

## A survey on the knowledge, opinions, and approaches in clinical practice of urology physicians about hyperbaric oxygen therapy application in Fournier gangrene

Üroloji hekimlerinin Fournier gangreninde hiperbarik oksijen tedavisi uygulamasına dair bilgi düzeyleri, görüşleri ve pratik uygulamadaki yaklaşımları

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Geliş tarihi (Submitted): 2022-02-01

Kabul tarihi (Accepted): 2022-09-12

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### Özet

**Amaç:** Fournier gangreni, yüksek mortaliteye sahip bir nekrotizan fasiit formudur. Hiperbarik oksijen tedavisi (HBOT) başarılı bir destek tedavi seçeneği olarak gösterilmektedir. Bu çalışmada, üroloji doktorlarının Fournier gangreninde HBOT uygulaması hakkındaki bilgi düzeyleri, görüşleri ve pratik uygulamadaki tercihlerini bir anket ile sorgulamayı amaçladık.

**Gereç ve Yöntemler:** Üroloji alanında uzman olan veya en az 1 yıldır uzmanlık eğitimine devam eden doktorlarımıza online veya yüz yüze olarak anket uygulanmıştır.

**Bulgular:** Anketi dolduran 90 üroloji hekiminin %69,7'si Ankara'da çalışan hekimlerdi. Hekimlerin %42,2'si yılda 1-5 Fournier gangreni vakasını tedaviye etmekteydi; ancak çoğunlukla (%56,4) hastaları HBOT için hiçbir zaman yönlendirmedikleri görüldü. Çoğunluk (%55,3) HBOT'ni ancak cerrahi debridman ve antibiyotik tedaviye yanıtız durumlarda tercih ettiğini belirtti. Hekimlerin HBOT hakkındaki bilgi düzeylerini kendilerinin değerlendirmeleri istendi; %27,3'ü hiçbir bilgisi olmadığını bildirdi. Daha önce bir HBOT merkezinde bulunmuş olan 12 hekim (%13,3), HBOT ile ilgili bir bilimsel çalışmada yer aldığını bildiren 15 hekim (%16,7) vardı. Fournier gangreni hastalarında HBOT'nin faydası olmadığını düşünen sadece 3 hekim (%3,4) vardı. Fournier gangreninde HBOT etkinliği hakkındaki gö-

### Abstract

**Objective:** Fournier gangrene is a form of necrotizing fasciitis with high mortality. Hyperbaric oxygen therapy (HBOT) is a successful and supportive treatment option for Fournier's gangrene (FG). This study aimed to analyze urologists' knowledge, opinions, and preferences about HBOT application in FG.

**Material and Methods:** An online or face-to-face questionnaire was applied to physicians who are experts in the field of Urology or who have been continuing Urology residency training for at least one year.

**Results:** Ninety urology physicians filled out the questionnaire. Most of them (56.4%) never refer FG cases to HBOT. Physicians (55.3%) mostly preferred HBOT only in patients unresponsive to surgical debridement and antibiotherapy. Besides, 27.3% of them stated they had no information when asked to self-assess their knowledge. Only 12 physicians (13.3%) had previously been in an HBOT center, and 15 (16.7%) physicians had participated in a scientific study on HBOT. Only three physicians (3.4%) stated HBOT was not beneficial to FG patients. Urologists' opinions about HBOT efficiency in FG were examined (3-point-Likert type questions) in 5 questions; the median score was 2 points (minimum-maximum: 1-3 points). On the other hand, physicians who did not know HBOT had more negative opinions about HBOT efficiency in FG (p = 0.002).

The study was approved by Health Sciences University Gulhane Research and Training Hospital Non-Invasive Investigation Ethics Committee (Approval No: 2021-424, Date: 2021/12/16). All research was performed in accordance with relevant guidelines/regulations, and informed consent was obtained from all participants.

rüşler 3'lü likert tipi şeklinde 5 soru halinde sorulmuştur; ortanca puan 2 (minimum-maksimum: 1-3) olarak hesaplanmıştır. HBOT hakkında hiçbir bilgisi olmayan hekimlerin, Fournier gangreninde HBOT uygulaması hakkındaki daha olumsuz görüşlere sahip olduğu görüldü ( $p=0,002$ ).

**Sonuç:** Üroloji hekimlerimizin Fournier gangreninde HBOT hakkındaki bilgilerinin az olması, pratik uygulamadaki çekinceleri ve farkındalıklarının az olması çalışmamızda net olarak görülmüştür. Hekimlerimizin HBOT deneyimlerini arttırmaları, bilimsel çalışmalar planlamaları ve üroloji dernekleri tarafından bu konunun tartışmaya açılması gerektiğini düşünüyoruz.

**Anahtar Kelimeler:** Fournier gangreni, hiperbarik oksijenasyon, anket, ürolog

**Conclusion:** Urology physicians' knowledge of HBOT, their doubts about HBOT in FG, and their relatively low experience with HBOT are clearly shown in this study. Therefore, urology physicians should be encouraged to increase their HBOT experience in FG and participate in scientific studies. Also, Urology Associations should discuss HBOT efficiency more effectively in guidelines and meetings.

**Keywords:** Fournier's gangrene, hyperbaric oxygenation, questionnaire, urologists

## INTRODUCTION

Fournier's Gangrene (FG) is necrotizing fasciitis that affects the deep and superficial layers of the perineum and genital area (1). The incidence of FG in men aged 50-79 in the United States (US) is 1.6/per 100,000. In most case series, the mortality rate of FG is reported to be between 20% and 40%, but it ranges from 4% to 88% (2). Due to the rapid progression and high mortality of FG, early diagnosis and intervention are vital. Medical resuscitation and urgent surgical debridement are required (1).

Hyperbaric oxygen therapy (HBOT) is a supportive treatment option that can be applied under emergency conditions after surgery and medical intervention in FG (1). The mortality rates in FG patients who underwent HBOT are reported to be between 0% and 26.9% (3-9). It has been stated that HBOT reduces systemic toxicity, prevents the progression of necrosis, and accelerates the development of the demarcation line (4). It is an emergency HBOT indication accepted by our country's Health Practice Communique (HPC) (10). However, it is not included among the common treatment recommendations in the 2021 Guidelines of the European Association of Urology (EAU) due to insufficient evidence about HBOT in FG treatment (11). Notably, only 35 FG cases were consulted for 25 years in a retrospective series conducted by an HBOT center (12). Based on our own experience, we think that very few FG patients are consulted for HBOT.

Applying all beneficial treatment options to this highly fatal disease is vital. In this study, we aimed to

question the level of knowledge, opinions, and practical preferences of Urology physicians in our country about applying HBOT in FG, a real urological emergency. Secondly, we aimed to raise awareness among Urology physicians about HBOT application in FG.

## MATERIAL AND METHODS

In this study, a face-to-face or online questionnaire was applied to Urology physicians who were members of the International Association of Laparoscopic Robotic Surgery (ILRSA) and the Turkish Urology Association Central Anatolia Branch between 17th December 2021 and 15th January 2022. The questionnaire consists of four sections: information about professional experience, clinical experience in FG, knowledge level about HBOT, and opinions about HBOT in FG. The first section has four open-ended questions, and the rest of the questionnaire consists of closed-ended questions. The survey questions are available in Table 1. In addition, Likert-type scoring is used to analyze clinicians' opinions and knowledge of the HBOT application in FG. For further statistical analyses, knowledge level is classified into two groups "no knowledge of HBOT" and "know about HBOT." The second group consists of "little knowledge," "intermediate level of knowledge," and "adequate knowledge for Urology physicians."

Among the criteria for inclusion in the study are; (i) having expertise in Urology or actively receiving a Urology residency training program, (ii) having completed at least one year of Urology residency training program (iii) actively continuing as a physician in the field of

Urology. Among the exclusion criteria from the study are; (i) physicians who are receiving a Urology residency training program and have not completed one year.

The study was approved by the Health Sciences University Non-Invasive Investigation Ethical Committee (Approval: 2021-424, Date: 2021/12/16). In addition, permission was obtained from the ILRSA and the Turkish Urology Association. An explanation was written at the beginning of the questionnaire. The completion of the questionnaire was accepted as consent.

Data analysis was performed using SPSS Statistics version 21 (IBM Corp., Armonk NY, USA). Data were expressed as n (%) or median (minimum-maximum). Those who did not answer the questions were excluded from the calculations and statistical analysis of the related questions. The Kolmogorov-Smirnov test exam-

ines the normal distribution of continuous data. The Chi-square test was used to compare the groups. The Likert-type question scoring was expressed by the median value (minimum-maximum). The Wilcoxon test was applied to compare the knowledge level score before and after the questionnaire. The Mann-Whitney U test was used for inter-group comparisons of the opinions on HBOT. A P-value <0.05 was considered statistically significant.

## RESULTS

A total of 90 urology physicians participated in our survey. All of them were male. Table 2 displays demographic and professional information about physicians. Most of the respondents (n = 62, 69.7%) were from Ankara, and eight more provinces participated in this study.

**Table 1.** The questions of the survey

<b>1-Demographic Data (professional experience)</b>
Sex
Birth year
Title
City
Institution type
How long have you been working in Urology? (years)
<b>2-Clinical Experience in Fournier's Gangrene</b>
Have you ever treated a Fournier's Gangrene case?
How many Fournier's Gangrene cases approximately do you diagnose in a year?
Which treatment modalities do you prefer to use in Fournier's Gangrene patient?
Who is responsible for the wound care of a Fournier's Gangrene case?
Do you refer Fournier's Gangrene cases to hyperbaric oxygen therapy?
When do you prefer to consult Fournier's Gangrene patient for hyperbaric oxygen therapy?
<b>3- The Knowledge about Hyperbaric Oxygen Therapy</b>
Do you have adequate knowledge about the HBOT application in Fournier's Gangrene?
What is the pressure of a hyperbaric oxygen therapy session in Fournier's Gangrene? (ATA: absolute atmosfere)
What is the hyperbaric oxygen therapy session duration in Fournier's Gangrene?
What is/are the oxygen delivery methods during hyperbaric oxygen therapy?
What is the frequency of the hyperbaric oxygen therapy sessions in Fournier's Gangrene?
How do you examine a Fournier's Gangrene patient's treatment response during hyperbaric oxygen therapy period?
The mechanisms of action of hyperbaric oxygen therapy are listed below. Please state your opinion about the effectiveness of each mechanism in Fournier's gangrene. (Yes / I do not know / No)
a. hyperoxygenation
b. augmenting the effects of some antibiotics

- c. stimulation of angiogenesis
- d. anti-inflammation
- e. anti-infective
- f. enhancing collagen formation and granulation tissue formation
- g. anti-edema
- h. reduction of the gas bubbles sizes

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Is there a Hyperbaric Oxygen Therapy Center in your institution?

Have you ever referred a patient to hyperbaric oxygen therapy other than Fournier's Gangrene?

Please state the disease if you answered yes.

Do you have adequate knowledge about hyperbaric oxygen therapy in Fournier's gangrene?

Have you ever been participated in a scientific study about hyperbaric oxygen therapy?

Have you ever visited a hyperbaric oxygen therapy center?

Is there a hyperbaric oxygen therapy center in your province?

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Please state your opinion about the incidents below, whether it is a complication of hyperbaric oxygen therapy. (Yes / I am not sure / No)

- a. perforation of the tympanic membrane
- b. cerebrovascular incident
- c. seizure
- d. pneumothorax
- e. worsening of heart failure
- f. renal failure
- g. headache
- h. failure of the pacemaker

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Please state your opinions about the statements below.

- a. There is only a few hyperbaric oxygen therapy center in our country.
- b. Hyperbaric oxygen therapy is a treatment modality in which the person breathes 100% oxygen in a closed room under high pressure.
- c. Claustrophobia is a relative contraindication for hyperbaric oxygen therapy.
- d. Psychiatric diseases are relative contraindications for hyperbaric oxygen therapy.
- e. Fire could develop if safety rules were not followed during hyperbaric oxygen therapy.
- f. Patients with VAC (vacuum-assisted closure) could enter hyperbaric oxygen therapy sessions.

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#### 4- Opinions about Hyperbaric Oxygen Therapy

Do you believe hyperbaric oxygen therapy is effective in Fournier's gangrene?

Please state your opinion about the statements below. (Yes / I do not know / No)

- a. Hyperbaric oxygen therapy is effective in Fournier's Gangrene.
  - b. Hyperbaric oxygen therapy is a cost-effective treatment in Fournier's Gangrene.
  - c. Hyperbaric oxygen therapy is a safe treatment modality in Fournier's Gangrene.
  - d. Hyperbaric oxygen therapy shortens the recovery period in Fournier's Gangrene.
  - e. Hyperbaric oxygen therapy is a supportive treatment option in Fournier's Gangrene.
  - f. Surgical debridement should be completed before hyperbaric oxygen therapy.
  - g. If the patient is intubated, hyperbaric oxygen therapy cannot be applied.
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**Table 2.** The demographic data of participants

	Median (Minimum-Maximum) or n (%)
Age	30 (27-65)
Experience	5 (1-40)
<b>Title</b>	
Residency program student	46 (51.7%)
Specialist	11 (12.4%)
Assistant Professor	6 (6.7%)
Associate Professor	14 (15.7%)
Professor	12 (13.5%)
<b>Institution</b>	
University	26 (29.2%)
Research and Training Hospital	55 (61.8%)
State Hospital	2 (2.2%)
Private Hospital	5 (5.6%)
Private Personal Clinic	1 (1.1%)

### 1- Clinical Experience

Almost all physicians (n=89, 98.9%) had experience with FG. The majority reported the average number of FG cases examined in a year as "1-5 cases" (n=38, 42.2%). Physicians who examined "more than 5 FG cases in a year" were 37.8% (n=34). While surgical debridement (n=88, 97.7%), antibiotherapy (n=80, 88.8%), blood glucose control (n=70, 77.7%) and wound care (n=67, 74.4%) were the most preferred treatment options, wound care of a FG patient was mostly planned by Urologists (n=65, 72.2%) and by General Surgeons (n=10, 11.1%), and Plastic Surgeons (n=3, 3.3%), respectively.

The referral rates of FG patients' for HBOT are shown in Figure 1. Most (n=21, 55.3%) referred FG patients for HBOT when they were unresponsive to surgical debridement and antibiotherapy. Clinical findings (n=68, 75.6%), anamnesis (n=36, 40%), blood tests (n=30, 33.3%), intraoperative findings (n=23, 25.6%) and other (n=1, 1.1%) were used for follow-up during HBOT period, respectively.

### 2- The Knowledge of HBOT

At the beginning and the end of the questionnaire, the participants were asked to self-assess their knowledge of HBOT in FG patients on a 4-point Likert scale.

In the beginning, 24 physicians (27.3%) stated they did not know about HBOT. The median score for this question was calculated as 2 (1-4). Subsequently, general descriptive essential information about HBOT was questioned. At the end of the section, physicians were asked again to self-assess their knowledge of HBOT. The median score was calculated as 2 (1-4). There was a statistically significant decrease in the scores of the self-assessment questions about HBOT knowledge repeated before and after the survey ( $p < 0.001$ ). A detailed comparison is shown in Figure 2.

The participants were asked about the characteristics of an HBOT session applied in FG. The majority did not know about the pressure levels (87.5%), session duration (85.2%), and frequency of HBOT sessions (84.1%). Their knowledge of the oxygen delivery methods during HBOT is examined in Figure 3. The mechanisms of action (hyperoxygenation, augmenting the effects of some antibiotics, angiogenesis, anti-inflammatory effect, anti-infective effect, supporting collagen formation, anti-edema effect, reduction in the size of gas bubbles) were listed, and it was asked which of these mechanisms were beneficial in FG. Among these effects, the majority stated that they expect benefit from hyperoxygenation (n=66, 73.3%), enhancing the effects of some antibiotics (n=51, 56.7%), angiogene-

sis (n=57, 63.3%), anti-inflammatory effects (n=55, 61.1%), anti-infective effects (n =54, 60%) anti-edema effects (n=48, 53.3%) and collagen formation (n=47, 52.2%).

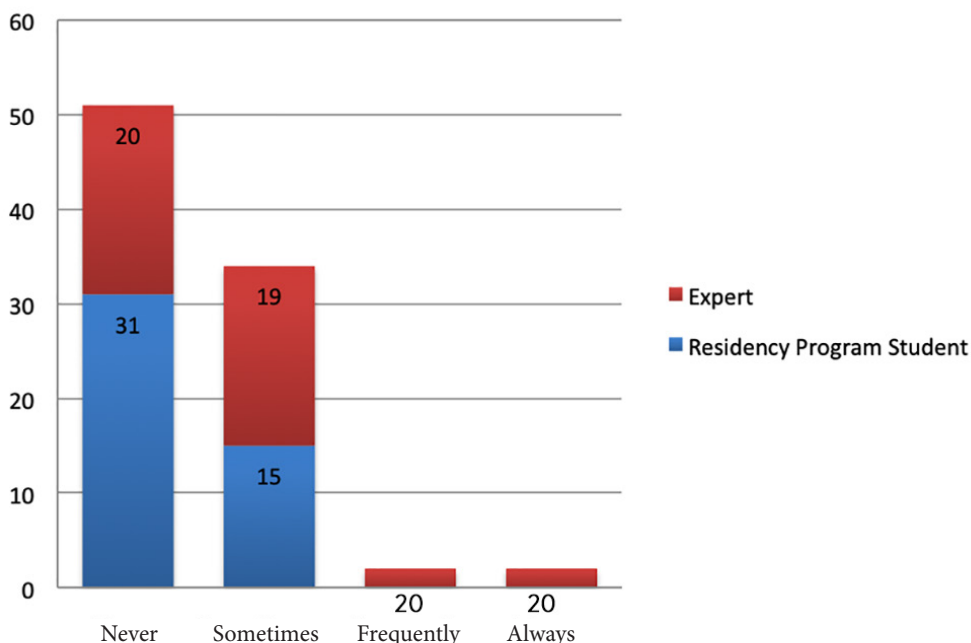
HBOT complications were asked of the participants. Fifty-four (62.8%) of the physicians were unsure about tympanic membrane perforation, 63 (74.1%) regarding seizures, 50 (58.8%) regarding worsening heart failure, and 69 (76.7%) regarding the failure of the pacemaker. Eighteen physicians (21.2%) and six physicians (7%) considered a cerebrovascular incident, which was not actually among the complications of HBOT, as a complication. Most physicians (n=36, 41.9%) knew that claustrophobia was a relative contraindication for HBOT. Similarly, most physicians (n=37, 42.5%) knew that fire could develop if safety rules were not followed during HBOT. Only 18 doctors (20.7%) stated that patients could enter the HBOT session with “vacuum-assisted closure-VAC.”

Only eight physicians (9.1%) stated that there was an HBOT center in the hospital where they worked. However, 67 physicians (14.8%) stated that no HBOT center existed in their institution. While 68 physicians

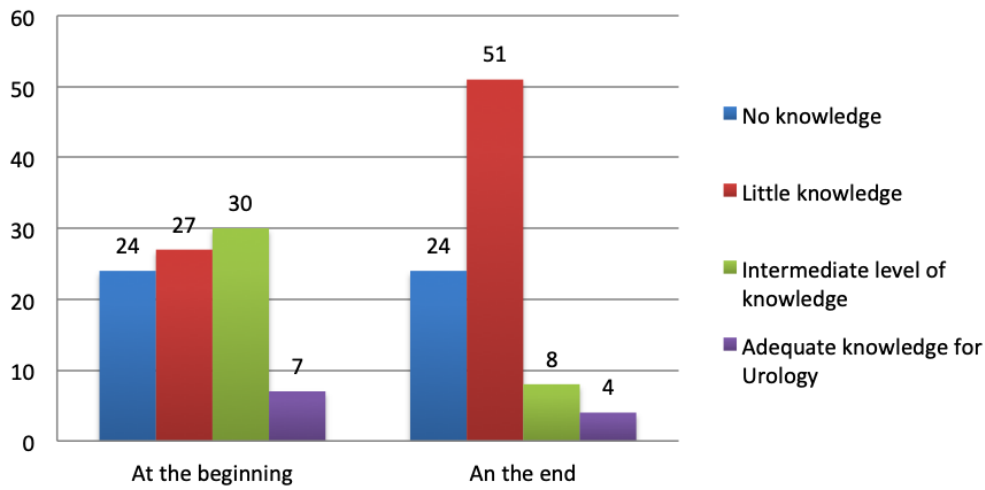
(77.3%) stated that there was an HBOT center in their city, 13 physicians (14.8%) stated that they did not know, and seven (7.9%) stated that there was no HBOT center in their city. Most physicians (n=44, 50.6%) thought HBOT centers were only in a few provinces in our country. Twenty-one physicians (23.3%) referred patients for HBOT other than FG. There were 12 physicians (13.3%) who had been to an HBOT center before. Fifteen physicians (16.7%) previously participated in a scientific study on HBOT, and 14 of these physicians took part in animal studies.

### 3- The Opinions about HBOT

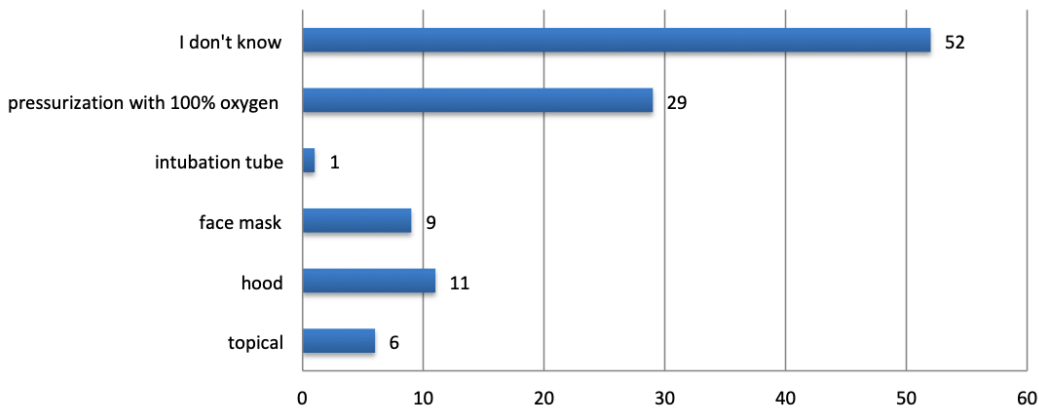
There were 28 physicians (31.8%) believed that HBOT was beneficial in FG patients, 32 physicians (36.4%) believed it was partially beneficial, 25 physicians (28.4%) were indecisive on this issue, and three physicians (3.4%) did not believe it was beneficial. In addition, two physicians did not answer this question. The 3-point Likert-type scoring questions examined other opinions about HBOT. These questions’ median score was 2.4 (1.8-3). The detailed examinations according to the questions are shown in Figure 4.



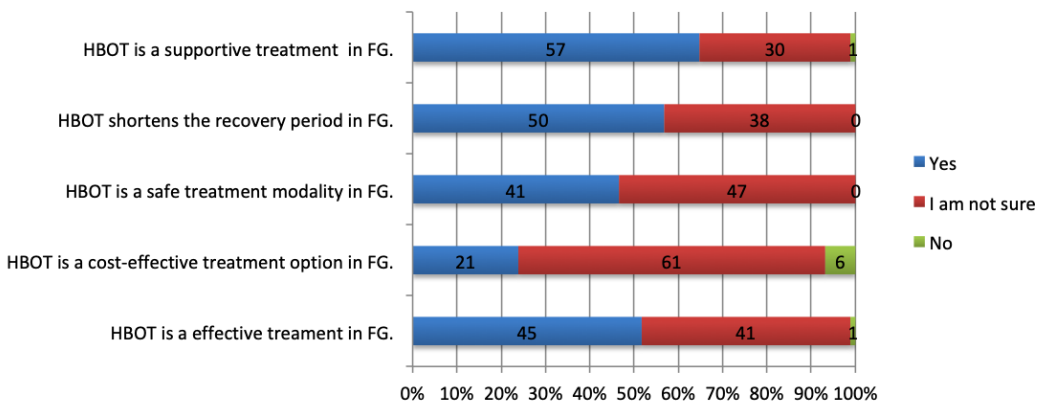
**Figure 1.** The rates of HBOT referrals of Fournier’s Gangrene cases (Data were expressed as a number)



**Figure 2.** The results of self-assessment questions about the knowledge of HBOT in Fournier's Gangrene (Data were expressed as a number)



**Figure 3.** The answers of the Urology physicians' about the oxygen delivery methods during HBOT (Data were expressed as numbers)

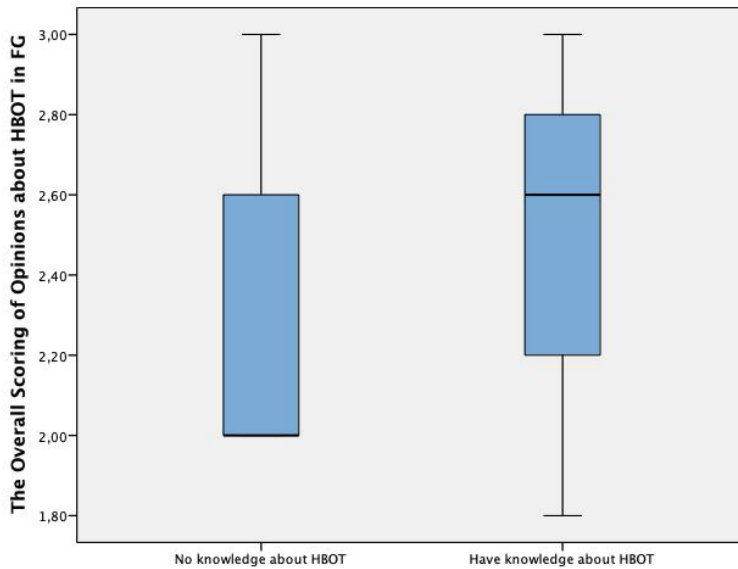


**Figure 4.** The opinions of Urology physicians' about HBOT in Fournier's Gangrene Data were expressed as a number) (HBOT = hyperbaric oxygen therapy, FG= Fournier's Gangrene)

#### 4- Subgroup Comparisons

According to the first response of the physicians to the self-assessment of knowledge of HBOT, there was a statistically significant difference in the general opinion score of HBOT between those who did not know (n=24) and those who had low knowledge (n=63) (p=0.002) (Figure 5). Similarly, the general opinion score about

HBOT application in FG was compared between experts and residency training program students, those working at universities and those working in other institutions, and those with more than ten years of experience and those with less experience. There was no significant difference (respectively, p=0.066, p=0.865, p=0.060). A detailed analysis is given in Table 3.



**Figure 5.** The comparison of the overall scoring of the Urology physicians’ opinions about HBOT in Fournier’s Gangrene between subgroups according to knowledge self-assessment about HBOT (Mann-Whitney U Test was used; p=0.002) (HBOT = hyperbaric oxygen therapy, FG= Fournier’s Gangrene)

**Table 3.** The subgroup comparisons of the Urology physicians’ opinions about HBOT in Fournier’s Gangrene (Data were expressed as n(%). The Chi-square test was used.)

	Residency Program Student			Expert			P-value
	Yes	I am not sure	No	Yes	I am not sure	No	
Hyperbaric oxygen therapy is effective in Fournier’s Gangrene.	20 (43.5%)	26 (56.5%)	0	25 (62.5%)	14 (35%)	1 (2.5%)	0.093
Hyperbaric oxygen therapy is a cost-effective treatment in Fournier’s Gangrene.	9 (19.6%)	32 (69.6%)	5 (10.9%)	12 (29.3%)	28 (68.3%)	1 (2.4%)	0.214
Hyperbaric oxygen therapy is a safe treatment modality in Fournier’s Gangrene.	17 (37%)	29 (63%)	0	24 (58.5%)	17 (41.5%)	0	<b>0.044*</b>
Hyperbaric oxygen therapy shortens the recovery period in Fournier’s Gangrene.	26 (56.5%)	20 (43.5%)	0	23 (56.1%)	18 (43.9%)	0	0.968
Hyperbaric oxygen therapy is a supportive treatment option in Fournier’s Gangrene.	25 (54.3%)	21 (45.7%)	0	31 (75.6%)	9 (22%)	1 (2.4%)	<b>0.046*</b>



	University			Other institutions			
	Yes	I am not sure	No	Yes	I am not sure	No	
Hyperbaric oxygen therapy is effective in Fournier's Gangrene.	15 (57.7%)	11 (42.3%)	0	30 (49.2%)	30 (49.2%)	1 (1.6%)	0.649
Hyperbaric oxygen therapy is a cost-effective treatment in Fournier's Gangrene.	4 (15.4%)	22 (84.6%)	0	17 (27.4%)	39 (62.9%)	6 (9.7%)	0.087
Hyperbaric oxygen therapy is a safe treatment modality in Fournier's Gangrene.	15 (57.7%)	11 (42.3%)	0	26 (41.9%)	36 (58.1%)	0	0.176
Hyperbaric oxygen therapy shortens the recovery period in Fournier's Gangrene.	12 (46.2%)	14 (53.8%)	0	38 (61.4%)	24 (38.7%)	0	0.191
Hyperbaric oxygen therapy is a supportive treatment option in Fournier's Gangrene.	16 (61.5%)	10 (38.5%)	0	41 (66.1%)	20 (32.3%)	1 (1.6%)	0.710
	No knowledge about HBOT			Have knowledge about HBOT			
	Yes	I am not sure	No	Yes	I am not sure	No	
Hyperbaric oxygen therapy is effective in Fournier's Gangrene.	7 (29.2%)	17 (70.8%)	0	38 (60.3%)	24 (38.1%)	1 (1.6%)	<b>0.022*</b>
Hyperbaric oxygen therapy is a cost-effective treatment in Fournier's Gangrene.	2 (8.3%)	21 (87.5%)	1 (4.2%)	19 (29.7%)	40 (62.5%)	5 (7.8%)	0.072
Hyperbaric oxygen therapy is a safe treatment modality in Fournier's Gangrene.	5 (20.8%)	19 (79.2%)	0	36 (56.3%)	28 (43.8%)	0	<b>0.003*</b>
Hyperbaric oxygen therapy shortens the recovery period in Fournier's Gangrene.	9 (37.5%)	15 (62.5%)	0	41 (64.1%)	23 (35.9%)	0	<b>0.025*</b>
Hyperbaric oxygen therapy is a supportive treatment option in Fournier's Gangrene.	10 (41.7%)	14 (58.3%)	0	47 (73.4%)	16 (25%)	1 (1.6%)	<b>0.012*</b>

## DISCUSSION

While 27.3% of the participants did not know about the HBOT application in FG, only three physicians (3.4%) did not believe HBOT was beneficial. Besides, the majority (n=51, 56.4%) never referred their FG patients for HBOT. Finally, physicians who did not know about HBOT had more negative opinions about HBOT's application in FG (p=0.002).

We may refer our patients to other treatment options that we did not apply. It is essential for physicians specializing in other medical fields to know how this treatment is applied, its complications,

and contraindications. We should have adequate knowledge of the treatments we refer to. In this study, 27.3% of urology physicians were found to have no knowledge of HBOT administration in FG.

HBOT has been used successfully in a variety of diseases (13,14). HBOT is a treatment method in which the patient breathes 100% oxygen in a closed room pressurized to at least 1.4 atmospheres (ATA). Oxygen can be inhaled through a mask, hood, or endotracheal tubes or by pressurizing the environment with oxygen (13). In this study, most physicians (n=52, 57.8%) did not know the oxygen delivery methods during HBOT.

HBOT is a safe treatment method without serious complications (15,16). However, it is noteworthy that most physicians (n=44, 53.4%) in this study were unsure whether HBOT is a safe treatment. Hyperoxygenation is the main mechanism of action of HBOT (15). HBOT also enhances the oxidative killing capacity of leukocytes, suppresses the synthesis of some bacterial toxins, and augments the effects of some antibiotics.

On the other hand, it strengthens wound healing by increasing angiogenesis and cellular proliferation (13). Middle ear barotrauma, sinus barotrauma, pulmonary barotrauma, epileptic seizures due to central oxygen toxicity, cataract formation, and transient myopia may develop as complications (15,16). In our study, while most of the complications of HBOT were answered correctly, some physicians considered cerebrovascular accidents (n=18, 21.2%) as a complication that are not actual complications of HBOT. On the other hand, the risk of fire increases during HBOT if easily combustible materials are taken into the pressure chamber due to the high oxygen level in the pressure chamber. With the determined standards and rules, no fire cases have been reported in the multi-placed pressure chambers in the world for the last five years (15). Most Urology physicians (n=37, 42.5%) were aware of the fire risk that could develop if this study's rules were not followed. While the only definite HBOT contraindication is untreated pneumothorax, upper respiratory tract infection, emphysema, bulla or bleb in the lungs, high fever, pregnancy, and claustrophobia are considered among the relative contraindications. In patients with implanted electronic devices such as pacemakers, the operability and safety of these devices under high pressure should be tested (15,16). In our study, most physicians knew about the disruption of the pacemaker during HBOT (n=69, 76.7%), and claustrophobia might be a relative contraindication (n=36, 41.9%). In necrotizing fasciitis, it is recommended that an HBOT session be applied for 90 minutes at 2-2.5 ATA, two sessions per day in the first few days (13). In our study, the majority answered the questions about the HBOT session as they did not know. On the other hand, most physicians (n=57, 64.7%) stated HBOT is a supportive treatment consistent with the Undersea and Hyperbaric Medicine Society (UHMS) guideline

(13). In this study, we noticed that most Urology physicians had adequate information about the complications and contraindications of HBOT, but their knowledge about the administration of HBOT was lacking.

There are many case series and clinical studies regarding the application of HBOT in FG patients; however, randomized-controlled double-blind studies are rare. The difficulty of planning randomized-controlled trials with a high number of patients should not be underestimated, as the disease is quite fatal, and its incidence is relatively low (13). Along with the low mortality rates reported in FG patients who underwent HBOT, two studies with a large sample size published in the last five years concluded that HBOT is an independent predictor of low mortality in FG (3-9). However, in the last guideline published by EAU, only the results of a review published in 2005 were evaluated. Emphasis is placed on the fact that all of the studies in this review were published before 2000 (11, 17). Besides this review, only Li et al. evaluated the comparative case series. In this case series, 28 FG patients with similar FG severity index scores (FGSI) were divided into two groups: those who received HBOT and those who did not. The mean number of debridements was lower, and the recovery period was shorter in the group receiving HBOT ( $p<0.05$ ). The mean number of debridements was lower, and the recovery period was shorter in the group receiving HBOT ( $p<0.05$ ) (6). As a result, no clear recommendation has been made about HBOT in the EAU guideline (11). UHMS emphasized that it is not possible to conduct double-blind, randomized-controlled HBOT studies due to the seriousness of FG. HBOT was recommended for use in FG and accepted as an indication based on current research (13).

Similarly, type 1 recommendation by the European Committee of Hyperbaric Medicine (ECHM) in Europe, and HBOT application in all necrotizing soft tissue infections, especially perineal gangrene, is recommended as evidence level C (14). Our study also clearly showed the lack of consensus in the current literature. In our study, most Urology physicians (n=51, 56.7%) never referred FG patients for HBOT. The 55.3% of participants who recommended HBOT stated that they only consulted for HBOT in cases where surgical debridement and antibiotherapy had failed. It is strik-

ing that Urology physicians have practical applications in line with the guidelines of the EAU association.

On the other hand, when the physicians' opinions about the HBOT application in FG were questioned, only three physicians (3.4%) thought it was not beneficial. In addition, most physicians (51.7%) stated that HBOT was an effective treatment for FG and shortened the recovery period (56.8%); this is a contradictory and striking point, with most physicians ( $n=51$ , 56.7%) never referring their FG patients to HBOT. On the other hand, most physicians were unsure about the cost-effectiveness (69.3%) of HBOT in our study, which may be because the current scientific data on HBOT has not yet been examined in detail by Urology societies; detailed information is not given in the Urology guides. While urology physicians have a positive point of view about HBOT application in FG in general, it is obvious that more studies should be conducted, and Urology associations should discuss the results of HBOT. Our study determined that physicians who knew HBOT had more positive opinions about HBOT in FG than physicians who did not know. ( $p=0.002$ ) This result again shows us the importance of closing the knowledge gap among physicians.

There were no presentations about HBOT in FG at the American Urological Association (AUA), European Urological Association (EAU), and Turkish Urology Association annual meetings in the last three years (18-26). When the term "hyperbaric oxygen AND Fournier's gangrene" was searched in the Dergipark database, only one case series and a review about anaerobic soft tissue infections were found (27). The small amount of literature and the absence of any statement on this subject in meetings may explain physicians' low level of knowledge and interest in HBOT for FG. On the other hand, it is emphasized in the literature that there are few HBOT centers, and HBOT is a costly treatment, the fees of which are between 8000-25000 EUR per patient; among the main reasons, HBOT is less preferred in FG patients (5). Indeed, the number of HBOT centers globally and in our country is limited (28, 29). However, accessibility to HBOT centers in our country is relatively better than in other countries. While there are 20 HBOT centers in France, there is at least one HBOT center in only 23 provinces in our country (29, 30).

On the other hand, HBOT is a very cheap treatment in our country compared to other countries. In the Public Health Services Price Schedule dated 16.12.2021, one "2-3 ATA HBOT session" was determined as 135 Turkish Liras (30). In addition, FG has been accepted as a reimbursed HBOT indication under HPC (10). For this reason, scientific studies can be carried out easily in our country. Urology physicians should increase their experience with HBOT and participate in or conduct scientific studies on this subject. It will clarify their opinions on HBOT. In our study, the number of physicians who answered the questions about HBOT as "indecisive" was relatively high.

Increasing awareness about HBOT in the Urology community is critical. Seven physicians who participated in our study stated that there was no HBOT center in their city. It is noteworthy that two of these physicians work in Ankara, where there are four HBOT centers. In addition, 13 physicians did not have any information about available HBOT centers. It is evident that physicians, who participated in this study, do not have enough awareness about HBOT. We found that very few physicians had been in an HBOT center before ( $n=12$ , 13.3%) and had participated in a study related to HBOT ( $n=15$ , 16.7%). Since there is no HBOT center in every province in our country, the chance of our physicians visiting an HBOT center during their education in Medical Faculty and residency training is really low (29). However, adding a lecture on HBOT to the urology residency training programs or discussing literature on this subject in lectures could, at least in theory, increase doctors' awareness.

The main limitation of this study is that we do not have a sample that reflects the whole of our country. Other limitations are the uneven distribution of our sample number according to provinces, titles, and institutions; the length of the questionnaire; and the relatively small number of samples.

## CONCLUSION

The lack of interest of Urology physicians in HBOT, their hesitancy about the effectiveness of HBOT in FG, and their relatively low experience with HBOT in their daily clinical practice were demonstrated in this study. However, given the encouraging outcomes in the

existing literature, HBOT application following surgical debridement under emergency conditions may be life-saving. For this reason, Urology physicians should be encouraged to discuss HBOT-related literature during their residency training or to address this issue in residency training courses, to increase clinical experience with HBOT application in FG, to conduct or participate in scientific studies about HBOT applications in FG, to share these studies in Urology meetings, and to publish them in Urology journals. We think that awareness can be raised by drawing attention to this issue. Last but not least, we believe that bringing this topic up for debate by national and international Urology associations and going into more detail about it in the guidelines may grab the interest of all urology doctors.

#### **Conflict of Interest**

The authors declare to have no conflicts of interest.

#### **Financial Disclosure**

The authors declared that this study has received no financial support.

#### **Informed Consent**

Informed consent was obtained from all individual participants included in the study.

#### **Ethical Approval**

The study was approved by Health Sciences University Non-Invasive Investigation Ethical Committee (Approval: 2021-424, Date: 2021/16/12) and written informed consent was received from all participants. The study protocol conformed to the ethical guidelines of the Helsinki Declaration.

#### **Author Contributions**

Conception and design; KÖK, KCD, Data acquisition; KÖK, KCD, Data analysis and interpretation; KÖK, Drafting the manuscript; KÖK, KCD, Critical revision of the manuscript for scientific and factual content; KÖK, KCD, Statistical analysis; KÖK, Supervision; KÖK.

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