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THESIS SUMMARY

COVID-19

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I. **CONTENTS**

II. INTRODUCTION

In December 2019, SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) was identified in Wuhan, China. A large number of cases of severe pneumonia, often followed by acute respiratory distress syndrome (ARDS), have been described. The virus subsequently spread to Lombardy, northern Italy, then worldwide, leading to a World Health Organisation (WHO) pandemic declaration.

The COVID-19 pandemic has triggered significant changes and challenges in health care worldwide. In recent years, hospitals and medical staff have faced extremely difficult situations related to treating patients with COVID-19, and at the same time continuing to work in other medical specialties.

Urology practice, like other areas of medicine, has been affected by the pandemic. In this context, understanding the impact of COVID-19 on urology practice and adapting hospital services are essential to maintain quality of care and patient safety.

The aim of this dissertation is to study the impact of the COVID-19 pandemic on the urology clinic of the University Hospital "St. Marina" - Varna, with the main focus on hospitalizations and surgical interventions. The dissertation examines two periods according to the emergence of the emergency epidemic situation in the Republic of Bulgaria on 13.03.2020.

By analyzing data from these two periods, this dissertation aims to identify how the pandemic has affected urological procedures as well as offer recommendations for improving urological practice in a pandemic setting.

III. OBJECTIVE

To investigate and analyze the challenges of the impact of the COVID-19 pandemic on hospitalizations and operative activity in inpatient urology practice by proposing an algorithm for the management of post-prioritization patients with different urological diseases.

IV. TASKS

1. To prepare a retrospective analysis of patients hospitalized and operated in the Urology Clinic for two periods 2018-2019 and 2020-2021.
2. To evaluate the order, choice of anaesthesia and duration of surgical interventions before and during the COVID-19 pandemic.
3. To analyze the impact of the COVID-19 pandemic on therapeutic management of patients with urological malignancies, urolithiasis and other benign urological diseases.
4. To compare the surgical management of patients with GUT obstructions before and during the COVID-19 pandemic.
5. To produce an analysis of the impact of age and co-morbidities on patients' hospital stays before and during the COVID-19 pandemic.
6. To propose a diagnostic and therapeutic algorithm that is consistent with the health system of our country and suitable to serve as a model in future epidemic situations of a similar nature.

V. MATERIAL AND METHODS

1. CLINICAL MATERIAL

The information provided in tabular form (including in the form of **epicrises, case histories and operative logs)** by the "Reporting and Coding of Medical Activity" department at St. Marina Hospital - Varna was obtained and processed. From it, we performed a retrospective analysis of the number of hospitalized and operated patients in the Urology Clinic for the period 2018-2021. All patients aged 0-18 years were excluded. In this study, we defined two periods according to the occurrence of the epidemic emergency in R. Bulgaria on 13.03.2020:

- for the period from 1.01.2018 to 13.03.2020 inclusive ***(period before COVID-19) - P1***
- for the period from 14.03.2020 to 31.12.2021 ***(period during COVID-19) - P2***

2. DOCUMENTARY METHODS

2.1 According to demographic characteristics

After documenting the clinical material, we found that the **number** of hospitalized patients for the entire period was *4764 men (68%) and 2260 women (32%)* aged *18 to 98 years*. The mean age of the studied patients was 57.26, approximately 57 years.

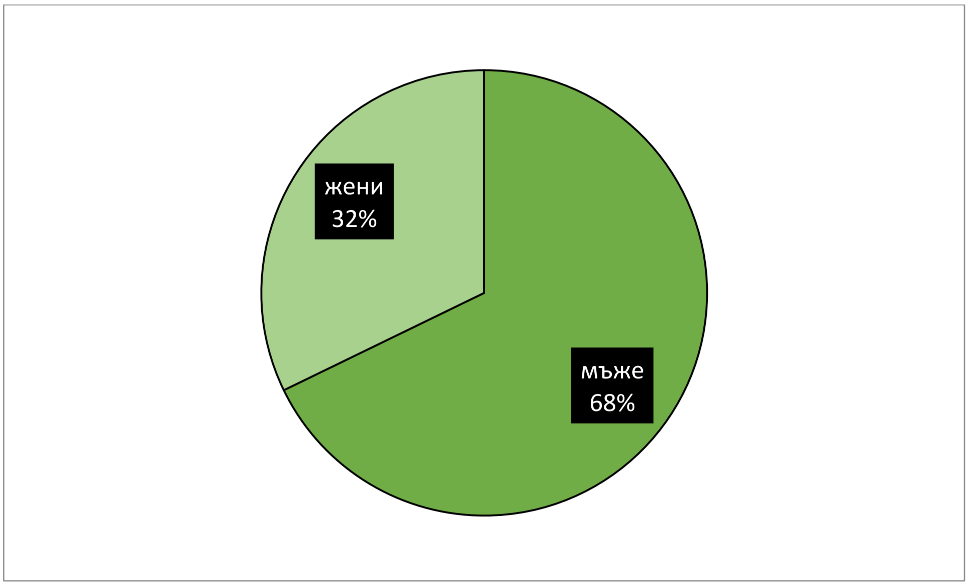


Fig. 1. Structure of patients by sex for the whole **period** considered

2.2 According to the characteristics of the hospital stay

- ***Number of hospitalized patients in the Urology Clinic of University Hospital "St. Marina" - Varna:***

- for the period from 1.01.2018 to 13.03.2020 inclusive (period before COVID-19) - 4230 patients;
- for the period from 14.03.2020 to 31.12.2021 (period during COVID-19) - 2794 patients.

➢ ***Number of surgeries performed in the Urology Clinic of the University Hospital "St. Marina" - Varna:***

- for the period from 01.01.2018 to 13.03.2020 inclusive (period before COVID-19) - 4487 operations;
- for the period from 14.03.2020 to 31.12.2021 (period during COVID-19) - 2782 operations.

➢ ***The period of hospital stay*** ranged from 1 to 45 days, an average of 8 days for the period **before COVID-19, and ranged** from 1 to 33 days, an average of 7 days for the period **during COVID-19.**

Tab. 1. Characteristics of the hospital population

Feature	П1	П2
Number of hospitalizations	4230	2794
Number of operations	4487	2782
Hospital stay	1 to 45 days, 8 days on average	1 to 33 days, average 7 days

2.3 According to the order of the operational intervention carried out

All patients were hospitalized and operated on either electively or emergently. According to the order of the surgical interventions performed for the two periods, they are divided as follows:

- **planned operations:**

3194 pcs (*pre-COVID-19 period)* and **1601 pcs** *(COVID-19 period)*

- **emergency operations up to 6 h after hospitalization**

841 pcs (*pre-COVID-19 period)* and **767 pcs** *(COVID-19 period)*

- **emergency operations between 6 and 12 h after hospitalization**

28 pcs *(period before COVID-19)* and **34** pcs *(period during COVID-19)*

- **emergency interventions between 12 and 24 h after hospitalization**

22 pcs *(period before COVID-19)* and 30 **pcs** *(period during COVID-19)*

- **emergency operations over 24 h after hospitalization**

145 pcs *(pre-COVID-19 period)* and **362 pcs** *(COVID-19 period)*

Table 2. Order of surgical intervention after hospitalization

Order of operation	П1	П2
Plan	3194	1601
Urgent until 6 pm	841	767
Urgent until 6-12 pm	28	34
Urgent 12-24 h	22	30
Urgent > 24 h	145	362

2.4 According to the type of anaesthesia used

In our study, we divided the types of anaesthesia administered during urological interventions for the two periods into three main groups:

- *General anaesthesia* - this group includes all anaesthesia with the following general scope - intravenous, inhalation, intubation and combined (intubation + epidural) anaesthesia. Their number was 2792 **for the period before COVID-19 and 1943 for the period during COVID-19;**
- ***Regional anesthesia*** - all spinal anesthesia is included in this group. Their number was 255 **for the period before COVID-19 and 132 for the period during COVID-19;**
- ***Local anaesthesia*** - this group includes all superficial and infiltration anaesthesia with local anaesthetic. Their number was 1430 **for the period before COVID-19 and 707 for the period during COVID-19.**

Tab. 3. Type of anaesthesia used

Type of anaesthesia	П1	П2
General	2792	1943
Regional	255	132
Local	1430	707

2.5 According to the duration of the surgical intervention

We recorded the duration of the surgical interventions in the periods indicated:

- from 15 minutes to 7 hours and 30 minutes, and the average operating time e (57 minutes) for the period **before COVID-19;**
- from 15 min to 6 h and 20 min and the average operational time e (1 h and 5 min) for the period **during COVID-19.**

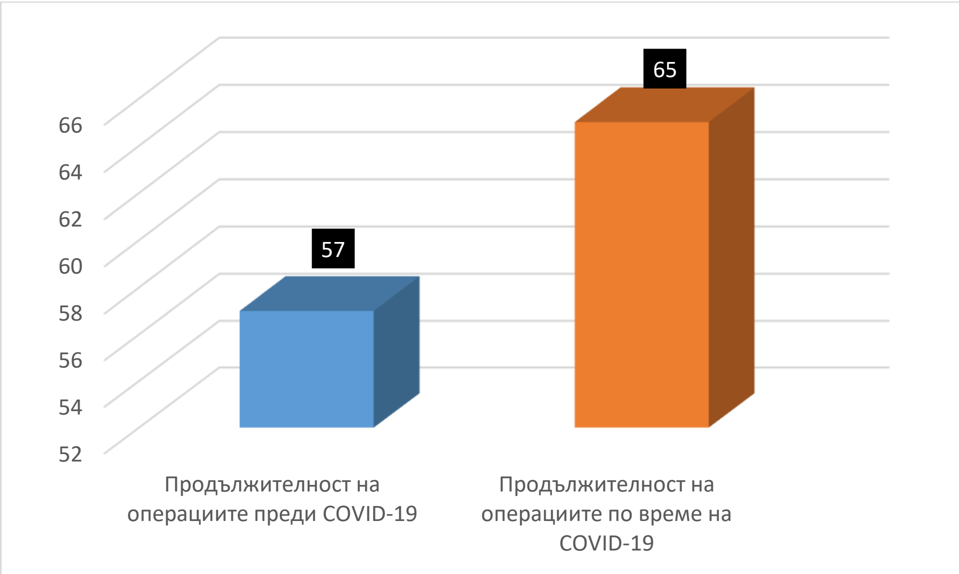


Fig. 2. Average duration of operations for the two periods (minutes)

2.6 According to underlying urological disease

In our study, we analyzed patients for both periods. According to the underlying disease, we defined them into three predominant groups:

- **Patients with malignant urological diseases -** in this group we classified all patients discharged from the Urology Clinic during the specified period with the following diagnoses:

➢ Prostate carcinoma
➢ Carcinoma of the bladder

- ➢ Carcinoma of the kidney
- ➢ Carcinoma of the upper ureteral tract (UUT)
- ➢ Carcinoma of the penis
- ➢ Carcinoma of the testis
- ➢ Secondary malignancies in urology

Their number **for the** period before COVID-19 was 885 and 687 for the period during COVID-19.

- **Patients with urolithiasis -** in this group we classified all patients discharged from the Urology Clinic during the indicated period with the following diagnoses:
- ➢ Concrement(s) in kidney
- ➢ Concrement(s) in ureter
- ➢ Concrement(s) in bladder and urethra

Their number **for the** period before COVID-19 was 960 and 512 for the period during COVID-19.

- **Benign urological diseases** - the group "benign" includes urological conditions not classified in the other 2 groups.

Respectively, this represents the broadest group of diseases. Their number **for the** period before COVID-19 was **2385** and **1595** for the period during COVID-19.

2.7 According to the intervention conducted (diagnostic-therapeutic groups)

According to the International Classification of Diseases (ICD9 - CM) procedure codes and the medical procedure coding system (MPCS) in the Republic of Bulgaria, patients were classified into main groups based on clinical diagnosis and/or surgical treatment performed during their stay in the clinic. We defined the following predominant groups of patients hospitalized and operated in the Urology Clinic of the University Hospital "St. Marina" - Varna:

Table 4. Diagnostic and therapeutic groups

1.	Prostate carcinoma - all ***radical prostatectomies - conventional, laparoscopic and robot-assisted*** - are classified in this group
2.	Bladder carcinoma - all ***radical cystectomies (conventional, laparoscopic and robot-assisted) and transurethral resections*** performed are classified in this group
3.	Kidney carcinoma and GUT - in this group are classified all ***partial resections, nephrectomies, nephroureterectomies - conventional, laparoscopic and robot-assisted***
4.	Carcinoma of the penis - all ***partial and total penectomies*** performed are classified in this group
5.	Testicular carcinoma - all ***orchiectomies*** performed are classified in this group
6.	Lymph node dissections - all lymph node dissections performed concomitantly with the main urological malignancy are classified in this group - ***open, laparoscopic and robot-assisted***
7.	Urolithiasis - all ***open, laparoscopic and endoscopic surgeries*** performed ***for BCS*** are classified in this group
8.	GUT disobstruction operations - all ***percutaneous nephrostomies and ureteral catheterisations*** performed ***with Double J stent*** are classified in this group
9.	BPH - all performed ***TURP, TULEP, conventional suprapubic adenomectomies, laparoscopic and robot-assisted adenomectomies*** are classified in this group
10.	Benign penile, testicular and scrotal lesions - this group includes all operations for ***phimosis, hydrocele, varicocele, epididymal cysts and*** orchidopexy
11.	Subvesical obstructions - this group includes all ***interna urethrotomies, transurethral incisions of the bladder neck in sclerosis and provision of suprapubic drainage by cystofyx***
12.	Biopsy procedures - all procedures for diagnostic purposes are included here

13. Drainage of lymphocele - in this group are classified all drains performed on the occasion of lymphocele after radical surgical treatment

14. UCS - this group includes all ***urethrocystoscopies for diagnostic and therapeutic purposes (including endoscopic cystolithotripsies)***

15. Other urological interventions - this group includes all urological operations performed and not classified elsewhere for benign diseases such as ***nephrectomies for kidney dysfunction***, ***pyeloplasties, ureter reimplantations, bladder plastics, diverticulectomies, decortications of renal cysts, etc.***

3. STATISTICAL METHODS

3.1 Descriptive methods

In the descriptive statistical analysis, the frequency distribution of the considered attributes (sex of patients, number of patients in the different structures, types of diseases, etc.) broken down by study groups, mean values, etc., is presented in tabular and graphical form. Tables and graphs are used for visual presentation of the results.

3.2 Statistical hypothesis testing

Statistical hypothesis testing to compare two relative proportions based on independent samples. The verification goes through the following stages:

1) We formulate (define) H0 - null hypothesis, and H1 - alternative hypothesis
- But: P1 = P2 (there is no statistically significant difference between the two relative shares)
- H1: P1 ≠ P2 (there is a statistically significant difference between the two relative shares)

2) We fix a significance level α=0.05 to test the hypothesis

3) We choose a statistical criterion for testing the hypothesis - z-criterion (standard normal distribution)

4) We calculate the empirical characteristic of the chosen statistical criterion - zemp.

5) Determine the theoretical characteristic of the chosen statistical criterion from the table of quantiles of a standard normal distribution - ztheor.

6) We compare the empirical and theoretical characteristics of the chosen statistical criterion and make a decision

- zemp. < ztheor., we assume H0 (the null hypothesis) to be true

- zemp. > ztheor., we bias H0 (the null hypothesis) in favor of H1 (the alternative hypothesis)

The sets we consider are:

1) Hospitalized patients in the Urology Clinic of the University Hospital "St. Marina" - Varna:
   - for the period from 1.01.2018 to 13.03.2020 inclusive (period before COVID-19) - 4230 patients;
   - for the period from 14.03.2020 to 31.12.2021 (period during COVID-19) - 2794 patients.
2) Surgeries performed in the Urology Clinic of St. Marina Hospital - Varna:
   - for the period from 1.01.2018 to 13.03.2020 inclusive (period before COVID-19) - 4487 operations;
   - for the period from 14.03.2020 to 31.12.2021 (period during COVID-19) - 2782 operations.

We will compare the two periods before COVID-19 and during COVID-19

We will apply a series of statistical hypothesis tests to compare two relative shares.

3.3 Analysis of structures

Statistical structure is a dynamic concept. It undergoes continuous minor or significant changes, determined by the action of endogenous and exogenous factors. New units are constantly entering the subgroups, while at the same time others are leaving them. Structural changes represent changes over time in the definitions of the relative shares of the different parts of the aggregates. Measuring structural change can be done using a variety of approaches. One is the use of the integral coefficient of structural change. It is used to compare the same structure for two different periods.

We will calculate the integral coefficients of structural change for 4 indicators before and during COVID-19:

- Type of disease:
  - oncourological diseases
  - urolithiasis
  - benign diseases
- Order of surgical intervention after hospitalization of the patient:
  - planned operations;
  - emergency operations up to 6 h after hospitalization;
  - emergency operations between 6 and 12 h after hospitalization;
  - emergency interventions between 12 and 24 h after hospitalization;
  - emergency operations over 24 h after hospitalization.
- Volume/complexity of the surgical intervention:
  - Medium volume;

- High volume;
- Very high volume.

3.4 Correlation analysis

Correlation analysis is a statistical method for measuring the strength (closeness) of a correlation between two or more mass phenomena. This is done by **correlation coefficients**. Unlike regression coefficients, correlation coefficients do not quantify the relationship between the resulting phenomenon and the relevant factors in the model, but only measure how strong the relationship is between them.

The different indicators available to us are presented on all possible statistical scales (nominal, ordinal, rank and interval). For this purpose, we will use different single correlation coefficients based on which scales each pair of correlated indicators are represented on. We will only present the resulting statistically significant correlations where the cutoff $\alpha < 0.05$.

We will interpret the resulting correlation coefficients based on the following table:

Table 5. Interpretation of correlation coefficients

Correlation coefficient value	Narrowness (strength) of the connection
0.0	Missing link
0.0-0.1	Very weak connection
0.1-0.3	Weak connection
0.3-0.5	Moderate connection
0.5-0.7	Significant relationship
0.7-0.9	Strong connection
0.9-1.0	Very strong connection
1.0	Functional connection

3.5 Regression analysis

Regression analysis measures correlation-type relationships and examines the shape of the relationship between two or more correlated phenomena. It is established by means of modelling. The model chosen to describe the relationship under study must necessarily have a defined analytical (mathematical) form.

The regression analysis solves the following problems:

1) Determination of the form of dependence between variables by graphical and analytical methods;

2) Determine the regression function and estimate its parameters;

3) Test statistical hypotheses about the reliability of regression models and their parameters.

We will consider single-factor regression models. We will denote the outcome variable by Y_i , and the factor variable by X_i .

Statistical hypothesis testing of the significance of regression models and their parameters proceeds in the following sequence:

I. Statistical test for adequacy of the regression model - based on Fisher's F-criterion.

II. Statistical test of the significance of the parameters in the regression model - based on the Student's t-criterion.

III. Statistical test for the presence of autocorrelation in the residual component - based on the Durbin-Watson criterion.

An important point in regression modelling is the selection of the variables (factor and outcome) to be included in the models. They should be kept to a minimum, i.e. only those that can be quantified and express stable relationships. These are:

1) Patient age (years);

2) Number of comorbidities (number);

3) Hospital stay (days).

VI. RESULTS AND DISCUSSION

From the retrospective analysis of the clinical material by the above methods we found the following results:

Table 6. Difference in hospital population characteristics

	П1	П2	P
Number of hospitalizations	4230	2794	P<0.001
Number of operations	4487	2782	P<0.001

Hospital stay	3.64 ± 2.89 (3,55-2.72)	2.95 ± 3.22 (3.95-4.2)	P<0.001

The number of hospitalized patients in the Urology Clinic of the University Hospital "St. Marina" - Varna for the period from 1 January 2018 to 13 March 2020 inclusive (P1) is 4230 patients. For the second period (P2) from 14.03.2020 to 31.12.2021, 2794 patient hospitalizations were reported.

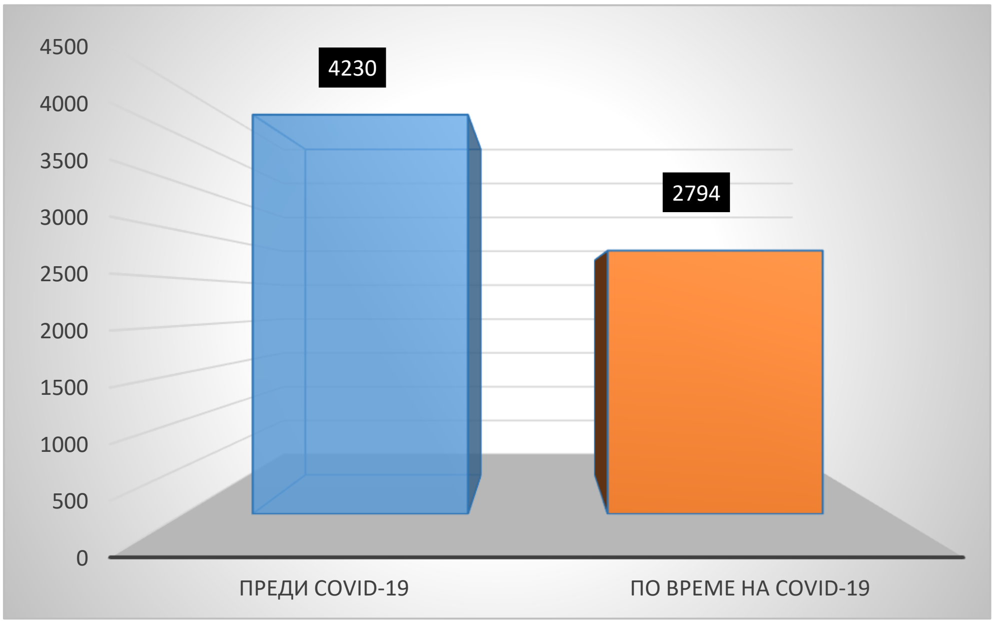


Fig. 3. Hospitalizations before and during COVID-19 (number of patients)

The COVID-19 pandemic has led to a significant increase in hospitalizations, with many health systems struggling to cope with the influx of patients. As it is known, COVID-19 is an emerging infectious disease that can cause a wide range of symptoms, ranging from mild to severe. Most of the severe cases of COVID-19 may require hospitalization, and some of these patients may need to be admitted to intensive care units. The severity of the disease varies, and certain factors may increase the risk of hospitalization. These factors include age, past and comorbidities. With increasing age and patients with chronic illnesses are at higher risk of severe illness and hospitalization.

Hospitalizations associated with COVID-19 can be challenging for patients and their families. In many countries, the availability of hospital and intensive care beds has become a major concern during the pandemic. Hospitals had to increase their capacity to accommodate the increase in the number of COVID-19 patients, and some had to postpone or cancel elective procedures to free up beds. A recently published study in Europe found that bed occupancy in urology departments was reduced by 48.6% and clinical activity was reduced in 54.2%.

In our study, we report a decrease of 1436 hospitalizations, which is a difference of 20.44% from the two periods. We argue the available difference with easier access to emergency care.

The number of surgeries performed in the Urology Clinic of St. Marina University Hospital - Varna for the period from 1 January 2018 to 13 March 2020 (P1) is 4487 surgeries. For the second period (P2) from 14.03.2020 to 31.12.2021, 2782 operations were reported.

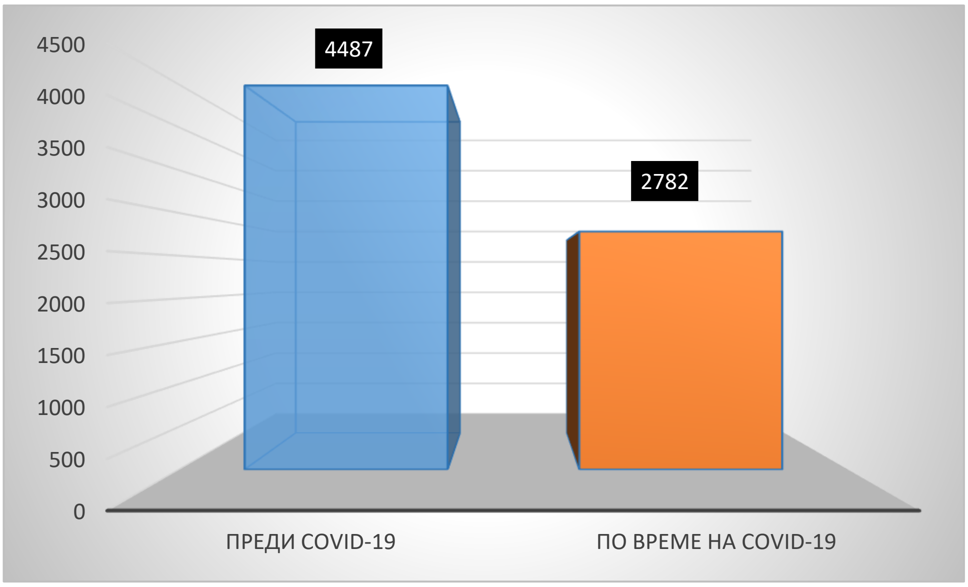


Fig. 4. Operations performed before and during COVID-19 (number)

The COVID-19 pandemic has had a significant impact on healthcare globally, including in urological surgery. A review of the literature shows that urology departments implemented various measures to reduce the number of surgeries during the pandemic. These measures include postponement of elective procedures, use of telemedicine for remote assessment of patients, and implementation of strict protocols for in-person consultations and surgeries. In our study, we report a decrease of 1705 surgeries, which is 23.46%.

The reasons for the reduction in the number of operations in urology departments during the pandemic were mainly to reduce the risk of transmission of COVID-19, conserve resources such as personal protective equipment (PPE), hospital beds and health workers. In an interim, web-based study conducted from 30 March 2020 to 7 April 2020 by Teoh et al. a 55-item questionnaire was developed to examine the impact of COVID-19 on various aspects of urology services. A total of 1004 respondents participated in the study. They were urology practitioners, urology trainees and nurses in urology departments primarily based in Asia, Europe, North America and South America. Globally, 41% of respondents reported that members of their hospital staff had been diagnosed with COVID-19 infection, 27% reported staff shortages, and 26% had to be sent to care for patients with COVID-19. Globally, only 33% of respondents felt they had received adequate personal protective equipment, and some health care workers expressed fear of visiting their workplace (47%). In the survey, 13% of respondents reported that they were advised not to wear a surgical mask to avoid scaring their patients.

In addition, the hesitancy of a large proportion of patients to undergo elective procedures during the pandemic due to concerns about potential infection with the virus must also be taken into account. A study by Campi R et al. aimed to analyse the perspective of urological patients on the possibility of delaying elective surgery due to fear of infection with COVID-19. A total of 332 patients were included in the study, 51.5% and 48.5% with established oncological and benign urological diseases, respectively. Of these, 47.9% patients would postpone elective surgery (33.3% vs. 63.4% for the two groups, respectively), whereas the proportion of patients who would prefer to postpone surgery for more than 6 months was comparable (87% vs. 80%). These responses were influenced by the patient's age, the American Society of Anesthesiologists score, and the underlying urologic disease. Finally, 182 (54.8%) patients considered the risk of COVID-19 to be potentially more harmful than the risk of delayed surgery (37% vs. 73%). From the patient's perspective, the choice to undergo surgery during such a complex period can be particularly complex given the competing risks of delaying intervention (with possible consequences on oncologic/functional outcomes) and contracting a potentially life-threatening disease.

Although reducing the number of operations may have short-term implications for patients who need emergency or major operations, it is a necessary step to ensure the safety of both patients and healthcare workers during the course of the pandemic. Urology departments are being proactive in implementing measures to ensure patients still receive the care they need.

The reduction in urological surgical activity at the onset of the COVID-19 pandemic is considered a necessary response to the current crisis. Although there may be short-term consequences for patients, the measures implemented by urology departments have been successful in reducing the risk of COVID-19 transmission in hospitals and in conserving resources.

In our study, we also analyzed the length of hospital stay from 1 to 45 days, averaging 7.8~8 days for the pre-COVID-19 period. It ranged from 1 to 33 days, averaging 6.9~7 days for the period during COVID-19. An average difference of 1 day is found for the two periods. We rationalize the statistically insignificant difference of 1 day with the compliance of successful risk reduction measures for COVID-19.

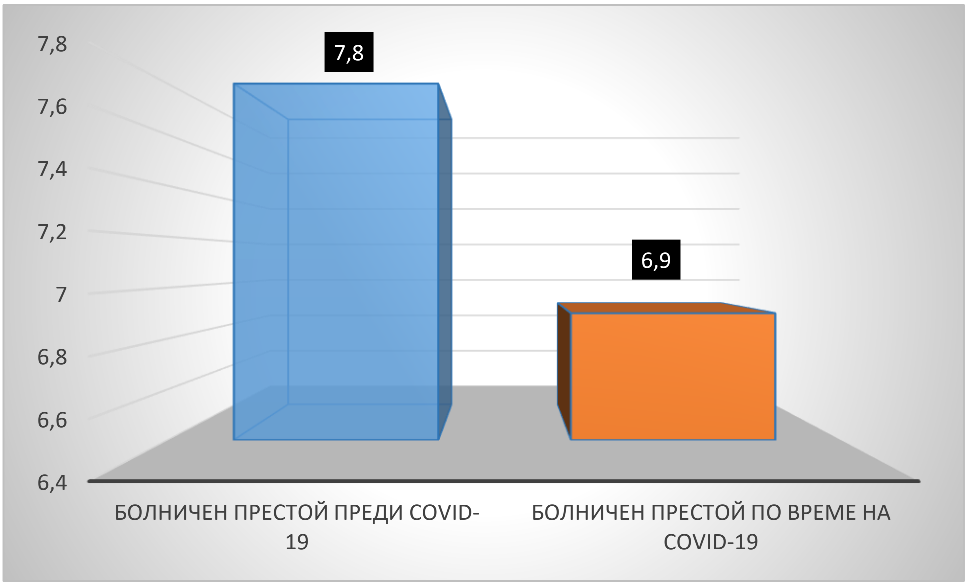


Fig. 5. Average hospital stay during the two periods (days)

All patients were hospitalized and operated on either electively or emergently. According to the order of the surgical interventions performed for the two periods, they are divided as follows:

Table 6. Outcomes by order of surgical intervention after hospitalization

Order of operation	П1	П2	p
Plan	3194	1601	$p<0.05$
Urgent until 6 pm	841	767	$p<0.05$
Urgent w/o 6-12 pm	28	34	$p>0.05$
Urgent M/W 12-24 h	22	30	$p>0.05$
Emergency over 24 h	145	362	$p<0.05$

The clinic performed 3,194 elective surgeries in **the pre-COVID-19 period and 1,601 in the COVID-19 period.**

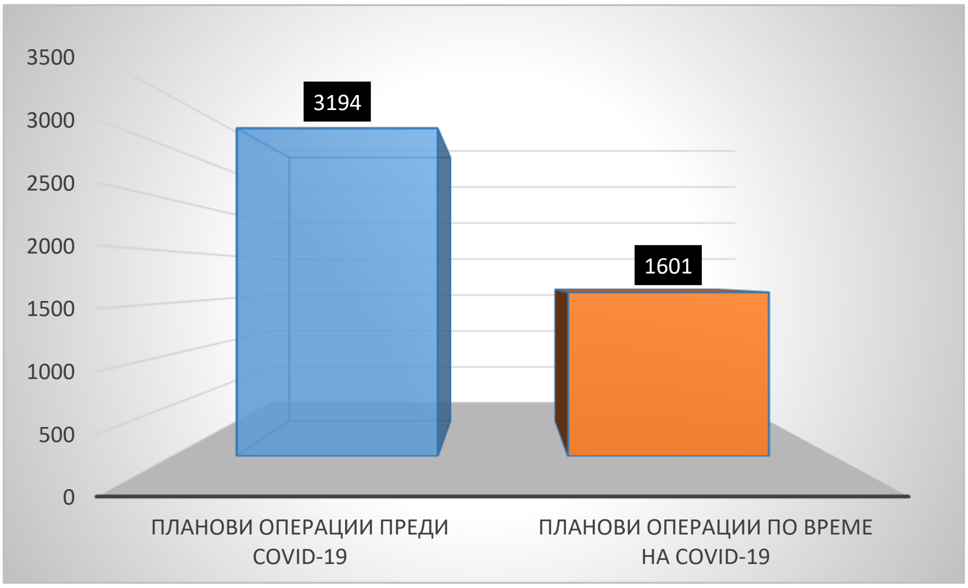


Fig. 6 . Scheduled operations carried out in both periods (number)

We compared the **relative proportions of planned operational interventions** for the two periods:

- H0: P1 = P2 (no statistically significant difference between the two relative proportions)
  H1: P1 ≠ P2 (there is a statistically significant difference between the two relative shares)

- α=0.05
- z-criterion (standard normal distribution)
  k1 = 3194; k2 = 1601; n1 = 4230; n2 = 2794; p1 = 0.755; p2 = 0.573
  zemp. = 15.84
- ztheor. = 1.96
- zemp. = 15.84 > ztheor. = 1.96, therefore we assume H1, i.e. ***there is a statistically significant difference*** between the relative proportions of elective hospitalization**.**

In an online survey conducted by Gravas S et al. urologists from around the world completed an optional online survey from the Société Internationale d'Urologie (SIU). The total number included was 2494 urologists from 76 countries. Of these, 1161 (46.6%) were urologists in academic settings, 719 (28.8%) in private practice and 614 (24.6%) in the public sector. The majority 1074 (43.1%) were from Europe, with the remainder from East/Southeast Asia 441 (17.7%), West/Southwest Asia 386 (15.5%), Africa 209 (8.4%) , South America 198 (7.9%) and North America 186 (7.5%) respectively. The study analyzed differences in responses by region and practice. The results revealed significant limitations in elective surgery with non-specific efforts towards additional precautions to prevent the spread of COVID-19 during emergency surgery. These limitations were less marked in East/Southeast Asia. The limitation of both outpatient clinics and elective surgery is significant globally but is less in East/Southeast Asia. Measures to control the spread of COVID-19 during emergency surgery are general but not specific. In the study, the authors reported a decline of up to 30% in elective surgeries, with an average of 16%. We report similar results to data in the world literature. In our study, there was an 18.2% reduction in elective surgical interventions over the two periods compared to the total. With the indicated chart in **Fig. 7**, we present the indicated comparison.

Another study by Bheenick et al. demonstrated the impact of the pandemic on admissions to a urology clinic of a busy regional multidisciplinary hospital in the United Kingdom. The study included 1092 patients, reporting an overall reduction of 32.5% in the total number of emergency hospital admissions.

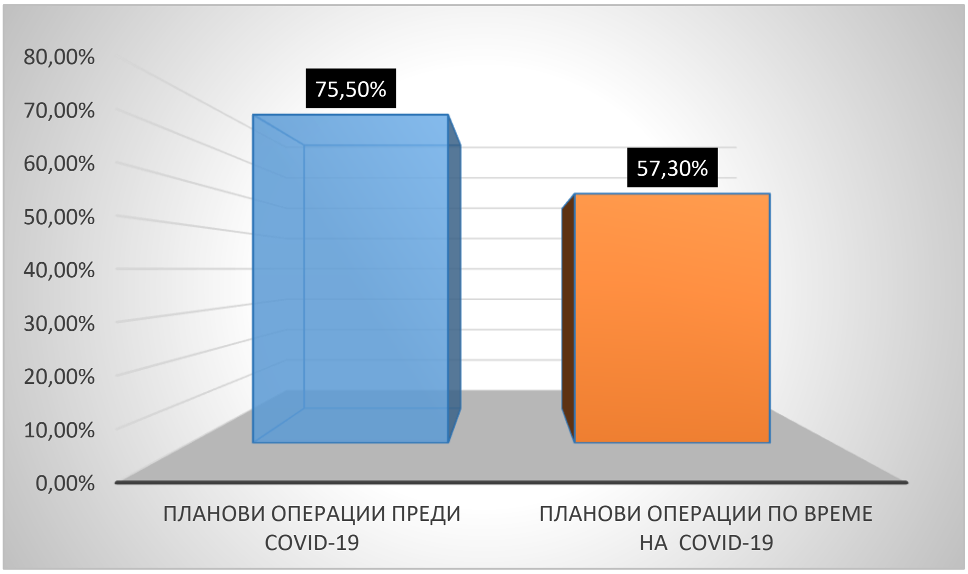


Fig. 7. Scheduled operations carried out in the two periods (% of total)

In the Urology Clinic of the University Hospital "St. Marina" - Varna 841 emergency operations were performed *within 6 h after hospitalization* for the period before COVID-19 and 767 for the period during the pandemic of COVID-19**,** presented **in Fig. 8.**

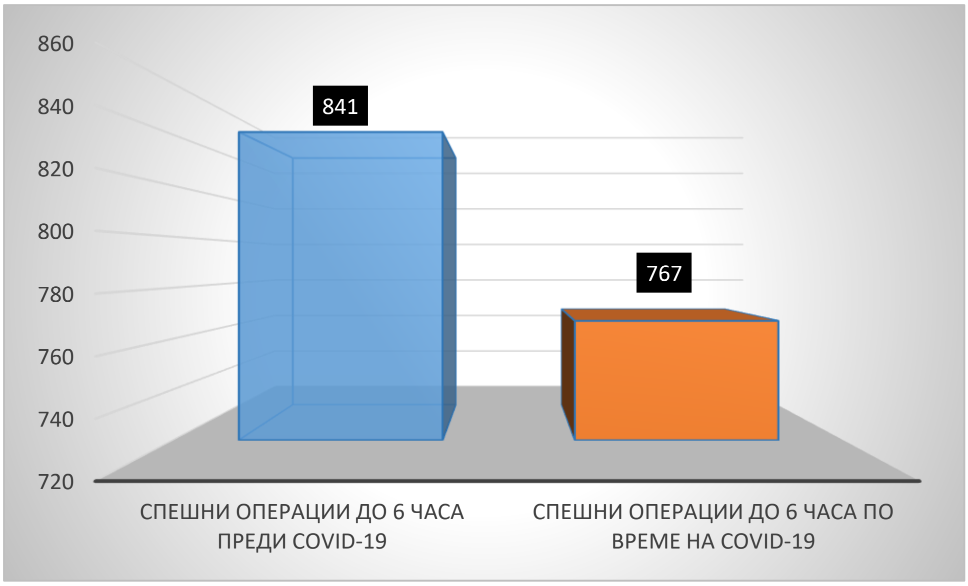


Fig. 8. Emergency operations performed within 6 hours after hospitalization in both periods (number)

We compared the **relative proportions of urgency within 6 hours** for the two periods

- H0: P1 = P2 (no statistically significant difference between the two relative proportions)
  H1: P1 ≠ P2 (there is a statistically significant difference between the two relative shares)
- α=0.05

- z-criterion (standard normal distribution)
- k1 = 841; k2 = 767; n1 = 4230; n2 = 2794; p1 = 0.199; p2 = 0.275
  zemp. = 7.05
- ztheor. = 1.96
- zemp. = 7.05 > ztheor. = 1.96, therefore we assume H1, i.e. **there is a statistically significant difference** between the relative shares of urgency up to 6 hours

In this regard, we compared trends with other research papers. A retrospective study by Gallioli et al.[64] aimed to quantify and characterize the burden of urological patients admitted through the emergency department in Lombardy during the COVID-19 pandemic, comparing it with a reference population from 2019. The authors found that the number of emergency operations was not associated with the COVID-19 outbreak, but increased as a percentage after 10 March 2020, with 8.8% in 2020 versus 2.1% in 2019. In this regard, we report similar results relating to a 7.6% increase in emergency surgical interventions for P2 compared to the total for both periods. With the chart in **Figure 9**, we present the above comparison visually.

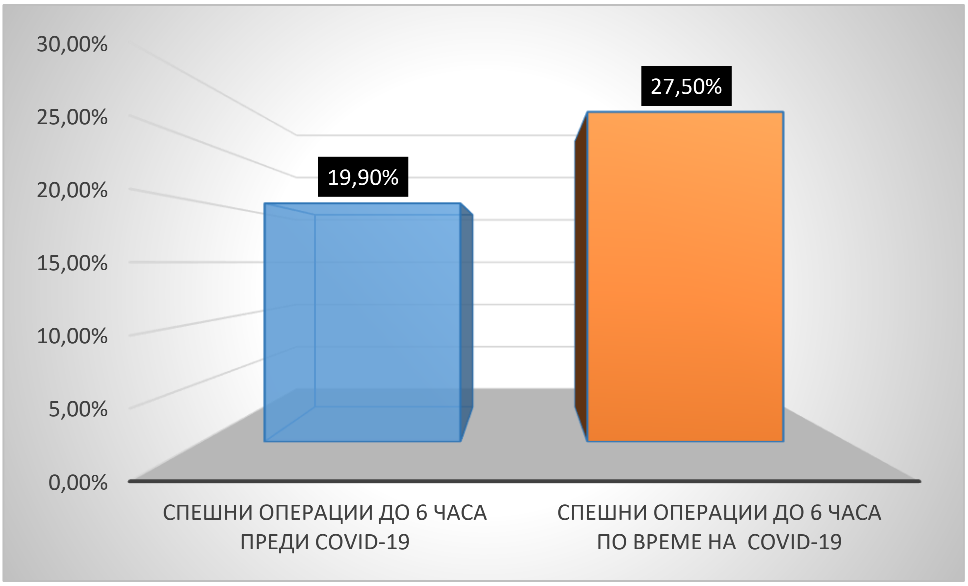


Fig. 9. Emergency operations performed within 6 hours after hospitalization in both periods (% of total)

In our clinic, 28 emergency operations were performed between 6 and 12 h after hospitalization for the **period before COVID-19 and 34 for the period during COVID-19.**

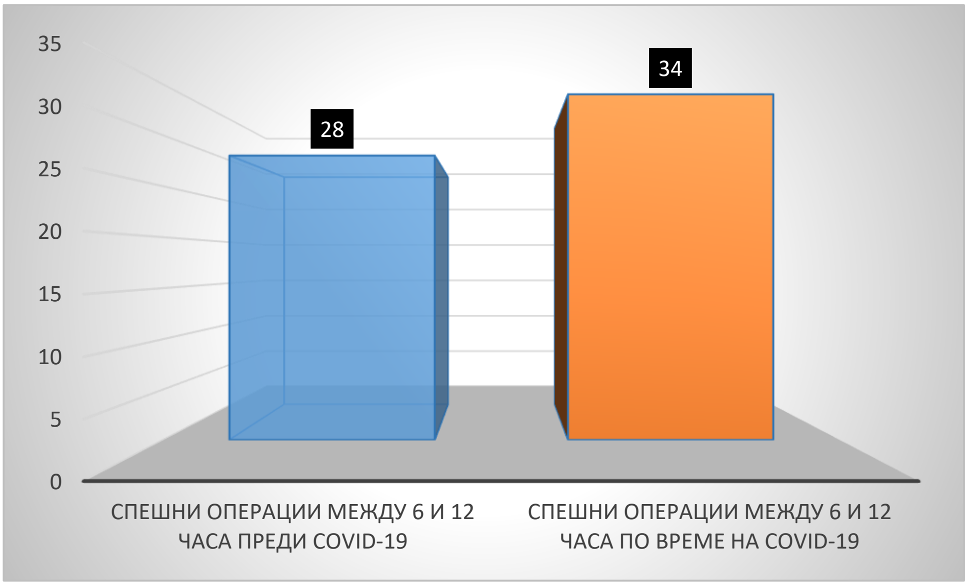


Fig. 10. Emergency operations performed between 6 and 12 hours after hospitalization during both periods (number)

We compared the **relative proportions of urgency between 6 and 12 pm** for the two periods

- H0: P1 = P2 (no statistically significant difference between the two relative proportions)
  H1: P1 ≠ P2 (there is a statistically significant difference between the two relative shares)
- α=0.05
- z-criterion (standard normal distribution)
- k1 = 28; k2 = 34; n1 = 4230; n2 = 2794; p1 = 0.007; p2 = 0.012
  zemp. = 0.86
- ztheor. = 1.96
- zemp. = 0.86 < ztheor. = 1.96, hence we assume H0, i.e. ***there is no statistically significant difference*** between the relative urgency shares between 6 and 12 hours**.**

In this regard, we report a 0.50% increase in emergency surgical interventions over the two periods relative to the total. The difference is not statistically significant **Fig. 11.**

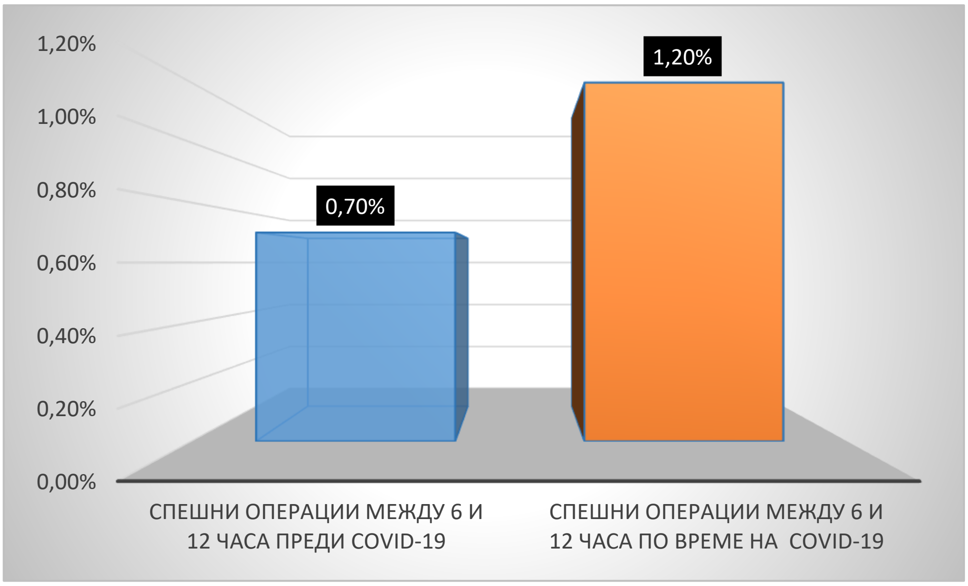


Fig. 11. Emergency operations performed between 6 and 12 hours after hospitalization during both periods (% of total)

The clinic performed 22 emergency operations between 12 and 24 h after hospitalization for the period before COVID-19 and 30 for the period during COVID-19.

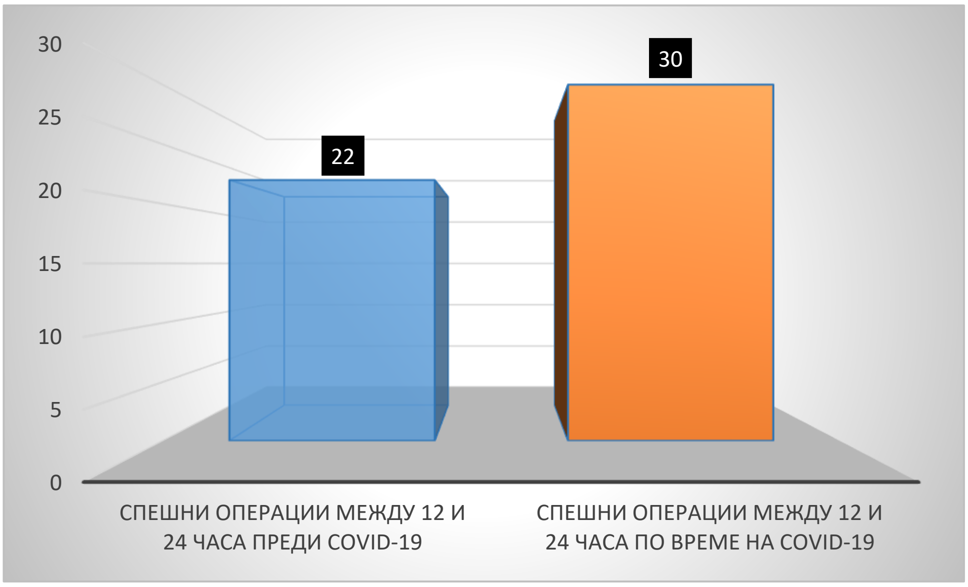


Fig. 12. Emergency operations performed between 12 and 24 hours after hospitalization in both periods (number)

We performed a comparison of the **relative shares of urgency between 12 and 24 h** for the two periods

- H0: P1 = P2 (no statistically significant difference between the two relative proportions)
  H1: P1 ≠ P2 (there is a statistically significant difference between the two relative shares)
- α=0.05

- z-criterion (standard normal distribution)
- k1 = 22; k2 = 30; n1 = 4230; n2 = 2794; p1 = 0.005; p2 = 0.011
  zemp. = 0.78
- ztheor. = 1.96
- zemp. = 0.78 < ztheor. = 1.96, therefore we assume H0, i.e. ***there is no statistically significant difference*** between the relative urgency shares between 12 and 24 hours**.**

In this regard, we report an increase in emergency surgical interventions for both periods by 0.60% compared to the total. The resulting difference is not statistically significant **(Fig. 13).**

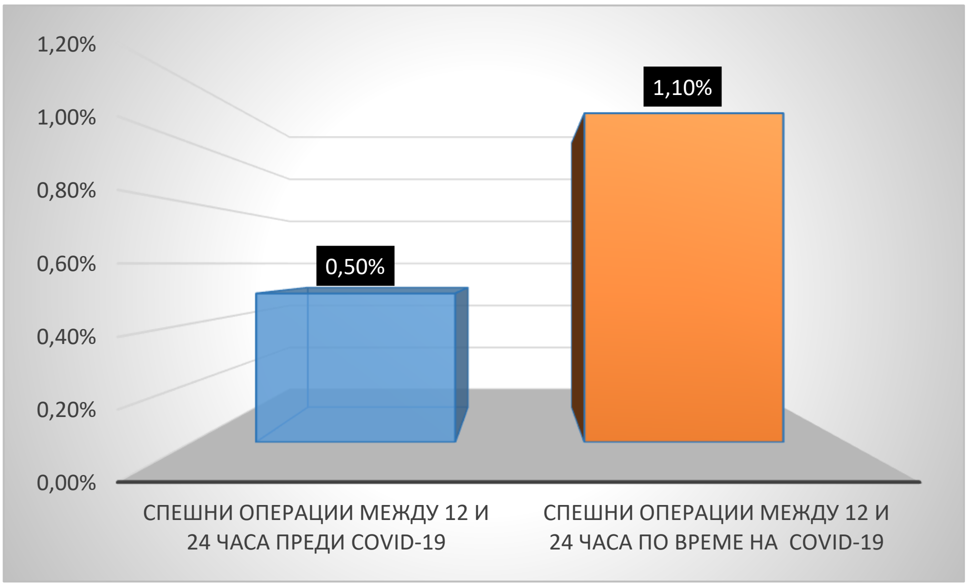


Fig. 13. Emergency operations performed between 12 and 24 hours after hospitalization during both periods (% of total)

The clinic performed 145 emergency surgeries between over 24 h after hospitalization for the **period before COVID-19 and 362 for the period during COVID-19.**

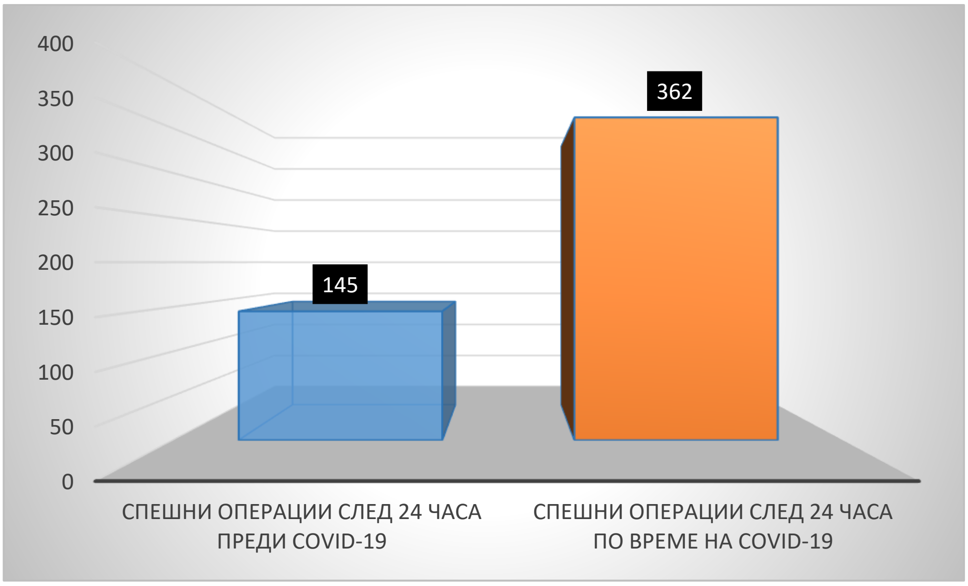


Fig. 14. Emergency operations performed after 24 hours of hospitalization in both periods (number)

We compared the **relative proportions of emergency after 24 hours** for the two periods

- H0: P1 = P2 (no statistically significant difference between the two relative proportions)
  H1: P1 ≠ P2 (there is a statistically significant difference between the two relative shares)
- α=0.05
- z-criterion (standard normal distribution)
- k1 = 145; k2 = 362; n1 = 4230; n2 = 2794; p1 = 0.034; p2 = 0.129
  zemp. = 11.87
- ztheor. = 1.96
- zemp. = 11.87 > ztheor. = 1.96, therefore we assume H1, i.e. ***there is a statistically significant difference*** between the relative urgency shares after 24 hours**.**

Reasons for delaying surgical treatment by 24 hours during the course of a pandemic may include multiple factors. The urology practice at St. Marina" we report the following:

- Lack of available operating rooms due to the presence of other emergencies that require immediate full medical staffing.
- Conduct PCR testing - at the beginning of the pandemic, the finished result was announced every 24 h.
- Delaying other diagnostic procedures (so-called "cavity windows"), such as CT scans, that can help better define the problem and plan treatment.
- The need to consult other specialists, such as anaesthetists and cardiologists, before surgery is undertaken.
- Need to prepare the patient for surgery, including stabilization of other health problems such as hypertension, diabetes, intake of anticoagulants/anti-aggregants or other chronic diseases.

- The need to prepare the operating room itself and the surgical team to ensure the safety and efficiency of the operation.

Naspro et al. reported a 30% reduction in urologic surgical volumes within 15 days of the start of the epidemic. The same authors report a complete cessation on 19 March 2020. This fact is determined by the use of hospital beds for COVID-19 patients. In addition, it is reported that the capacity to perform emergency urological surgeries has been significantly affected due to the lack of anesthesiologists, operating rooms, and ventilators needed for critically ill patients with COVID-19

In this regard, we justify the delay in emergency surgical interventions and their conduct after 24 h for both periods compared to the total number with an increase of 9.5%. With the diagram in **Fig. 15** we present the above comparison visually.

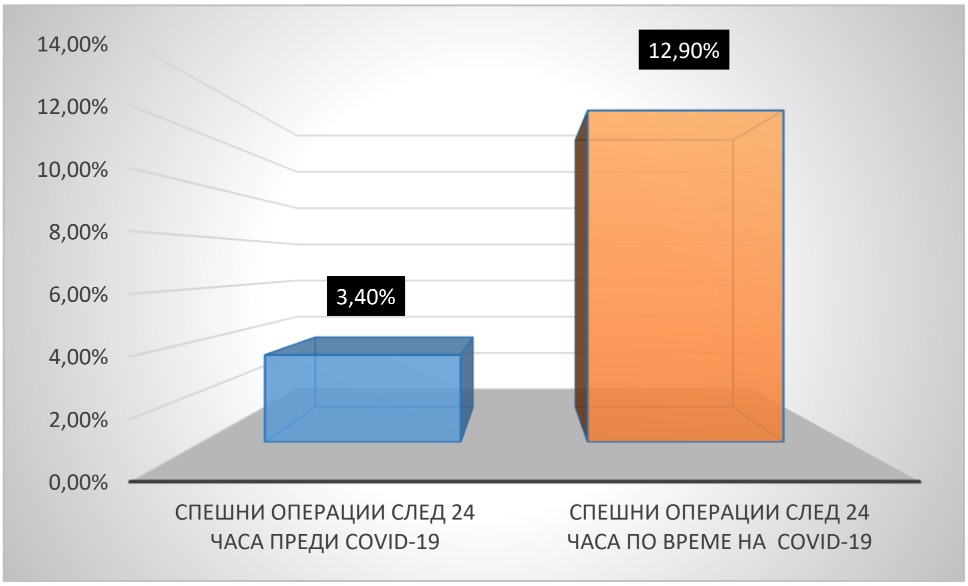


Fig. 15. Emergency operations performed after 24 hours of hospitalization in both periods (% of total)

According to the order of the surgical interventions performed for the two periods, we present the structure of the patients through the diagram in **Fig. 16**:

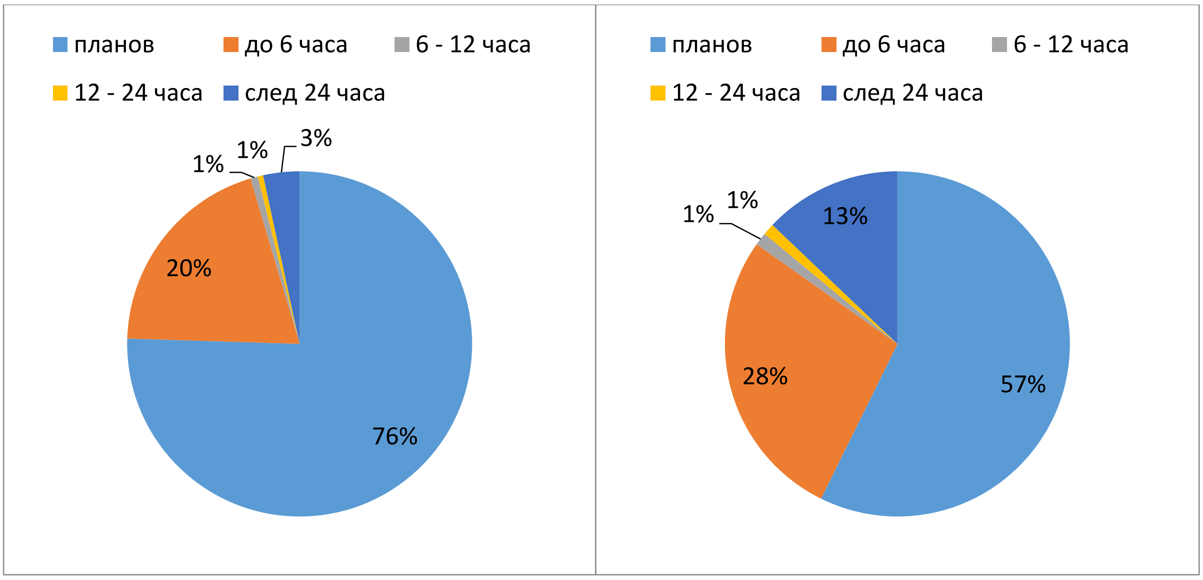


Fig. 16. Structure of the order of operations before **and** during **COVID-19**

The analysis shows a trend of 18% decrease in elective surgeries compared to the total number for both periods, with an 8% increase in emergency interventions up to 6 h after hospitalization and 10% after 24 h.

An important aspect of urologic surgery is anesthesia, which can impact patient outcomes and the risk of COVID-19 transmission. There are three main types of anaesthesia that can be used during urological surgery - general, regional and local anaesthesia. In our study, we divided the types of anesthesia used for the two periods into these three main groups:

Table 8. Results of types of anaesthesia used

Type of anaesthesia		П1	П2	P
General	Number	2792	1943	<0.00001
	%	62.6%	70.1%	
Local	Number	1430	707	<0.00001
	%	31.6%	25.1%	
Regional	Number	255	132	0.0780693
	%	5.7%	4.8%	
	Total	4487	2782	

- *General anaesthesia* - this group includes all anaesthesia with the following general scope - intravenous, inhalation, intubation and combined (intubation + epidural) anaesthesia. Their number was 2792 for the period before COVID-19 and 1943 for the period during COVID-19

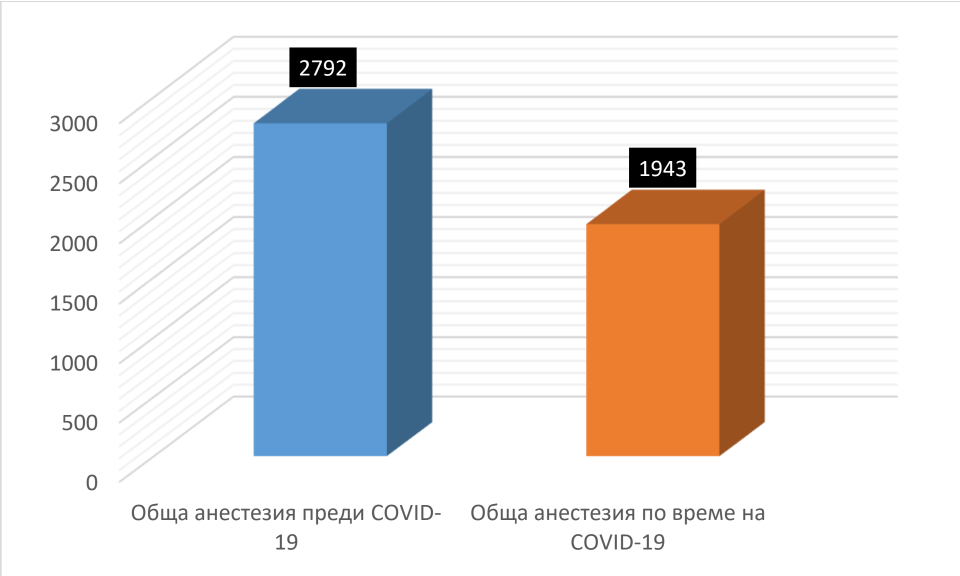


Fig. 17. General anaesthesia operations for both periods (number)

We compared the relative proportions of operations with general anesthesia (intravenous, inhalation, and intubation) for the two periods:

- H0: P1 = P2 (no statistically significant difference between the two relative proportions)
  H1: P1 ≠ P2 (there is a statistically significant difference between the two relative shares)
- α=0.05
- z-criterion (standard normal distribution)
- k1 = 2792; k2 =1943; n1 = 4487; n2 = 2782; p1 = 0.65; p2 = 0.708
  zemp. = 6.47
- ztheor. = 1.96

zemp. = 6.47 > ztheor. = 1.96, we therefore assume H1, i.e. there is a statistically significant difference between the relative proportions of general anaesthesia operations.

In this respect, we present graphically in **Figure 18** the changes characterized by a 6.8% increase for P2 relative to the total.

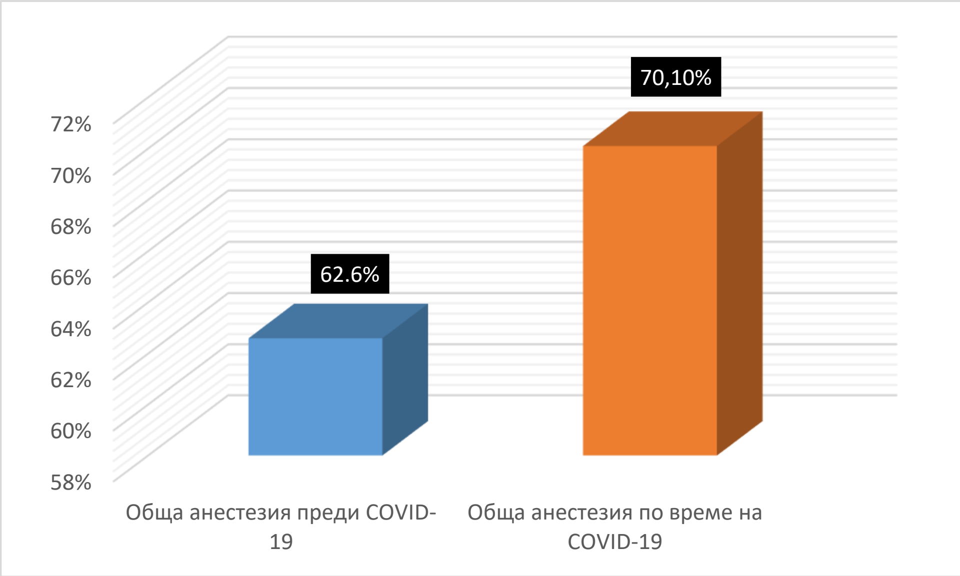


Fig. 18. General anaesthesia operations for both periods (% of total)

- *Regional anesthesia* - all spinal anesthesia is included in this group. Their number was 255 for the period before COVID-19 and 132 for the period during COVID-19.

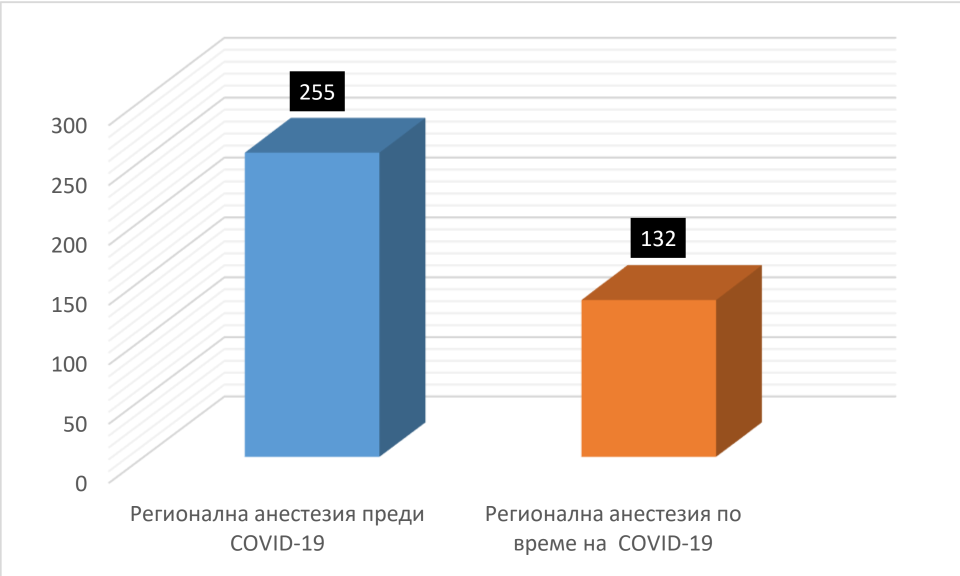


Fig. 19. Operations with regional anaesthesia for both periods (number)

We compared the relative proportions of surgeries with regional anesthesia (spinal) for the two periods:

- H0: P1 = P2 (no statistically significant difference between the two relative proportions)
  H1: P1 ≠ P2 (there is a statistically significant difference between the two relative shares)
- α=0.05
- z-criterion (standard normal distribution)

- k1 = 255; k2 = 132; n1 = 4487; n2 = 2782;
  zemp. = 1.87
- ztheor. = 1.96

zemp. = 1.87 < ztheor. = 1.96, we therefore assume H1, i.e. there is no statistically significant difference between the relative proportions of operations with regional anaesthesia.

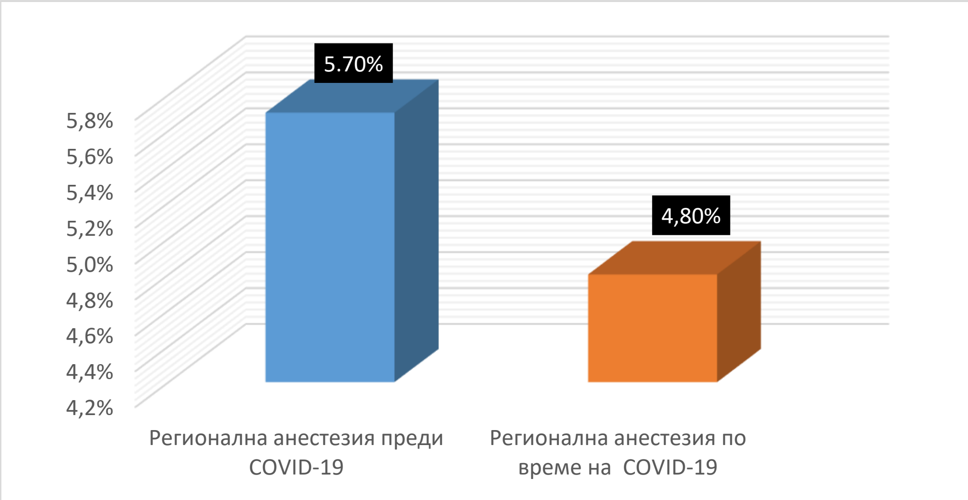


Fig. 20. Operations with regional anaesthesia for both periods (% of total)

In this regard, in **Fig. 20,** we graphically present the changes characterized by a 0.9% decrease for P2 relative to the total number of regional anesthesias used. We take this difference to be statistically insignificant.

- *Local anaesthesia* - this group includes all superficial and infiltration anaesthesia with local anaesthetic. Their number was 1430 for the period before COVID-19 and 707 for the period during COVID-19.

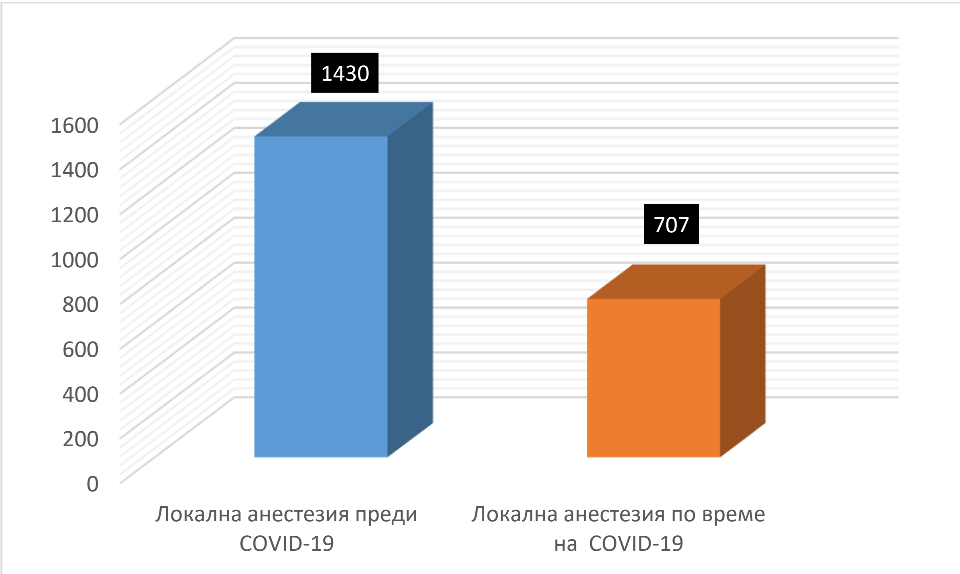


Fig. 21. Operations with local anaesthesia for both periods (number)

We compared the relative proportions of operations with local anesthesia for the two periods:

- H0: P1 = P2 (no statistically significant difference between the two relative proportions)
  H1: P1 ≠ P2 (there is a statistically significant difference between the two relative shares)
- α=0.05
- z-criterion (standard normal distribution)
- k1 = 1430; k2 =707; n1 = 4487; n2 = 2782; p1 = 0.36; p2 = 0.292
  zemp. = 5.90
- ztheor. = 1.96

zemp. = 5.90 > ztheor. = 1.96, therefore we assume H1, i.e. there is a statistically significant difference between the relative proportions of local anaesthesia operations.

Fig. 22 shows the percentage of results relative to the total. We take the 6.5% difference for P2 to be statistically significant.

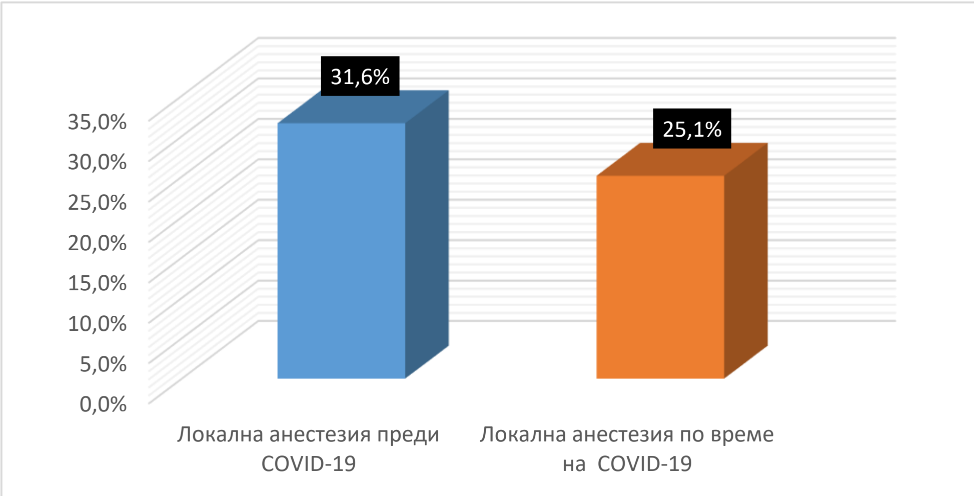


Fig. 22. Operations with local anaesthesia for both periods (% of total)

We present the structure of patients according to anesthesia for both periods:

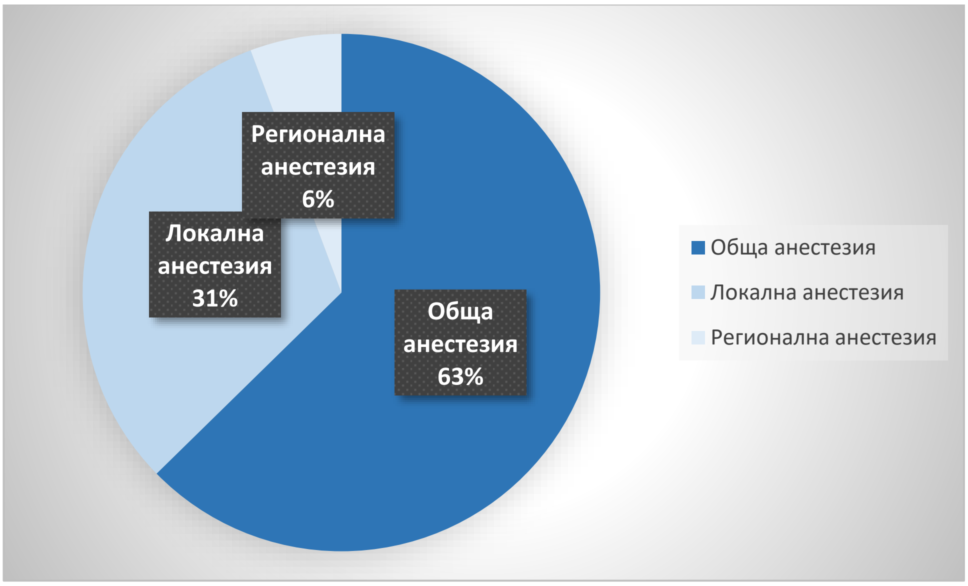


Fig. 23. Structure of operations according to type of anaesthesia in the period before COVID-19

Fig. 24. Structure of surgeries according to type of anaesthesia in the period during COVID-19

The analysis showed a trend of a decrease in local and regional anaesthesia by 6% and 1% respectively, while the administration of general anaesthesia increased by 7%.

In the course of the COVID-19 pandemic, the potential for aerosolization of the virus during intubation and extubation, which are necessary steps in the administration of general anesthesia, was identified. It is important to note that the use of general anaesthesia for urological surgery during the COVID-19 pandemic should be based on several factors: the type and complexity of surgery, the patient's medical history, comorbidities and the availability of equipment. This has set a new guideline for the choice of regional or local anesthesia as an alternative to general anesthesia for some urologic surgeries.

Several studies have investigated the use of regional or local anaesthesia during urological surgery in the context of the COVID-19 pandemic. Uppal et al.[161] found that regional anesthesia can be a safe and effective alternative to general anesthesia for some urologic surgeries, especially those that are less invasive. Another study by Hong A et al. found that transrectal ultrasound-guided prostate biopsy performed under local anesthesia was associated with a lower risk of COVID-19 transmission compared with general anesthesia. The authors' data show that the most painful stage of the procedure was related to the infiltration of local anesthetic in all but one patient. The significant reduction in the pain score was found at the introduction of the TRUS probe and the first pass of the biopsy needle. From the reported results, it is clear that the procedure was not discontinued due to pain, discomfort and no patient required additional analgesia or anaesthetic. 45% of patients described no pain, which is a further argument for good tolerability.

In conclusion, the choice of anaesthesia for urological surgery during the COVID-19 pandemic is an important consideration. While regional or local anaesthesia may only be appropriate in some cases, anaesthetists should carefully assess the risks and benefits of each approach and follow established guidelines to ensure safe and effective treatment.

It remains imperative that guidelines and protocols from local and national health authorities are followed to ensure the safety of both patients and health workers.

In the next part of the study, we compared the following durations of surgical interventions for the two periods:

- from 15 minutes to 7 hours and 30 minutes, and the average operating time e (57 minutes) for the period before COVID-19;
- from 15 min to 6 h and 20 min, and the average operating time e(/1 h and 5 min) for the period during COVID-19.

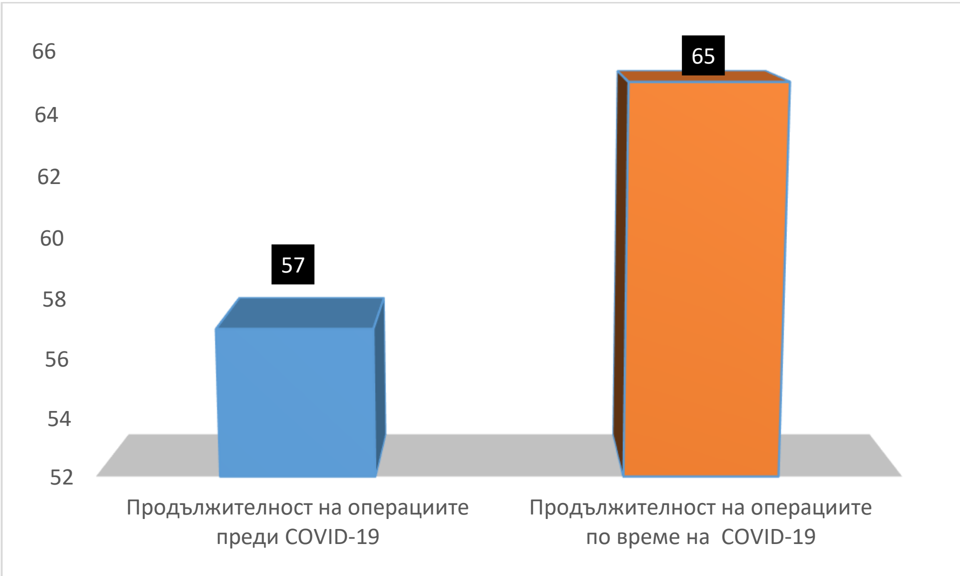


Fig. 25. Average duration of operations for the two periods

One of the concerns during the pandemic was the length of urological surgeries, as longer surgeries can increase the risk of exposure to the virus for both medical staff and patients.

Two studies examined the duration of urological surgery during the COVID-19 pandemic. A study by Porter et al. examined the impact of COVID-19 on surgical team length and length of stay for minimally invasive urological surgery. The study found that mean operative times did not differ significantly between the pre-COVID-19 and COVID-19 periods, suggesting that the pandemic did not have a significant impact on the length of these operations.

The second study by Motterle et al. *analysed the* impact of COVID-19 on the duration of minimally invasive urological surgery. The study found that the mean operative time was longer during the COVID-19 period compared with the pre-COVID-19 period, although the difference was not statistically significant. The authors suggest that this may be due to additional precautions taken during the pandemic, such as the use of personal protective equipment and increased disinfection measures.

We report a mean difference of eight minutes delay, which is statistically insignificant and is argued to be due to the strict use of personal protective equipment and increased disinfection measures.

According to the International Classification of Diseases (ICD9 - CM) procedure codes and the medical procedure coding system (MPCS) in the Republic of Bulgaria, patients were classified into main groups based on clinical diagnosis and/or surgical treatment performed during their stay in the clinic. We defined the following predominant groups of patients hospitalized and operated in the Clinic of Urology of University Hospital "St. Marina" - Varna:

1. Prostate carcinoma - all radical prostatectomies - conventional, laparoscopic and robot-assisted - are classified in this group
2. Bladder carcinoma - all radical cystectomies (conventional, laparoscopic and robot-assisted) and transurethral resections performed are classified in this group
3. Kidney carcinoma and GUT - in this group are classified all partial resections, nephrectomies, nephroureterectomies - conventional, laparoscopic and robot-assisted
4. Carcinoma of the penis - in this group are classified all partial and total penectomies performed
5. Testicular carcinoma - all orchiectomies performed are classified in this group
6. Lymph node dissections - this group includes all lymph node dissections accompanying the main urological malignancy - open, laparoscopic and robot-assisted
7. Urolithiasis - all open, laparoscopic and endoscopic surgeries performed for BCS are classified in this group
8. GUT decubitus operations - all percutaneous nephrostomies and ureteral catheterisations performed with Double J stent are classified in this group
9. BPH - all performed TURP, TULEP, conventional suprapubic adenomectomies, laparoscopic and robot-assisted adenomectomies are classified in this group
10. Benign diseases of the penis, testis and scrotum - this group includes all operations for phimosis, hydrocele, varicocele, cysts of the epididymis and orchidopexy, etc.
11. Subvesical obstructions - this group includes all interna urethrotomies, transurethral incisions of the bladder neck in sclerosis and provision of suprapubic drainage by cystofyx
12. Diagnostic biopsy (TCB) procedures from the prostate (incl. Fusion TCB) and kidney
13. Drainage of lymphocele - in this group are classified all drains performed for lymphocele after lymph node dissection
14. UCC - this group includes all urethrocystoscopies for diagnostic and therapeutic purposes
15. Other urological interventions - this group includes all urological operations performed and not classified elsewhere for benign diseases such as pyeloplasties, ureteral reimplantations, bladder plastics, diverticulectomies, decortications of renal cysts, etc.

In the study, we compare the number of operations for the two periods and the percentage of the total number of interventions performed for the specific period. Proportions that show a statistically significant difference for the two periods are highlighted in red. In **Fig. 26** and **Tab. 9** we present the results of the retrospective analysis.

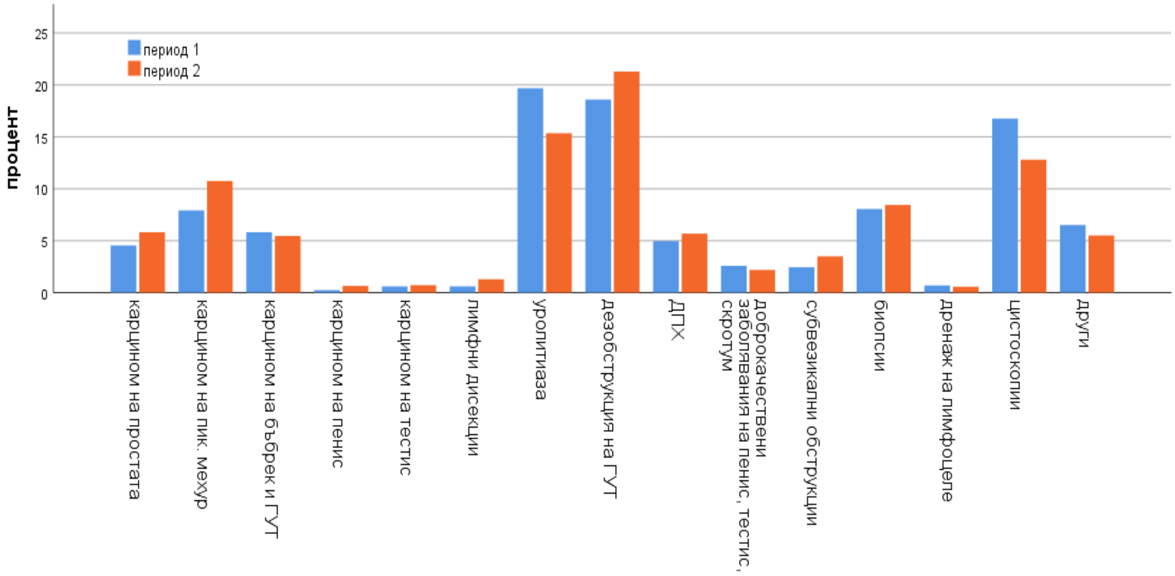


Fig. 26. Results of the number of surgical procedures performed for the two periods

Tab. 9. Results of the number of operational procedures performed for the two periods

Operative procedures in:		Period		P
		BEFORE COVID-19	PANDEMIC COVID-19	
1. Prostate carcinoma	Number	204	162	**0.01556**
	% of total	4.5%	5.8%	
2. Carcinoma of the bladder	Number	355	299	**0.00004**
	% of total	7.9%	10.7%	
3. Kidney carcinoma and GUT	Number	261	152	0.52739
	% of total	5.8%	5.5%	
4. Carcinoma of the penis	Number	11	18	**0.00824**
	% of total	0.2%	0.6%	
5. Carcinoma of testis	Number	27	20	0.54451
	% of total	0.6%	0.7%	
6. Lymph node dissections	Number	27	36	**0.00197**
	% of total	0.6%	1.3%	
7. Urolithiasis	Number	960	512	**<0.00001**
	% of total	19.7%	15.3%	
8. GUT Deconstructions:	Number	834	592	**0.00495**
	% of total	18.6%	21.3%	
9. BPH	Number	223	158	0.18717
	% of total	5.0%	5.7%	
10. Benign obstructions of testis and scrotum	Number	116	61	0.29143
	% of total	2.6%	2.2%	
11. Subvesical obstructions	Number	110	97	**0.00991**
	% of total	2.5%	3.5%	
12. Biopsy procedures for diagnostic purposes	Number	361	235	0.54385
	% of total	8.0%	8.4%	
13. Drainage of lymphocele	Number	31	16	0.54917
	% of total	0.7%	0.6%	
14. Cystoscopies	Number	675	271	**0.00000**
	% of total	16.8%	12.8%	
15. Other plastic and reconstructive interventions	Number	292	153	**0.081330**
	% of total	6.5%	5.5%	
	TOTAL NUMBER	4487	2782	

In the present study, for a more visual presentation of the data, we subdivided the reasons for surgical intervention according to the *leading (principal) diagnosis* into three predominant subgroups:

- Oncourology;
- Urolithiasis;
- Other benign diseases in urology.

The first group are patients with oncourological diseases. Their number is 885 for P1 and 687 for P2.

The spread of the pandemic has led to major changes in the management of cancer, including those affected by genitourinary malignancies. In this context, nearly all urology centers have been forced to prioritize surgical interventions for patients with urologic cancer by implementing a series of constraints on elective approaches to optimize health care resources and minimize the risk of hospital-acquired infection. A panel of experts from Europe and the United States recently proposed a list of urologic procedures that should be prioritized, taking into account factors that include the aggressiveness of each disease (and its stage), the impact of short-term delays in follow-up, care, and the availability of alternative treatments.It should be noted that the focus should be on high-volume urologic oncology, which represents a large proportion of practice in most referral centers.

We compared the relative proportions of surgical interventions for malignancies for the two periods:

- H0: P1 = P2 (no statistically significant difference between the two relative proportions)
  H1: P1 $\neq$ P2 (there is a statistically significant difference between the two relative shares)
- α=0.05
- z-criterion (standard normal distribution)
- k1 = 885; k2 = 678; n1 = 4487; n2 = 2782; p1 = 0.165; p2 = 0.206
  zemp. = 4.75
- ztheor. = 1.96
- zemp. = 4.75 > ztheor. = 1.96, we therefore assume H1, i.e. *there is a statistically significant difference* between the relative proportions of malignancies.

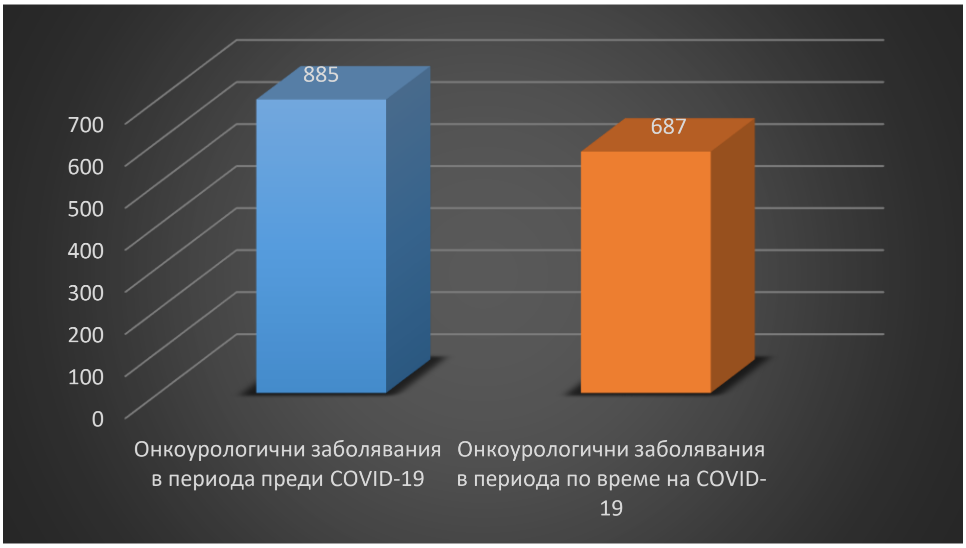


Fig. 27. Onco-urological diseases of patients in both periods (number)

In this regard, we report a decrease of 198 oncourological surgeries for P2, but find an increase of 3.7% in surgical interventions for patients with underlying oncourological disease compared to the total number of surgeries. In **Fig. 28**, we present the above comparison.

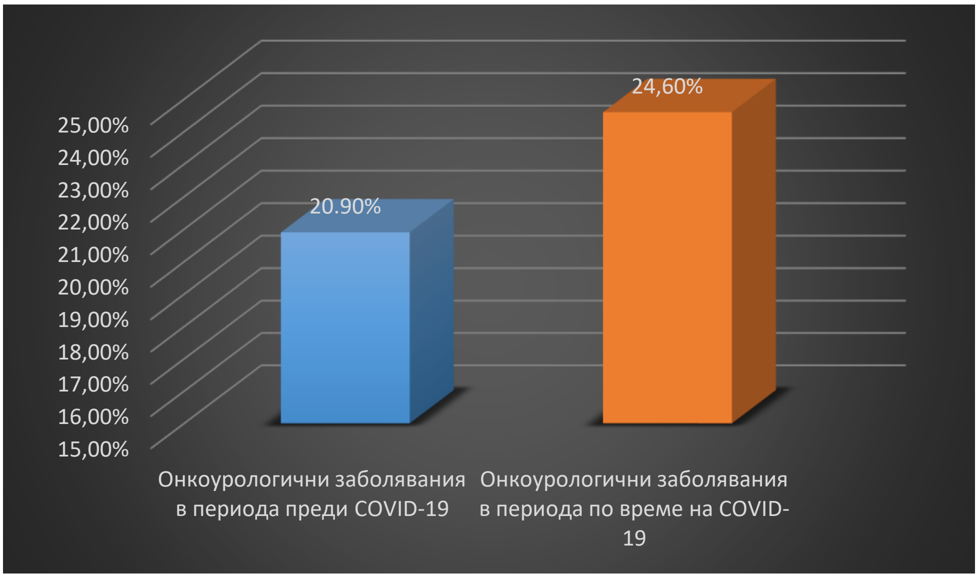


Fig. 28. Onco-urological diseases of patients in both periods (% of total)

Italy is one of the countries in Europe with the highest levels of both mortality and morbidity. A group of experts has published recommendations for prioritising urological surgery in a pandemic setting. The results of the effectiveness of the surgical treatment performed and the guidelines on urological practice are currently yet to be known. An important point is that urological oncology surgery as a whole represents a major challenge. A study of three Italian academic centres that perform high-volume oncourological surgery estimated the annual proportion of operations performed. Of 2387 major oncological interventions, 12.6% of cases underwent radical nephroureterectomy, 17.3% of nephrectomy, 33.9% of radical prostatectomy and 36.2% of radical cystectomy. The study data are consistent with the EMA's recommendations on prioritization strategies during the current COVID-19 pandemic, highlighting the need to better select patients for surgery. The authors found that approximately two-thirds of elective uro-oncologic surgeries could be safely deferred or changed to another treatment modality as a last resort.

On **Tab. 11** we present the results of oncourological surgical activity in the Urology Clinic of the University Hospital "St. Marina" - Varna

Tab. 10. Onco-urological surgical interventions performed for both periods

Oncological disease:		PERIOD П1	PERIOD П2	Total
1. Prostate carcinoma	Number	204	162	366
	% of total	23.1%	23.6%	23.3%
2. Carcinoma of the bladder	Number	355	299	654
	% of total	40.1%	43.5%	41.6%
3. Kidney carcinoma and GUT	Number	261	152	413
	% of total	29.5%	22.1%	26.3%
4. Carcinoma of the penis	Number	11	18	29
	% of total	1.2%	2.6%	1.8%
5. Carcinoma of the testis	Number	27	20	47
	% of total	3.1%	2.9%	3.0%
6. Lymph node dissections in N(+)	Number	27	36	63
	% of total	3.1%	5.2%	4.0%
	Total number	885	687	1572

From the analysis of 687 oncological interventions during the pandemic, 22.1% of cases were radical nephrectomy and nephroureterectomy, and 23.6% were radical prostatectomy.

At the start of the pandemic, for the period 1 January to 1 October 2020, the clinic Anakievsky et al.[2] reported 125 robot-assisted kidney and ureter surgeries performed. Of these, 44 radical nephrectomies for renal cell carcinoma, 14 nephrectomies for renal function, 28 partial nephrectomies, and 8 nephroureterectomies. Prostate carcinoma is the most common type in men in many countries. The choice of the appropriate technique for radical prostatectomy (RP) concerns both patients and urologists. According to the recommendations of the European Association of Urology, bilateral or unilateral nerve-sparing radical prostatectomy remains the first choice for patients with localized prostate cancer, life expectancy greater than 10 years, and normal preoperative sexual function. An initial PSA >20 ng/mL is generally considered an unfavorable prognostic feature in prostate cancer (PCa). High PSA values do not uniformly imply a poor prognosis after surgery. Patients who may benefit most from RP are those with localized prostatic adenocarcinoma and negative lymph nodes. Again, Anakievsky et al. report 137 robot-assisted prostatectomies performed between February 1, 2020, and May 1, 2021. All patients were operated on with the Da Vinci Xi robotic system. The operations were performed transperitoneally with 6 ports, 4 for the robot and 2 for the assistant. The average operative time for the performed operations was 160 min. Minimal blood loss was reported and no blood transfusion or conversion to open surgery was required. Extended pelvic lymph node dissection was performed in about half of the patients due to the high risk of the patients. In conclusion, the authors found that this method achieved a minimally invasive technique with the lowest levels of trauma and postoperative pain. Recovery is significantly faster than open surgery and patients can return to their normal routine in the shortest possible time.

Compared to the other oncological diseases, the largest share was occupied by cases of surgery for bladder cancer - 43.5% of the total number. Lymph node dissections for N(+) (5.2%), radical surgery for testicular cancer (2.9%) and penile cancer (2.6%) accounted for a smaller proportion.

The findings from our study are similar to those associated with the EMA recommendations on prioritization strategies during a COVID-19 pandemic, highlighting the need for better selection of patients for surgery. We find that the proportion of oncology interventions during the pandemic (P2) is higher (24.7%) compared to the same proportion for (P1) at 19.7%. We rationalize the difference of nearly 5% relative to the overall number by patients' faster and easier access to hospital care. In **Tab. 11** we present the differences.

Tab. 11. Operative treatment in relation to the type of underlying disease

Operative treatment for:		Period		Total number
		П1	П2	
Malignant diseases	Number	885	687	1572
	% of total	20.9%	24.6%	21.6%
Benign diseases	Number	3602	2095	5697
	% of total	80.3%	75.3%	78.4%
	Total	4487	2782	7269

Khene et al. examined trends in public online searches for the most common urologic cancers during the COVID-19 pandemic. The authors performed a retrospective analysis using the online tool Google Health Trends, extracting data on online search trends for prostate, kidney, and bladder cancer for five countries (Italy, the United Kingdom, France, Sweden, and the United States). The most significant finding of the study was that during the pandemic of COVID-19 (from 12 January 2020), online interest globally declined significantly for all types of urological cancers, especially for prostate cancer. The results are compared with the same periods in 2018 and 2019, with the most severe decline in the USA. Declining interest may ultimately lead to lower awareness, with potentially clinically meaningful changes in screening and/or early diagnosis pathways for urological cancers. If insufficiently informed, patients may believe that the risks of COVID-19 outweigh those associated with a cancer diagnosis. A consequence of this exposure is delayed diagnosis and reduced participation in screening programs.

The second main group are patients with a primary diagnosis of urolithiasis. Their number was 960 in the period before COVID-19 and 512 in the course of the pandemic.

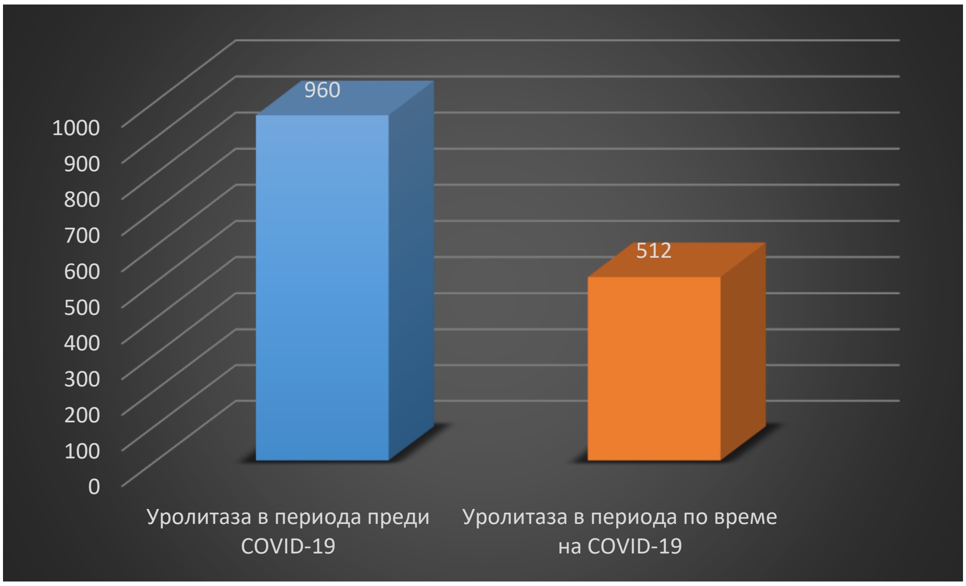


Fig. 29. Urolithiasis of patients during both periods (number)

Urolithiasis, commonly known as kidney stone disease (KD), is a condition characterized by the formation of concrements in the urinary system. These can cause significant pain, discomfort and lead to complications such as urinary tract infections and kidney damage. Urolithiasis typically affects men three times more often than women.

Optimal treatment during a pandemic such as Kovid-19 requires minimal consumption of resources, a reduced number of hospitalizations of patients, and as short a hospital stay as possible.[15] The conservative approach aims at the spontaneous elimination of small concrements up to 5-7 mm from the POS through pain and autonomic symptomatology management. Operative treatment is aimed at breaking and/or removing the stones. Treatment options include cystolithripsy, shock wave extracorporeal lithotripsy (ESWL), ureteroscopy with laser lithotripsy (URS), retrograde intrarenal surgery (RIRS), percutaneous nephrolithotomy (PCNL) or open surgery. The choice of appropriate treatment depends on several factors - the size and location of the nodules, the patient's general condition and comorbidities, the patient's preference and the urologist's experience. Early intervention and prompt treatment are essential to prevent progression and reduce the risk of complications.

We compared the relative proportions of patients with urolithiasis for the two periods:

- H0: P1 = P2 (no statistically significant difference between the two relative proportions)
  H1: P1 ≠ P2 (there is a statistically significant difference between the two relative shares)
- α=0.05
- z-criterion (standard normal distribution)
- k1 = 960; k2 = 512; n1 = 4487; n2 = 2782; p1 = 0.227; p2 = 0.183
  zemp. = 5.61
  ztheor. = 1.96

- zemp. = 5.61 > ztheor. = 1.96, therefore we assume H1, i.e. there is a statistically significant difference between the relative proportions of patients with urolithiasis

The pandemic has led to significant disruption of health services worldwide and has had a major impact on the treatment of urolithiasis. A study by Mazzon et al. is the first retrospective study involving three tertiary referral centers for urolithiasis in China. In it, the authors compared three periods, pre-Covid-19 (A), during the course of the Covid-19 pandemic (B), and post-Covid-19 (C). They evaluated the surgical volume and perioperative outcomes of procedures performed for upper urinary tract concrements. The analysis demonstrates that the COVID-19 pandemic causes significant disruption in both surgical volume and case complexity. Along with a reduced number of patients treated, there was a departure from standard practice prior to COVID-19. They report a 53.3% decrease in the total number of procedures for GUT nodules alone. We mirror the same results with a 53.3% decrease in surgical activity in patients with urolithiasis (lower urinary tract concrements were also included in our study).

We set a similar goal as the Mazzon et al. study, specifically to evaluate and compare the impact of the COVID-19 pandemic on the intracorporeal treatment of patients with upper urinary tract concrements who underwent the St. John's University Hospital Urology Clinic. Marina" - Varna for the two periods - (P1) 2018-2019 and (P2) 2020-2021.

Tab. 12. Operative treatment of GUT concrements for both periods

	Ureterolithotripsy (URS)	Nephrolithotripsy (RIRS+ PCNL)	Total number
П1	460	328	788
П2	213	274	487

A retrospective review of the information on patients treated by URS with laser lithotripsy, RIRS with laser lithotripsy and PCNL in the Urology Clinic of the University Hospital "St. Marina" - Varna for the respective two periods was performed. The analysis of our experience data shows a decrease of almost 39% in the number of surgical interventions for GUT BCS.

In conclusion, it is important to consider the difference for the two periods. We observed a 4.4% decrease between the two periods in the total number of operations performed for urolithiasis. In **Fig. 30**, we present a visual representation of that comparison.

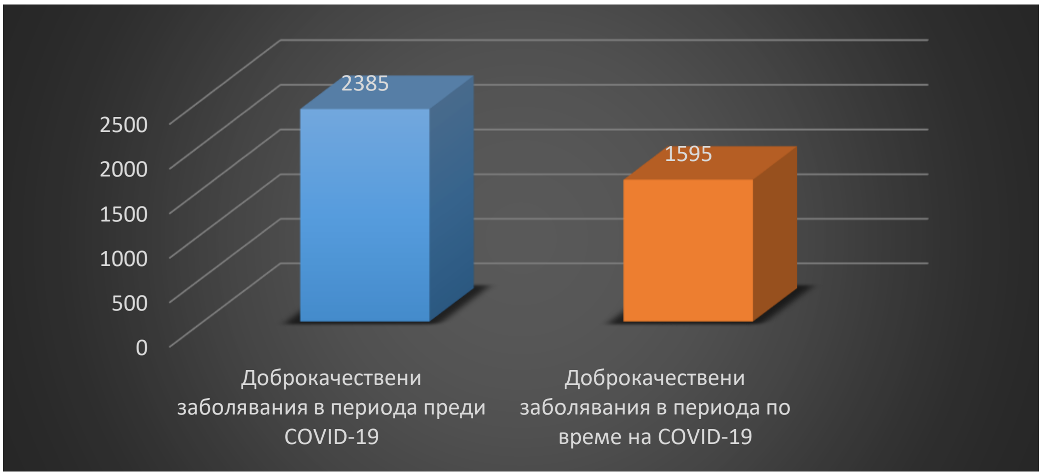


Fig. 30. Urolithiasis of patients during both periods (% of total)

The third group represents the largest share. It includes all other surgical interventions for benign urological diseases. Their number was 2385 in the period before COVID-19 and 1595 in the course of the pandemic.

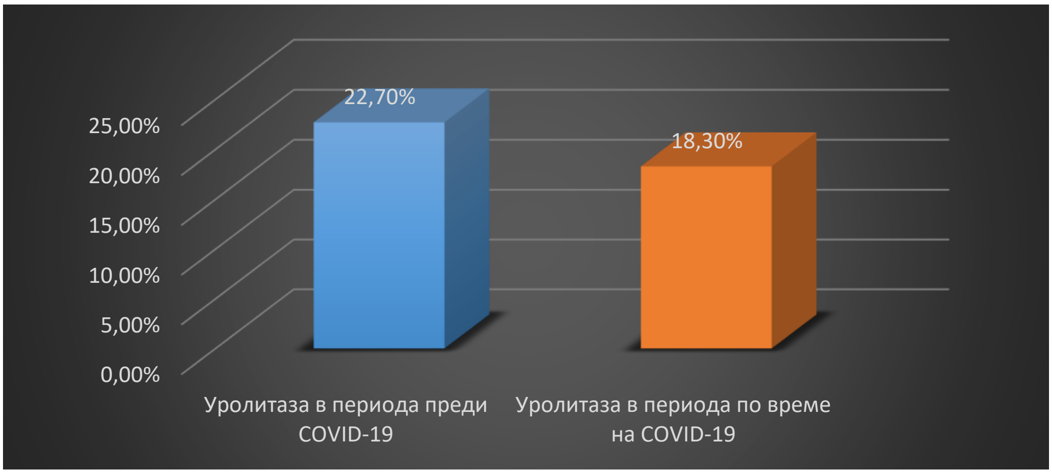


Fig. 31. Benign diseases of patients in both periods (number)

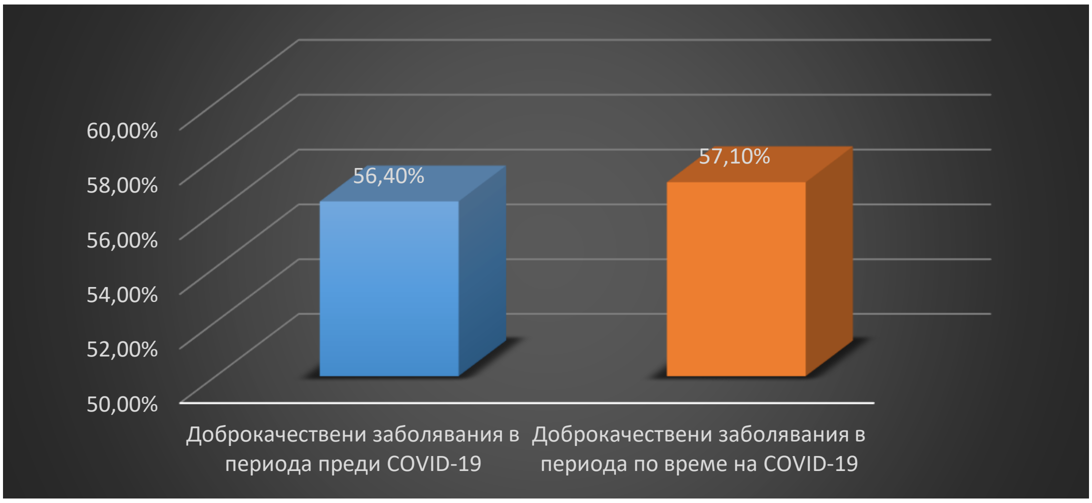
We performed a comparative analysis of the relative proportions of benign diseases for the two periods :

- H0: P1 = P2 (no statistically significant difference between the two relative proportions)
  H1: P1 ≠ P2 (there is a statistically significant difference between the two relative shares)
- α=0.05
- z-criterion (standard normal distribution)
- k1 = 2385; k2 = 1595; n1 = 4487; n2 = 2782; p1 = 0.608; p2 = 0.611
  zemp. = 1.26
- ztheor. = 1.96

zemp. = 1.26 > ztheor. = 1.96, therefore we assume H0, i.e. there is no statistically significant difference between the relative proportions of benign diseases

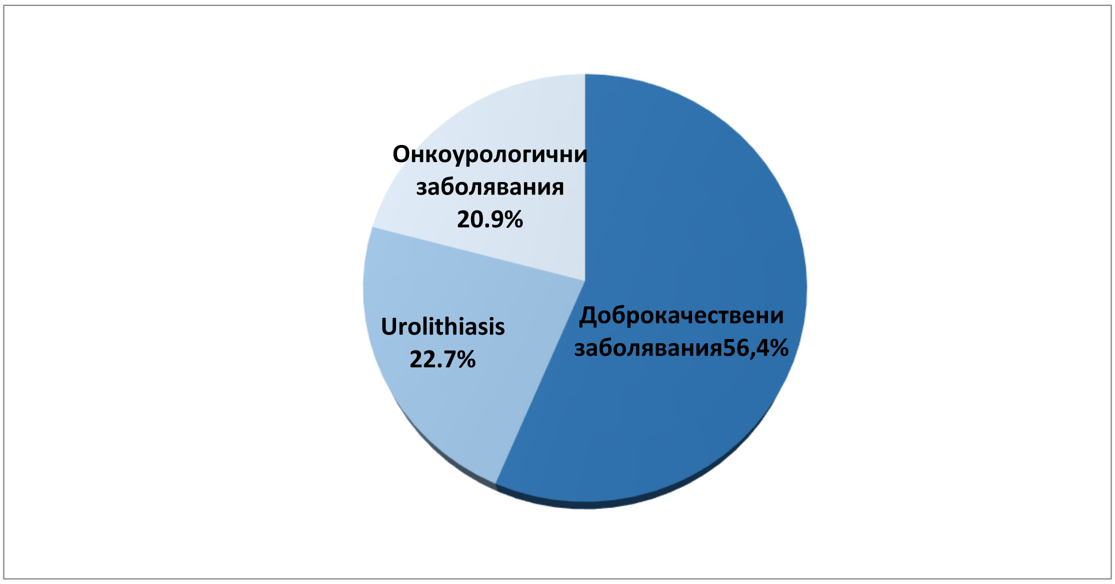
Between them, according to **Tab. 9** we report a minimal difference (0.7% of the total), which has no statistical value. The reasons are argued to be the fact that in the course of the COVID-19 pandemic, elective admissions of patients with benign POC were discontinued.

Fig. 32. Benign diseases of patients in both periods (% of total)



Although their "lower priority" during the COVID-19 pandemic may be understandable, the real problem for the future stems from their significant prevalence in urology practice and the wide range of diseases affected. Delaying these procedures represents one of the most significant challenges to our upcoming workload. On the one hand, such procedures cannot be entirely replaced by alternative strategies such as telemedicine[26] . On the other hand, significant treatment delays are expected, given the benign nature and widespread prevalence in the population, with consequent system-wide overload. These patients are predisposed and may experience a steady progressive deterioration not only in their quality of life but also in the underlying disease. This makes their treatment even more worrisome for urologists because of the potential risks of recurrent, complicated urinary tract infections and antibiotic resistance, especially in patients with indwelling catheters.[56]

We present the structure of the patients according to the type of their disease for both periods:



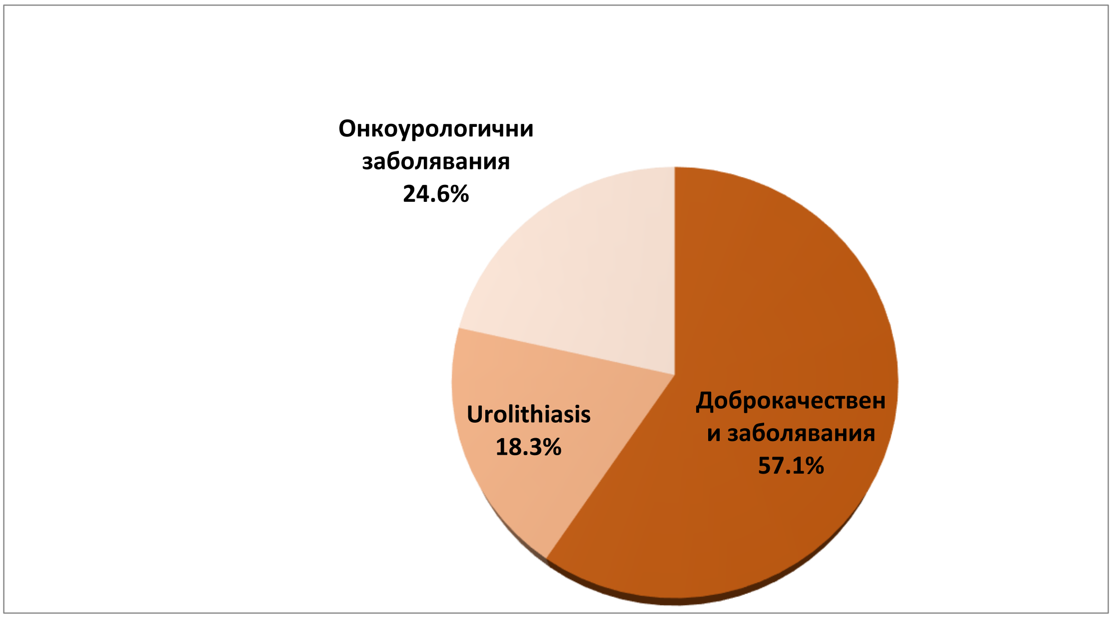


Fig. 33. Structure of patients according to type of disease in the period before COVID-19

Structure of patients according to type of disease in the period during COVID-19

The final conclusion of the analysis shows a trend of 4.4% decrease in hospitalizations of patients with urolithiasis compared to the total number during the pandemic, with a 3.7% increase in hospitalizations of oncological patients and a 0.7% increase in patients with benign urological diseases during the same period.

The COVID-19 pandemic also has a significant impact on diagnostic procedures in urology, including those for prostate cancer. According to the data in the world literature, the main changes and implications can be summarized:

- Defer elective surgeries to ensure sufficient resources to treat patients with COVID-19. Many hospitals and medical centers have postponed elective procedures, including routine screenings for prostate cancer.
- Reduced access to health services. Physical distancing, quarantine and travel restrictions further reduced access to urology services.
- Role of telemedicine - in order to reduce the risk of spreading the virus, many medical practices have switched to telemedicine - online consultations. This has helped patients receive medical care, but there are a number of limitations to conducting physical examinations and diagnostic procedures.

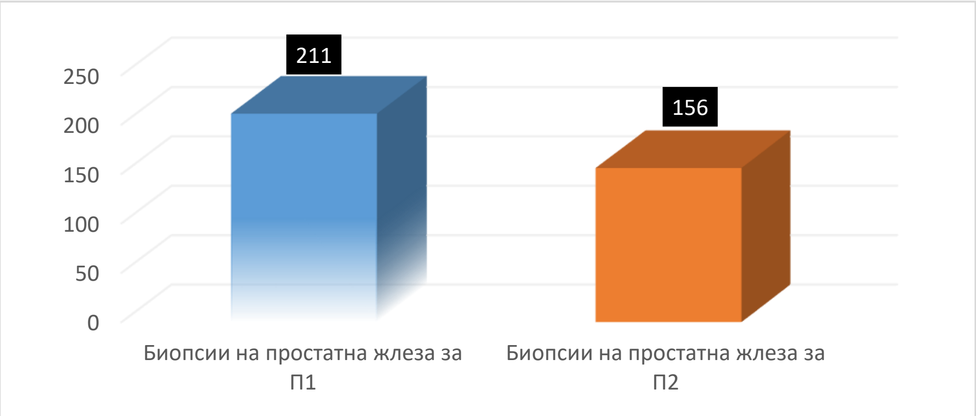
Despite these challenges, the medical community continues to adapt and find ways to provide quality urological treatment during the pandemic. In this regard, we compared the relative proportions of prostate biopsy procedures (via TCB/ Fusion TCB) for the two periods:

- H0: P1 = P2 (no statistically significant difference between the two relative proportions)
  H1: P1 ≠ P2 (there is a statistically significant difference between the two relative shares)
- α=0.05
- z-criterion (standard normal distribution)
- k1 = 211; k2 = 156; n1 = 4487; n2 = 2782; p1 = 0.047; p2 = 0.056
  zemp. = 1.67

zemp. = 1.67 < ztheor. = 1.96, hence we assume H0, i.e. there is no statistically significant difference between the relative proportions of diagnosis by TCB and fusion TCB.

Fig. 35 shows the biopsy procedures performed on patients during both periods (number)

Classical transrectal ultrasound (TRUS) biopsy is a commonly accepted method for diagnosing prostate cancer. A disadvantage of TRUS is the missed clinically significant cancerous masses located in the anterior part of the prostate. This often leads to the diagnosis



of clinically insignificant disease and overtreatment. Multiparametric MRI/ultrasound-guided transrectal fusion prostate biopsy combines MRI imaging with previously delineated sub-specific areas and real-time transrectal ultrasound scanning. In Abushev's study, conducted between July 2019 and September 2022 at the Clinic of Urology of St. Marina University Hospital in Varna, 167 patients underwent fusion biopsy. The Bk5000 ultrasound system with

Predictive Fusion software was used, which allows visualization and biopsy of suspicious MRI areas in real time under ultrasound control. Benign prostatic hyperplasia was found in 87 patients (52%) and adenocarcinoma in 79 patients (47%). The incidence of prostate cancer increased as the PI-RADS class of suspicious areas increased, with 6% of patients having cancer in PI-RADS 2 and 96% in PI-RADS 5. The author concludes that fusion biopsy is an accurate method for the diagnosis of prostate cancer, with the correlation between high PI-RADS grade and clinically significant prostate cancer confirming high diagnostic value.

In the Netherlands, a study by Deukeren et al. In it, the authors used preliminary data from the Netherlands Cancer Registry (NCR) and the National Pathology Network to assess the impact of the pandemic on prostate cancer care, diagnosis and treatment. The published results report an initial 17% decline in prostate cancer diagnoses. Our study reported results of a 55 intervention decrease, but a ~1% increase over the total number of P2 procedures. The results are justified by the introduction of anti-epidemic measures that suspend elective admissions and elective surgical activities in hospital medical care facilities, except for activities related to organ, tissue and cell transplantation, diagnosis and treatment of patients with oncological and oncohematological diseases, assisted reproduction activities, deliveries regardless of the method of delivery, termination of pregnancy activities, rehabilitation activities, continued In Figure **36** we present the above percentage comparison.

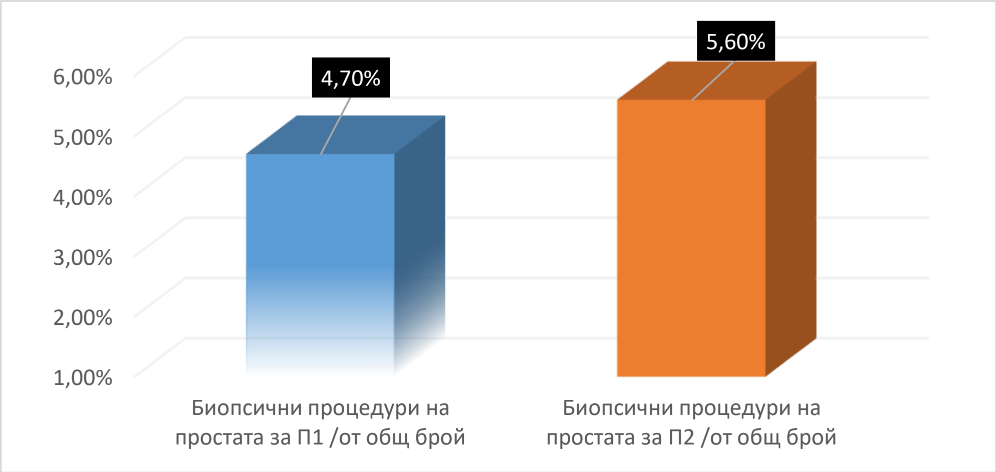


Fig. 36. Prostate gland biopsies in both periods (% of total)

During the COVID-19 pandemic, upper urinary tract decongestion surgeries also underwent changes. Such surgeries are usually performed for complications such as ureteral stones, stenoses, or tumors that can block or disrupt the normal flow of urine. Many hospitals and medical centers have focused on emergency cases and patients at high risk for complications. This meant that upper urinary tract decongestion surgeries may have been performed only in the presence of acute ureteral obstruction, infection, worsening kidney function, or other emergency conditions. There are two main methods to resolve the problem - percutaneous nephrostomy and endoscopic ureteral stent placement.

Percutaneous nephrostomy is particularly useful for obstructions of malignant origin and is primarily used under local anaesthesia. The procedure can be performed under USG, CT or combined USG and Ro control by introducing a "pig tail" catheter into the kidney that drains urine into an external bag to bypass the mechanical stop. We prefer to use this method for severe obstructions and when long-term decompression is needed.

Ureteral stents are used to quickly and minimally invasively resolve obstructions in the upper urinary tract, regardless of the cause. They also prevent complications after surgeries. We use indications for their placement including effective drainage after certain procedures, emergency decubitus in inflammatory diseases, emergency drainage in acute renal colic not amenable to conservative treatment and in patients with hydronephrosis of a single functioning and/or transplanted kidney.

Both methods, percutaneous nephrostomy and ureteral stent placement, are effective for upper urinary tract decompression. The choice of procedure depends on multiple factors, including the location and severity of the obstruction, the patient's health status, his or her preferences, the experience of the treating physician, and the availability of medical resources.

In the present work, we included all surgical interventions performed in the Urology Clinic for the two periods and divided them into two groups according to the type of decompressive intervention:

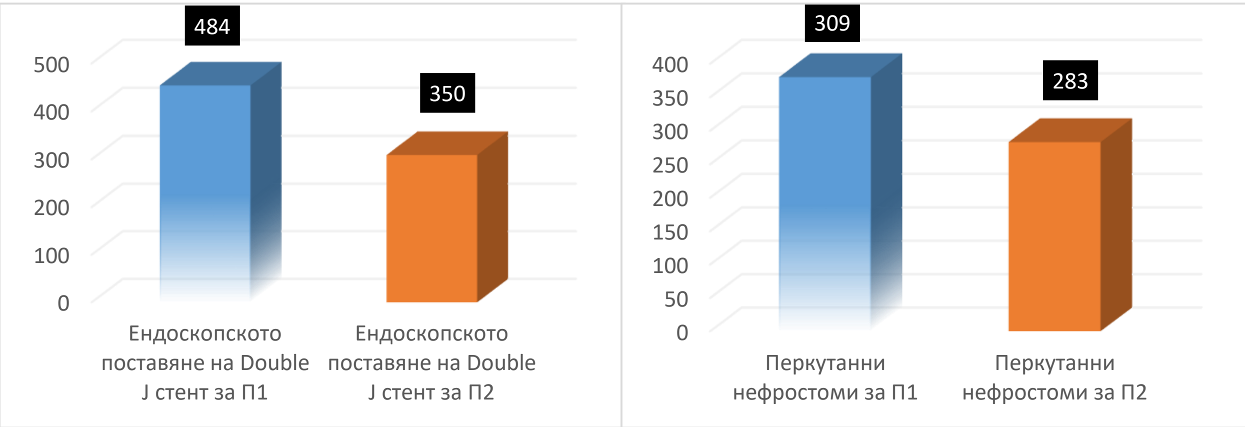
- Percutaneous nephrostomies;
- Endoscopic Double J stent placement;

Figure 37 presents the above groups for the two periods.

Fig. 37. Number of surgical interventions for GUT disobstruction to P1 and P2

Initially, we compared the relative proportions of percutaneous nephrostomies (unilateral and/or bilateral) placed for the two periods:

- H0: P1 = P2 (no statistically significant difference between the two relative proportions)



  H1: P1 ≠ P2 (there is a statistically significant difference between the two relative shares)
- $\alpha=0.05$
- z-criterion (standard normal distribution)
- k1 = 309; k2 = 283; n1 = 4487; n2 = 2782; p1 = 0.085; p2 = 0.101
  zemp. = 2.27
- ztheor. = 1.96
- zemp. = 2.27 > ztheor. = 1.96, we therefore assume H1, i.e. <u>there is a statistically significant difference between the relative proportions of nephrostomies inserted.</u>

While comparing the relative proportions of endoscopic Double J stent placement (unilateral and/or bilateral) for the two time periods, we find that:

- H0: P1 = P2 (no statistically significant difference between the two relative shares)
  H1: P1 ≠ P2 (there is a statistically significant difference between the two relative shares)
- $\alpha=0.05$
- z-criterion (standard normal distribution)
- k1 = 484; k2 = 350; n1 = 4487; n2 = 2782; p1 = 0.101; p2 = 0.111
  zemp. = 1.34
- ztheor. = 1.96
- zemp. = 1.34 < ztheor. = 1.96, therefore <u>we assume H0, i.e. *there is no statistically significant difference* between the relative proportions of stents placed.</u>

In **Fig. 38** we present the results in % of the comparison of specific interventions against the total number of operations performed during the period.

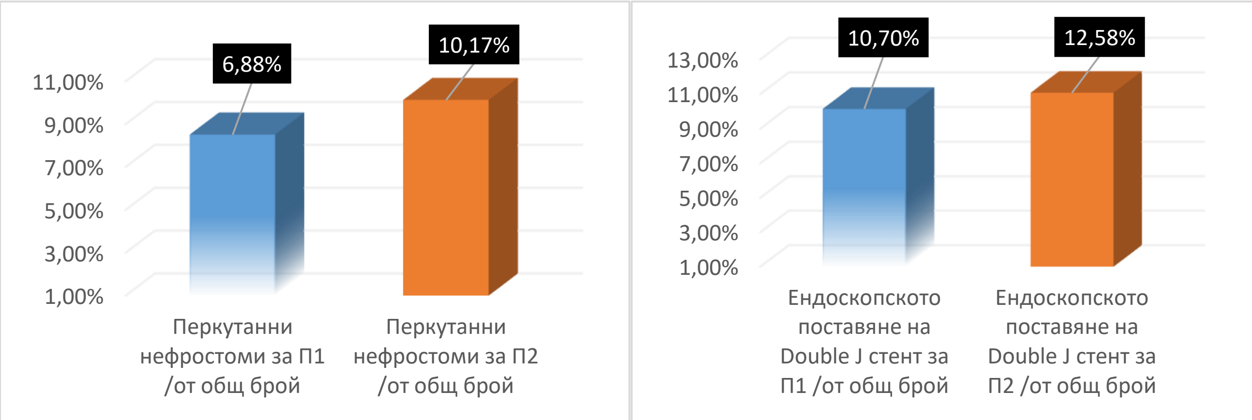


Fig. 38. Operative interventions for GUT decompression to P1 and P2 (% of total number of operations)

This study repeatedly focuses, drawing on evidence in the global literature, on the limited availability of anaesthetists and ventilators during the COVID-19 pandemic. In time, this has had a significant impact on the management of obstructive uropathies, in particular those of GUT. According to Ficarra et al. those procedures that can be performed under local anaesthesia are preferable. Specifically in the treatment of upper urinary tract obstruction, the authors recommend the use of ureteral stents. They argue that ureteral stents allow easier care by the patient at home and a lower risk of complications. However, in the absence of an anesthesia team, both percutaneous nephrostomy and ureteral stenting are recommended as the methods of choice when using local anesthesia. We have accepted these recommendations and report similar results to these, with a higher proportion of ureteral endoprostheses placed compared to the proportion of nephrostomies placed during the course of the pandemic (P2), 350 (12.58%) versus 283 (10.17%).

We set out to investigate the etiologic reasons for ureteral stent or nephrostomy placement by dividing patients into three main groups:

- Malignancies;
- Urolithiasis;
- Benign causes.

We report a total of 1426 manipulations (unilateral or bilateral) for the two periods, with 834 for P1 and 592 for P2. In **Tab. 13** and **Tab. 14** we present the results of the analysis performed for both periods:

Tab. 13. Reasons for percutaneous nephrostomy/double J stent placement for P1

Group Reason	Distribution %	Number of patients
Urolithiasis	54%	451
Malignant	17%	142
Benign	29%	241

Tab. 14. Reasons for percutaneous nephrostomy/double J stent placement for P2

Group Reason	Distribution %	Number of patients
Urolithiasis	60%	355
Malignant	18%	107
Benign	22%	130

From the processed data, it is clear that there was a 6% increase in the number of desobstructive manipulations in patients with urolithiasis and a 7% decrease in patients with benign causes. The proportion of oncological diseases remained without significant dynamics of 1%.

We justify these changes in the context of the COVID-19 pandemic by the following factors:

- Postponed medical examinations and treatment - after the introduction of the emergency epidemic situation in Bulgaria, many people were forced to postpone a number of control and preventive medical examinations. This, in turn, leads to delays in prevention, diagnosis and treatment of urolithiasis.
- The COVID-19 pandemic is a source of stress for many people, which can have a negative impact on their psychological health. Stress can cause changes in eating habits and general health, which can lead to an increased risk of urolithiasis.
- Changing lifestyles - as a result of pandemic-related restrictions, many people have been forced to spend more time at home. This factor affected their physical activity, eating habits and daily water intake.
- Health system strain - the COVID-19 pandemic has affected health systems worldwide. This has led to changes in priorities and resources for treating various diseases, including urolithiasis. In the EMA recommendations, patients with urolithiasis and intermediate priority were classified as those in whom clinical harm was possible but unlikely if delayed for 3-4 months. This in turn leads to an increased rate of eventual complications occurring.

To represent the remaining aspects of our study, we use different statistical methods. They help us to process and analyze the collected data. In this regard, we will consider structure analysis, correlation analysis and regression analysis as the main statistical tools.

In the analysis of structures we used the integral coefficient of structural changes. It is used to compare the same structure for two different periods.

We calculated the integral coefficients of structural change for 4 indicators before and during COVID-19:

- According to the type of disease and the surgical treatment performed

Tab. 15. Structure of patients according to type of disease

Type of disease	Before COVID-19 (number)	During COVID-19 (number)	Before COVID-19 (%)	During COVID-19 (%)
Benign diseases	2385	1595	56.40	57.10
Urolithiasis	960	512	22.70	18.30
Oncourological diseases	885	687	20.90	24.60
Total:	4487	2782	100	100

Ks = 0.445 (indicating the presence of moderate structural changes between the two groups of patients according to disease type).

- Order of surgical intervention after hospitalization of the patient

Tab. 16. Structure by order of operational intervention

Order of operative intervention	Before COVID-19 (number)	During COVID-19 (number)	Before COVID-19 (%)	During COVID-19 (%)
Plans	3194	1601	75.5	57.3
Urgency after 24 hours	145	362	3.4	12.9
Urgency up to 6 hours	841	767	19.9	27.5
Urgency between 6 and 12 pm	28	34	0.7	1.2
Urgency between 12 and 24 h	22	30	0.5	1.1
Total:	4230	2794	100	100

Ks = 0.437 (indicating the presence of moderate structural changes between the two groups of patients according to the urgency of hospitalization).

- Volume /complexity/ of the surgical intervention

Tab. 17. Structure according to the complexity of the operational intervention

Volume /complexity/ of the surgical intervention	Before COVID-19 (number)	During COVID-19 (number)	Before COVID-19 (%)	During COVID-19 (%)
Medium	2058	1217	45.9	43.7
Great	1712	1028	38.2	37.0
Very large	717	537	15.9	19.3
Total:	4487	2782	100	100

Ks = 0.217 (indicating the presence of weak structural changes between the two groups of patients according to the complexity of the operations).

Correlation analysis: using correlation analysis we will determine the relationships between different variables, such as number of cases of urolithiasis, need for desobstructive manipulation, delay in treatment, etc. This analysis will help us to understand how these variables interact with each other and how strongly they are related, giving us information about the important factors that influence urology practice during the pandemic.

All correlation coefficients presented have the cutoff $\alpha < 0.05$ and are statistically significant.

We interpreted the resulting correlation coefficients based on the following table:

Tab. 18. Interpretation of correlation coefficients

Correlation coefficient value	Narrowness (strength) of the connection
0.0	Missing link
0.0-0.1	Very weak connection
0.1-0.3	Weak connection
0.3-0.5	Moderate connection
0.5-0.7	Significant relationship
0.7-0.9	Strong connection
0.9-1.0	Very strong connection
1.0	Functional connection

- **Period before COVID-19 (P1)** for this period we found ***significant correlations*** between the quantities:
  - patient hospital stay and surgical treatment: R = 0.513;
  - Patient hospital stay and number of comorbidities: R = 0.504;

A moderate correlation was observed in the analysis of hospital stay and patient age: R = 0.434 and between patient age and surgical treatment performed: R = 0.412

- **Period during the course of the COVID-19 pandemic (P2)** - for this period we found ***significant correlations*** between the variables:

- Patient hospital stay and operative treatment: R = 0.568;
- patient's hospital stay and number of comorbidities: R = 0.557
- Patient age and surgical treatment: R = 0.504 (significant association);

We obtained a ***moderate correlation in*** the analysis between the patient's hospital stay and his age: R = 0.473

Regression analysis: regression analysis measures correlation-type relationships and examines the shape of the relationship between two or more correlated phenomena. It is established by means of modelling. The model chosen to describe the relationship under study must necessarily have a particular analytical (mathematical) form.

Single-factor regression models

- Period before COVID-19

After processing the information available to us, the following univariate regression models were obtained that met the necessary statistical requirements:

- The impact of the number of comorbidities on hospital stay is presented by regression models in **Table 19.**

Tab. 19. Regression models for the relationship between the number of comorbidities and hospital stay

Models	1	2	3	4	5	6
$\hat{Y}_i = b_0 + b_1 X_i$	2,1211 2,5396	6,231 5,0231	47,63	16,114	2,2306	1,96
$\hat{Y}_i = b_0 + b_1 \ln X_i$	3,4509 2,3631	6,523 5,224	53,36	18,533	2,2328	1,99
$\hat{Y}_i = b_0 + b_1 \frac{1}{X_i}$	1,9931 -0,1687	5,963 -4,216	45,62	17,237	2,2879	1,81
$\ln \hat{Y}_i = b_0 + b_1 X_i$	3,6683 1,4319	2,636 1,994	44,64	2,561	1,5708	1,91
$\ln \hat{Y}_i = b_0 + b_1 \ln X_i$	2,8791 0,0456	2,783 1,235	24,73	1,897	1,9851	1,89

Legend:
1 - Ratios (b_0 , b)₁
2 - Empirical t-criterion values (t)$_{емп.}$
3 - Coefficient of determination (R^2 .100) - %
4 - Empirical values of the F-criterion
5 - Standard model error (□)
6 - Empirical values of the Durbin-Watson criterion (d)

Statistical hypothesis testing of the significance of regression models and their parameters proceeds in the following sequence:
1. Statistical test for adequacy of the regression model - based on Fisher's F-criterion.
2. Statistical test for the significance of the parameters in the regression model - based on the Student's t-criterion.
3. Statistical test for autocorrelation in the residual component - based on the Durbin-Watson criterion.
The theoretical values of F, t and DW criterion are:
1) $F_{Teop.}$ = 3.841
2) $t_{Teop.}$ = 1.645
3) d_L = 1.65; d_U = 1.69
These values are for all one-factor regression models and are at 5% risk of error.

Statistical hypothesis testing is analogous for the other one-factor regression model.

- The effect of patient age on hospital stay is presented by regression models in **Table 20.**

Table 20. Regression models for the relationship between patient age and hospital stay

Models	1	2	3	4	5	6
$Y_i = b_0 + b_1 X_i$	0,1783 0,5158	2,224 3,231	33,77	4,721	3,632	1,98
$\hat{Y}_i = b_0 + b_1 \ln X_i$	0,1678 0,3939	2,029 2,372	31,03	4,265	3,7302	1,91
$\hat{Y}_i = b_0 + b_1 \frac{1}{X_i}$	0,7452 0,3725	1,235 1,741	29,39	3,965	3,9346	1,99
$\ln \hat{Y}_i = b_0 + b_1 X_i$	0,1779 0,3912	1,029 2,985	28,03	3,265	3,7421	1,93
$\ln \hat{Y}_i = b_0 + b_1 \ln X_i$	0,1262 0,2822	2,957 1,225	29,25	3,883	3,9954	1,97

From these tables, the best models describing the individual relationships (the shaded rows in the tables) are selected. We present these models in the following table

Table 21. Univariate regression models

Model No.	Regression models	R^2 .100	$t_{емп.}$	$F_{емп.}$	d
1	$\hat{Y}_i = 3{,}4509 + 2{,}3631 \ln X_i$	53,36	6,523 5,224	18,533	1,99
2	$\hat{Y}_i = 0{,}1783 + 0{,}5158 X_i$	33,77	2,224 3,231	4,721	1,98

On the basis of the obtained single-factor regression models we can make the following generalizations and conclusions:

1) ***Increasing the number of co-morbidities by one results in an increase in hospital stay of 2.3631 or 2 days;***
2) ***Increasing a patient's age by one year results in an increase in hospital stay of 0.5158, or approximately half a day.***

- **Period during the course of the COVID-19 pandemic**

After processing the information available to us, the following univariate regression models were obtained that met the necessary statistical requirements:

- The impact of the number of comorbidities on hospital stay is presented by regression models in **Table 22.**

Table 22. Regression models for the relationship between the number of comorbidities and hospital stay

Models	1	2	3	4	5	6
$\hat{Y}_i = b_0 + b_1 X_i$	3,5363 4,6258	7,536 6,5362	49,78	18,321	1,5369	1,99
$\hat{Y}_i = b_0 + b_1 \ln X_i$	4,3126 3,2611	7,321 6,137	55,18	21,631	1,9132	1,98
$\hat{Y}_i = b_0 + b_1 \frac{1}{X_i}$	2,0236 -0,1869	6,989 -5,318	47,33	19,365	2,0125	1,83
$\ln \hat{Y}_i = b_0 + b_1 X_i$	4,7454 1,6548	3,887 2,214	46,83	4,785	1,8796	1,91
$\ln \hat{Y}_i = b_0 + b_1 \ln X_i$	3,5666 0,0569	2,893 1,565	26,85	3,967	1,5621	1,87

Legend:

1 - Ratios (b_0 , b)$_1$

2 - Empirical t-criterion values (t)$_{емп.}$

3 - Coefficient of determination (R^2 .100) - %

4 - Empirical values of the F-criterion

5 - Standard model error (□)

6 - Empirical values of the Durbin-Watson criterion (d)

Statistical hypothesis testing of the significance of regression models and their parameters proceeds in the following sequence:

1. Statistical test for adequacy of the regression model - based on Fisher's F-criterion.
2. Statistical test for the significance of the parameters in the regression model - based on the Student's t-criterion.
3. Statistical test for autocorrelation in the residual component - based on the Durbin-Watson criterion.

The theoretical values of F, t and DW criterion are:

1) $F_{Теор.}$ = 3.841
2) $t_{Теор.}$ = 1.645
3) d_L = 1.65; d_U = 1.69

These values are for all one-factor regression models and are at 5% risk of error.

Statistical hypothesis testing is analogous for the other one-factor regression model.

- The effect of patient age on hospital stay is presented by regression models in **Table 23.**

Table 23. Regression models for the relationship between patient age and hospital stay

Models	1	2	3	4	5	6

$Y_i = b_0 + b_1 X_i$	0,2163 0,8617	3,363 4,826	36,37	5,221	3,312	1,99
$\hat{Y}_i = b_0 + b_1 \ln X_i$	0,1857 0,5014	2,856 2,812	32,94	4,865	3,5645	1,92
$\hat{Y}_i = b_0 + b_1 \frac{1}{X_i}$	0,8562 0,4456	1,856 2,026	31,45	4,784	3,8563	1,96
$\ln \hat{Y}_i = b_0 + b_1 X_i$	0,1859 0,4369	1,564 3,562	29,45	4,562	3,5263	1,91
$\ln \hat{Y}_i = b_0 + b_1 \ln X_i$	0,1563 0,3326	4,521 1,775	30,24	3,963	3,8651	1,95

From these tables, the best models describing the individual relationships are selected (the shaded rows in the tables).We present these models in the following table

Table 24. Univariate regression models

Model No.	Regression models	R^2 .100	$t_{емп.}$	$F_{емп.}$	d
1	$\hat{Y}_i = 4{,}3126 + 3{,}2611 \ln X_i$	55,18	7,321 6,137	21,631	1,98
2	$\hat{Y}_i = 0{,}2163 + 0{,}8617 X_i$	36,37	3,363 4,826	5,221	1,99

On the basis of the obtained single-factor regression models we can make the following generalizations and conclusions:

1) ***Increasing the number of co-morbidities by one results in an increase in hospital stay of 3.2611 or 3 days;***
2) ***Increasing the patient's age by one year results in an increase in hospital stay of 0.8617 or approximately one day.***

In conclusion, after conducting the overall regression analysis, we can report that in the period before the COVID-19 pandemic (P1), **an increase in the number of comorbidities by one resulted in an increase in hospital stay by 2 days, and an increase in patient age by one year resulted in an increase in hospital stay by approximately half a day**. While for the period during the course of the pandemic (P2), it was trend that **increasing the number of co-morbidities by one led to an increase in hospital stay by 3 days, and increasing the age of the patient by one year led to an increase in hospital stay by approximately one day**.

The EAU has developed guidelines and priorities for dealing with different situations that divide urological diseases and conditions into 4 priority levels:

Low priority: benign urological diseases where clinical harm is very unlikely, with deferral for 6 months;

Intermediate priority: patients with urolithiasis in whom clinical disability is possible but unlikely if delayed for 3-4 months;

High priority: cancer patients in whom clinical progression is highly likely if treatment is delayed for >6 weeks;

Emergency: patients in all three groups where clinical impairment and life-threatening situation has occurred - cannot be delayed for >24 h

As a conclusion of the study and starting from our experience and results, we propose a diagnostic and therapeutic algorithm. It is adapted in the management of urological diseases according to their priority in the context of a health crisis.

VII. DIAGNOSTIC AND THERAPEUTIC ALGORITHM

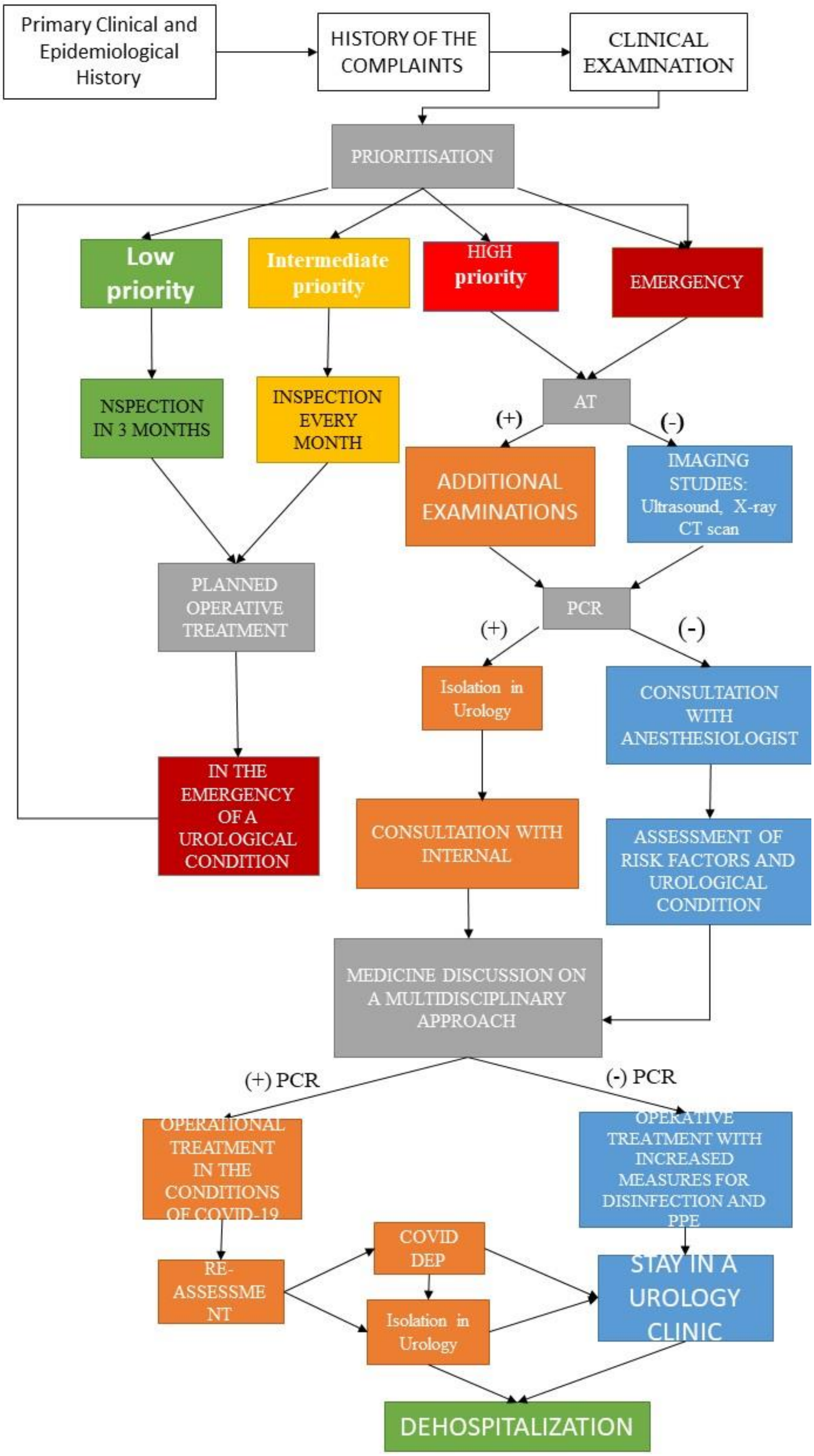


Fig. 39. Diagnostic and therapeutic algorithm

VIII. CONCLUSIONS

1. A decline in operational activity of nearly 24% over the period during the course of the COVID-19 pandemic.
2. Decrease in elective surgeries by 18% compared to the total for both periods, and increase in emergency interventions *within 6 h of hospitalization* by 8% and *after 24 h of hospitalization* by 10%.
3. Decrease in the choice of local and regional anaesthesia by 6% and 1% and increase in the relative proportion of general anaesthesia by 7%.
4. The average operating time before and during the pandemic did not change significantly, with an average delay of 8 minutes due to increased use of personal protective equipment and strict disinfection measures.
5. The proportion of therapeutic procedures in patients with urological malignancies increased by 3.7%, while the proportion of patients with urolithiasis decreased by 4.4%.
6. A 6% increase in decubitus manipulations in patients with complicated urolithiasis and a 7% decrease in patients with obstruction due to benign causes. The proportion of oncologic diseases remained stable (less than 1% difference between the two periods).
7. An increase in comorbidities by one resulted in an increased hospital stay of 3 days, and an increase in patient age by one year resulted in an increase in hospital stay of approximately one day.

IX. CONTRIBUTIONS

1. For the first time in Bulgaria, the impact of the COVID-19 pandemic on urological surgical activity is analysed, and the retrospective data presented can support the management of urological diseases in an emergency epidemic setting.
2. Trends and changes in the order of surgical interventions, choice of anesthesia and their duration are identified.
3. The most appropriate therapeutic procedures for different groups of patients with different urological diseases in the context of the COVID-19 pandemic are compared and analysed.
4. The impact of age and comorbidities on patients' hospital stay is reported, which may help in developing individual patient management strategies and optimizing their treatment and rehabilitation.
5. A diagnostic and therapeutic algorithm has been developed that is consistent with the country's health system and suitable to serve as a model in future epidemic settings of a similar nature.

X. CONCLUSION

This study analysed the impact of the COVID-19 pandemic on urological diseases, including the correlation between various factors such as duration of surgical interventions, choice of anaesthesia, hospital stay and comorbidities. The pandemic caused a significant increase in hospitalizations for COVID patients, leading to a decrease in urological surgeries. We report a 20.44% decrease in hospitalizations, whereas in Europe this decrease reaches 48.6%. The number of surgeries decreased by 23.46% due to the measures implemented to reduce the risk of transmission and to preserve resources such as PPE, hospital beds and staff.

The analysis reflects a trend of 18% decrease in elective surgeries compared to the total for both periods, with an increase in emergency interventions up to 6 h after hospitalization by 8% and after 24 h by 10%. Compared with international data, the results are similar, with a worldwide reported decrease of up to 30% in elective operations with an average of about 16%, while authors in Europe reported an increase of 8.8% in emergency operations, which is similar to our results.

In terms of anaesthesia, the analysis showed a 6% and 1% decrease in local and regional anaesthesia and a 7% increase in general anaesthesia. The choice of anaesthesia was an important factor in urological surgery during the COVID-19 pandemic. Anesthesiologists should assess the risks and benefits of different approaches and follow established guidelines.

The results showed no significant difference in mean operating time before and during the pandemic, but a slight delay was reported due to increased use of personal protective equipment and strict disinfection measures.

The study analyzed surgical interventions in three subgroups: urologic oncology, urolithiasis, and other benign urologic diseases. During the pandemic, urology centers focused on priority surgeries, especially for oncourology patients. This approach was supported by the recommendations of expert panels that proposed a list of priority urologic procedures, taking into account various factors related to the aggressiveness and stage of the disease, the possible consequences of delaying treatment, and the availability of alternative modalities. We report a 4.4% decrease in hospitalizations for urolithiasis and a 3.7% and 0.7% increase in hospitalizations for urologic oncology and benign urologic disease, respectively.

In the present study, we analyzed surgical interventions performed in a urology clinic during two different periods, and we considered the decubitus manipulations, including percutaneous nephrostomies and endoscopic Double J stent placement. We divided the patients into three main groups according to the etiologic causes of the decobstruction: malignancy, urolithiasis, and benign causes. Analysis of the data showed a 6% increase in the rate of disobstructive manipulations in patients with urolithiasis and a 7% decrease in patients with benign causes. The proportion of urological cancers remained without significant dynamics of 1%.

EAU[130] developed guidelines that divide urological diseases into 4 priority levels: low, intermediate, high priority and emergency. These levels are determined by the likelihood of clinical harm and the length of time for which treatment can be deferred without significant consequences:

- **Low priority**: benign urological diseases where clinical harm is very unlikely, with deferral for 6 months;
- **Intermediate priority:** patients with urolithiasis in whom clinical disability is possible but unlikely if delayed for 3-4 months;
- **High priority:** cancer patients in whom clinical progression is highly likely if treatment is delayed for >6 weeks;
- **Emergency**: patients in all three groups where clinical impairment and life-threatening situation has occurred - cannot be delayed for >24 h.

In this regard, a diagnostic and therapeutic algorithm for the management of urological diseases according to their priority in the context of the COVID-19 pandemic was developed and applied in practice.