, three scenarios were considered: conservative (cost of dressing per day = R\$ 77.10, lowest technical estimate), realistic (average operating cost = R\$ 300.00/day, including supplies and nursing time), and high cost (higher-value commercial kits, estimated at R\$ 900.00 per application; when two changes/day are performed, R\$ 1,800.00/day) (CONITEC; Kim et al., 2022; Brennefle & Bongards, 2023).

In the conservative scenario, the cost per patient per day in a ward with NPWT was estimated at R\$ 377.10 (R\$ 300.00 per day in the ward + R\$ 77.10 for dressing/day), while in the ICU, the estimated cost was R\$ 896.18 (R\$ 819.08 for the daily ICU rate + R\$ 77.10). In the realistic scenario, which incorporates an operational estimate closer to hospital practice, the cost per

patient per day in a ward with NPWT was estimated at R\$ 600.00 and in the ICU at R\$ 1,119.08. In the high-cost scenario, considering two expensive dressing procedures per day, the estimated costs per patient per day were R\$ 2,237.00 in the ward and R\$ 3,088.25 in the ICU (scenario panel; Kim et al., 2022; Brennefle & Bongards, 2023; SES-DF, 2023).

These estimates allow us to assess the potential economic impact of adopting NPWT and adjuvant therapies: although the incorporation of special dressings increases the daily cost per patient (especially in the high-cost scenario), the literature and economic models indicate that the reduction in length of stay and the decreased need for reinterventions and ICU admission can produce net savings for the system when compared to conventional care (Kim et al., 2022; Brennefle & Bongards, 2023; SES-DF, 2023).

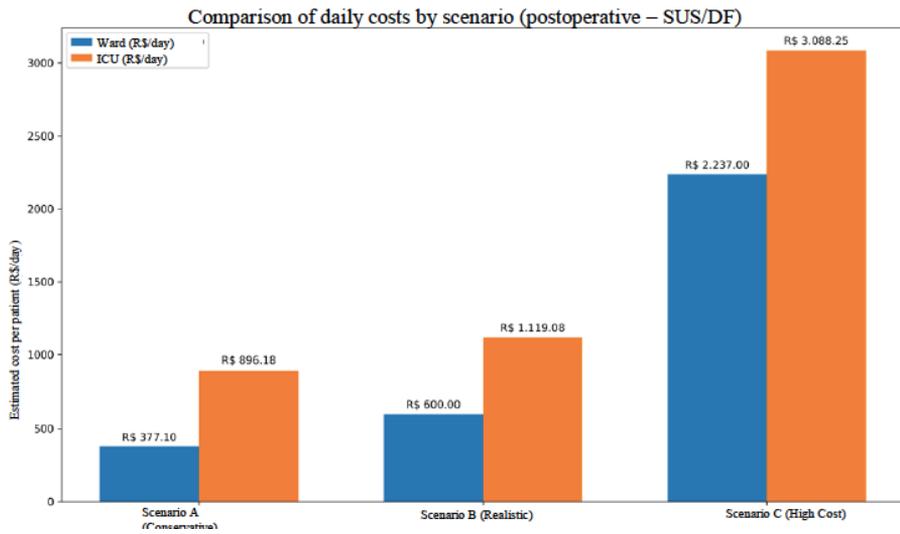
In practice, for the Federal District, it is recommended that the local analysis consider the realistic scenario as the primary reference (R\$ 600/day in a ward with NPWT), using the conservative scenario as a floor and the high scenario as a ceiling, and that management decisions (partnerships, kit purchases, training) be guided by local cost-effectiveness assessments that consider the probability of reducing hospitalization days and avoiding ICU admission. (SES-DF, 2023; CONITEC; Kim et al., 2022).

Currently, in the Federal District, only the Armed Forces Hospital (HFA) offers this therapy through the public health system, but it is restricted to military personnel. In the private sector, the service is offered by the Santa Helena Hospital and the Hyperbaric Medicine Center of Brasília, with sessions costing up to R\$400.00

(average price). It is worth noting that some treatments require 20 sessions, depending on the extent of the wound. According to a retrospective study by the Cleveland Clinic in 2018, the average length of stay for patients undergoing HBOT was 36% shorter than for patients receiving conventional treatment. Furthermore, survival in the HBOT group was 92% compared to 78% in patients undergoing standard treatment. A systematic review by the World Journal of Emergency Surgery in 2021 concluded that HBOT reduces the extent of debridement, accelerates wound granulation, and decreases systemic complications. In addition, HBOT is recommended by the Undersea and Hyperbaric Medical Society (UHMS) with a protocol of 10-20 sessions (2 to 2.8 ATM, 90 min session) with early initiation (after initial debridement).

The literature suggests that, in selected patients with Fournier's syndrome, the protocolized use of NPWT and HBOT as adjuvant therapies after surgical debridement may not only accelerate clinical recovery and improve outcomes but also contribute to the rationalization of hospital resources. These findings support the proposal to implement care protocols and institutional partnerships with hyperbaric oxygen therapy centers, especially in public health systems, aiming to improve the quality of care and optimize the costs related to the treatment of this serious condition. (Michalczyk et al., 2021; Creta et al., 2020; Sorensen et al., 2009; Yanar et al., 2006).

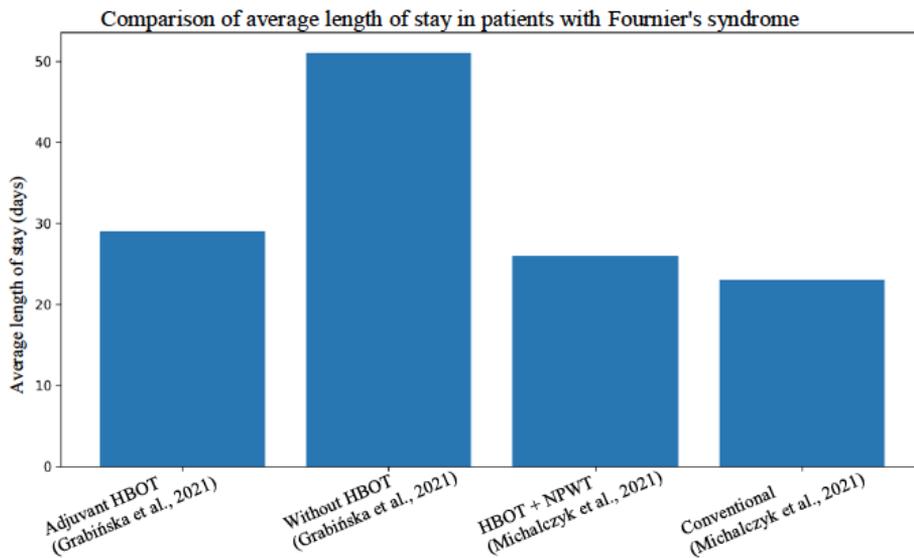
As shown in Table and Graph , patients with Fournier's syndrome undergoing hyperbaric oxygen therapy had a significant reduction in the average length of hospital stay when compared to conventional treatment, as evidenced in the study by Gra-

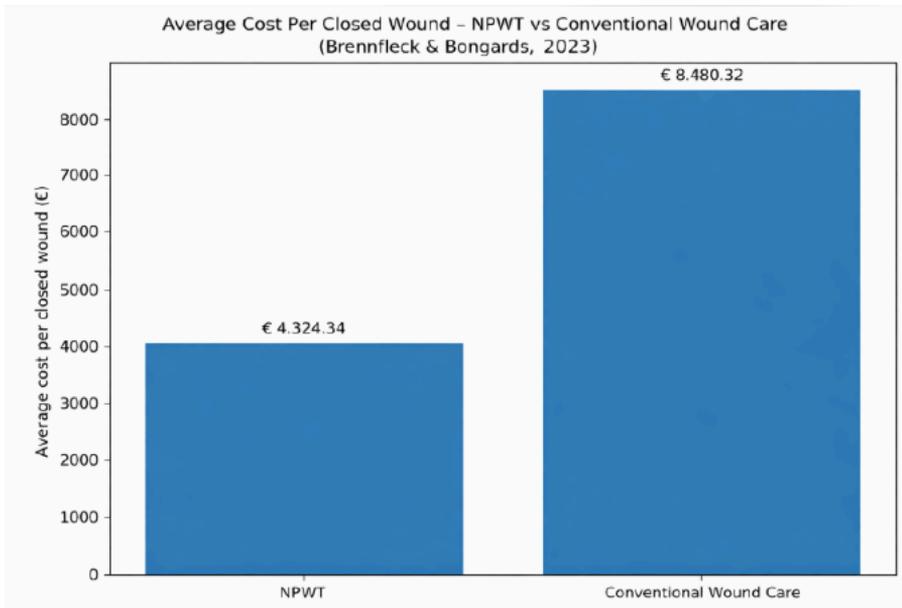
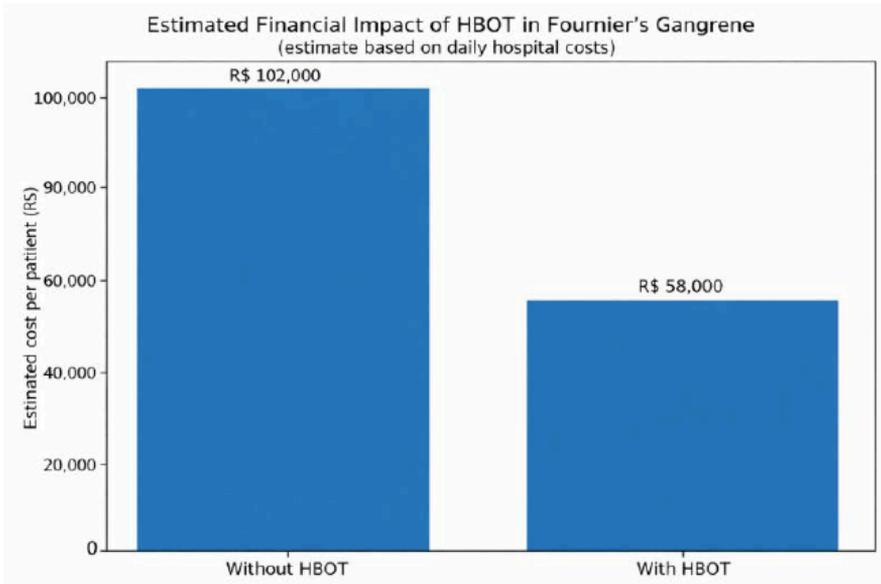


**Table – Comparison of average length of stay for Syndrome**

Study / Group	Therapy	Average length of stay
Grabińska et al., 2021	Adjuvant HBOT	29
Grabińska et al., 2021	No HBOT	51
Michalczyk et al., 2021	HBOT + NPWT	26
Michalczyk et al., 2021	Conventional	23

Figure 4 – Comparison of estimated daily cost per patient in the postoperative period, in ward and ICU beds, considering different scenarios for the use of special dressings (SUS/DF).





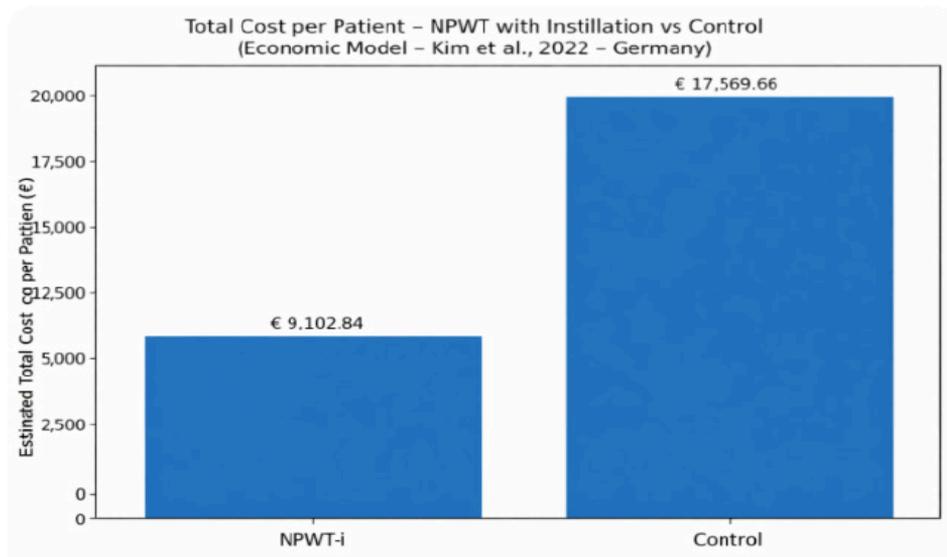


Figure 6 – Comparison of the cost and length of hospital stay between conventional therapies and negative pressure therapy, demonstrating the economic and clinical advantages of NPWT and NPWTi-d according to economic models published in the international literature.

bińska et al. (2021), in which the HBOT group had an average hospital stay of 29 days versus 51 days in the group without HBOT. These data reinforce the potential clinical and economic impact of adopting adjuvant therapies in the management of this condition.

Figure 5 shows an estimate of the financial impact associated with the use of hyperbaric oxygen therapy as an adjuvant therapy in the treatment of Fournier's syndrome. Considering an average daily cost of hospital admission of R\$ 2,000.00, it can be observed that the reduction in the average length of stay from 51 to 29 days, as described in the literature, can represent an approximate savings of R\$ 44,000.00 per patient. Although this is a theoretical estimate, these data reinforce the potential economic benefit of implementing care protocols that include hyperbaric oxygen therapy in selected patients, especially in the context of public health systems.

Surgery, in particular, is currently the mandatory treatment for all cases of Fournier's gangrene, and the first approach should be as aggressive as possible, with the aim of debriding any and all areas of necrosis present. That said, it is not necessary to have specific surgical materials available, and the lack of such materials can be listed as a determining factor for the preference for open abdominal approach techniques in HRT.

Currently, the main challenge for the surgeon is to compensate for the patient's associated comorbidities, as well as to quickly identify signs of SIRS, sepsis, or even septic shock in the preoperative and postoperative periods.

Also, the critical importance of early diagnosis and immediate surgical debridement as determining factors in reducing mortality and complications associated with the disease. For example, the studies by Cen et al. and Seong et al. reinforce that surgical

intervention within the first 24 to 72 hours after diagnosis is directly linked to better clinical outcomes. This corroborates the study, in which the average surgical approach was within the first 24 hours after patient admission.

Another point of agreement with the literature was the need for aggressive empirical antimicrobial therapy, which should be adjusted later based on the results of microbial cultures. The studies by Louro et al. and Seong et al. draw attention to the negative impact of antibiotic resistance, such as ES-BL-producing bacteria or MRSA, on patient prognosis, reinforcing the importance of targeted and individualized treatment.

In terms of mortality, the results vary significantly in the literature, ranging from 0% in some centers to 20-40% in others, with this literature being closer to the reality of the following study. This variation can be attributed to differences in the timeliness of treatment, the quality of multidisciplinary support, and the comorbidity profile of patients.

## Limitations

Therefore, the results should be interpreted with caution. Future prospective studies with a comparative design and analysis of direct costs in the context of the public health system are necessary for local validation of the clinical and economic benefits suggested by the literature.

Despite these limitations, the findings presented allow us to infer that the protocolled incorporation of NPWT and hyperbaric oxygen therapy in carefully selected patients has the potential to improve clinical outcomes and optimize the use of hospital resour-

ces. In this sense, the appendix presented in this paper translates the results of the study into a feasible healthcare policy proposal.

This study has limitations inherent to its retrospective design, small sample size, and lack of direct economic analysis based on institutional costs. Estimates of financial impact are based on data from the literature and should be interpreted with caution.

## CONCLUSION

This study characterized the clinical-epidemiological profile and outcomes of patients with Fournier's gangrene treated at a referral hospital in the Federal District, highlighting high morbidity and mortality and prolonged hospitalization. The findings reinforce the importance of early diagnosis, aggressive surgical debridement, and adequate management of associated comorbidities.

In light of the literature, adjuvant therapies such as negative pressure wound therapy (NPWT) and hyperbaric oxygen therapy (HBOT) show promise in accelerating clinical recovery, reducing hospitalization time, and rationalizing hospital costs in selected patients. Although such therapies were not used in the present case series, observational evidence and economic models suggest clinical benefit and potential favorable economic impact.

Conclusions related to economic impact are based on estimates from the international literature, using length of hospital stay as a proxy for hospital costs, with no direct analysis of institutional costs. Therefore, the results should be interpreted with caution.

In this context, we suggest the implementation of care protocols and the formalization of institutional partnerships with centers specializing in hyperbaric oxygen therapy as a strategy to improve the quality of care provided and optimize the use of resources in the public health system.

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Photo 1 - Facade of the hyperbaric medicine building at the Armed Forces Hospital (HFA)



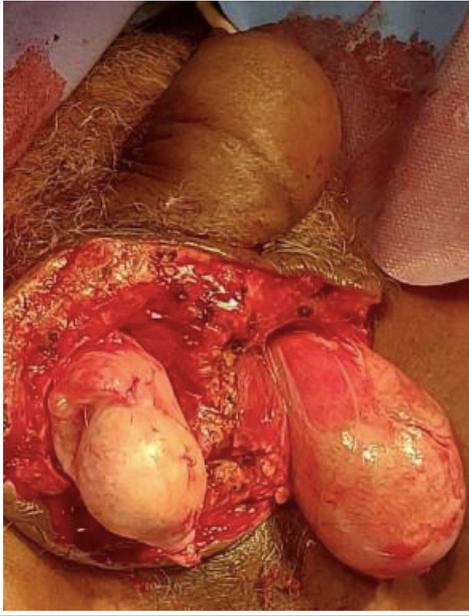
Photo 2 - Hyperbaric chamber at the Hyperbaric Medicine Center in Brasília



## APPENDIX







Photos (3-18) - Taken from the author's personal collection of patients treated at the service between 2023 and 2025.

## APPENDIX B - SOURCES USED FOR ESTIMATING HOSPITAL COSTS

Considering the retrospective nature of this study and the unavailability of individualized hospital cost data per patient, the economic analysis performed is descriptive and estimative in nature, and does not constitute a formal cost-effectiveness or cost-minimization study. Thus, we adopted the methodological strategy widely used in the health economics literature, in which the length of hospital stay is used as a cost estimate, especially in observational studies conducted within the Unified Health System (SUS). The estimated average daily hospital costs used in this study were obtained from official public sources and technical documents, as described below:

### 1. SUS Hospital Information System (SIH/SUS)

The SIH/SUS is the main public database for recording hospital admissions in the SUS and is widely used in epidemiological and economic studies. Although the Hospital Admission Authorization (AIH) values do not represent the actual cost per patient, they provide reference parameters for comparative analyses of hospital resource utilization.

Access: [<https://datasus.saude.gov.br/informacoes-de-saude> accessed on 09/10/2025]

### 2. InfoSaúde Panel – Federal District State Health Secretariat (SES-DF)

The InfoSaúde Panel provides consolidated information on healthcare produc-

tion, bed occupancy, and cost indicators within the Federal District's public health system, serving as an institutional source for health management and planning analyses.

Access:<https://www.saude.df.gov.br/infosus> - accessed on 09/10/2025

### 3. Hospital Care Cost Management Manual – SES-DF

Technical document that provides guidance on calculating and estimating hospital costs in the Federal District's public health system, including average parameters for infirmary beds and intensive care units, used for planning, evaluation, and management purposes.

Access:<https://www.saude.df.gov.br/gestao-de-custos>

### 4. Integrated System of Legal Standards of the Federal District (SINJ-DF)

Used as a complementary source for consulting regulations, contracts, and reference values related to the organization and financing of hospital care in the Federal District.

Access: <https://www.sinj.df.gov.br> - accessed on 09/10/2025

### 5. National and international scientific literature

In addition, studies published in indexed journals using similar methodologies to estimate hospital costs for patients with severe infections and complex wounds were consulted, reinforcing the validity of using length of stay as a cost estimate in contexts where individualized accounting data are not available. It should be noted that the

average values of R\$ 300.00 per day in a ward bed and R\$ 819.08 per day in an intensive care unit were adopted exclusively for comparative and exploratory purposes and should not be interpreted as actual costs per patient. The results presented are intended to support the discussion on the potential impact of incorporating adjuvant therapies in the management of Fournier's gangrene, recognizing the limitations inherent in the method used.

## APPENDIX 1

### OFFICIAL LETTER No. \_\_\_\_/2025 – PROPOSAL FOR THE IMPLEMENTATION OF A CARE PROTOCOL FOR THE TREATMENT OF FOURNIER'S SYNDROME IN THE FEDERAL DISTRICT

Dear Secretary, Dr. Juracy Cavalcante Lacerda Júnior

We cordially greet you and hereby present a technical proposal for the implementation of a standardized care protocol for the treatment of Fournier's syndrome within the public health network of the Federal District.

This proposal is based on a retrospective clinical study conducted at a referral hospital in the Federal District, which showed high morbidity and mortality rates, frequent need for admission to intensive care units, and prolonged hospitalization in patients affected by this serious condition. These findings reflect a significant impact on care, with direct repercussions on bed occupancy, hospital costs, and patients' quality of life.

Additionally, national and international scientific literature demonstrates that the

protocolized use of adjuvant therapies, such as hyperbaric oxygen therapy (HBOT) and negative pressure wound therapy (NPWT), after surgical debridement, can contribute to reducing mortality, accelerating healing, decreasing the number of surgical reinterventions, and reducing the length of hospital and intensive care unit stays. Consequently, there is potential for rationalization of overall healthcare costs.

Given this context, we propose:

### Hyperbaric Oxygen Therapy (HBOT)

- a) Establishment of institutional partnerships with duly accredited private clinics that have hyperbaric chambers, ensuring regulated and judicious access to selected patients with Fournier's syndrome;
- b) Technical and economic evaluation of the possibility of resuming hyperbaric oxygen therapy services at the Asa Norte Regional Hospital, considering its strategic location and potential as a referral unit;
- c) Definition of objective clinical criteria for HBOT indication, according to care protocols based on scientific evidence.

### Negative Pressure Wound Therapy (NPWT)

- a) Centralized acquisition of NPWT systems, with subsequent distribution to referral hospitals;
- b) Incorporation of NPWT as a protocolized adjuvant therapy after surgical debridement, especially in extensive and complex wounds;
- c) Standardization of equipment, supplies, and care flows, ensuring rational use and traceability.

## Training of Care Teams

a) Implementation of theoretical and practical training programs for nursing teams, focusing on the installation, management, and monitoring of negative pressure dressings;

b) Development of standardized operating manuals and institutional protocols;

c) Encouragement of continuing education, with support from educational institutions and healthcare technology providers.

The adoption of the proposed measures has the potential to improve clinical outcomes, reduce the average length of hospital stays, optimize the occupancy of critical beds, and rationalize public resources, in line with the principles of efficiency, comprehensiveness, and quality of care in the Unified Health System.

Therefore, we suggest that this proposal be reviewed by the relevant technical departments of this Secretariat, with a view to assessing its feasibility and possible gradual implementation, in accordance with administrative and budgetary criteria.

We are available for any additional clarifications that may be necessary.

Sincerely,

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Document prepared as a technical appendix to the Final Course Project, for academic purposes and to support the formulation of public health policies.