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**IMPACT OF COVID-19 ON OTORHINOLARYNGOLOGY**

DISSERTATION ABSTRACT

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## LIST OF ABBREVIATIONS:

AAO-HNS	American Academy of Otolaryngology Head and Neck Surgery
AGP	Aerosol-Generating Procedure
AIC	Akaike Information Criterion
ANOVA	Analysis of variance
ARDS	Acute respiratory distress syndrome
AU/ml	Arbitrary Units per Milliliter.
AMA	American Medical Association
AX	Артериална хипертония
BIC	Bayesian Information Criterion.
CAM	COVID-19-Associated Mucormycosis
CAM	COVID-19 асоциирана мукормикоза
COVID-19	Coronavirus disease 2019
ECMM	European Confederation of Medical Mycology
EHNS	European Head and Neck Society
EMR	Electronic medical records
ENT	Ear, nose throat
FFP2	Filtering Face Piece 2
HME	Heat Moisture Exchanger
HNC	Head and neck cancer
HNSCC	Head and neck squamous cell carcinoma
ICD-10	International Classification of Diseases
IRR	Incidence Rate Ratio
JAMA	Journal of the American Medical Association
JB	Jarque-Bera
LamB	Liposomal Amphotericin B
LLR	Log likelihood ratio
MSGERC	Mycoses Study Group Education and Research Consortium
N95	Not resistant to oil respirator that filters at least 95% of airborne particles
OLS	Ordinary Least Squares
OSAS	Obstructive sleep apnea syndrome
PAPR	Powered Air Purifying Respirator
PAS	Periodic Acid-Schiff
PCR	Polymerase chain reaction
PPE	Personal Protective Equipment
RFLP	Restriction fragment length polymorphism
ROCM	Rhino-orbital-cerebral-mucormycosis
RSV	Respiratory syncytial virus
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
SD	Standard deviation
SPSS	Statistical Package for the Social Sciences

## 1. INTRODUCTION

Over recent decades, the global medical community has not faced a challenge comparable in scale and complexity to the coronavirus disease (COVID-19) pandemic, which began in late 2019. In addition to its significant impact on public health, the pandemic exerted considerable pressure on healthcare systems, leading to major changes in the organisation of medical activities, including inpatient care. It resulted in alterations in access to healthcare services, hospital care priorities, and patient flow models. Consequently, hospital operational algorithms underwent a profound transformation. To respond to the exponentially increasing number of patients requiring hospitalisation, individual clinics were reorganised into COVID-19 units, and medical personnel were redeployed.

Of particular importance is the analysis of the effects on highly specialised structures such as otorhinolaryngology (ENT) clinics. Due to the nature of their work, these units were placed in a particularly high-risk position, both in terms of viral exposure and the need to reorganise their clinical activity. ENT practice involves high-risk procedures with significant potential for aerosol generation, which led to the imposition of strict restrictions on routine activities. Early data confirmed that ENT specialists are exposed to a substantially increased risk of SARS-CoV-2 infection due to close contact with patients' upper respiratory tract and the high viral load present in these regions. In response to these new circumstances, many countries implemented major organisational changes in ENT practice. Among the earliest and most rigorously applied measures were the suspension of elective surgical procedures and the limitation of outpatient activity to emergency cases and oncological patients.

All of these factors resulted in disruptions to the diagnosis and treatment of otorhinolaryngological diseases. Studies have documented significant increases in waiting times for elective ENT interventions. In the medical literature, numerous reports have been published describing an increased number of tracheostomies performed during the COVID-19 pandemic, associated with the growing number of patients requiring mechanical ventilation.

Another important aspect of the response was the enhanced protection of healthcare personnel through the use of personal protective equipment (PPE), combined with revised approaches to aerosol-generating procedures aimed at minimising the risk of viral particle transmission. Contemporary reviews emphasise that these changes are not merely temporary adaptations, but are likely to leave a lasting impact on otorhinolaryngological practice through protocol standardisation, improved safety, and increased preparedness for future epidemic or pandemic situations.

Studies have also documented increased levels of psycho-emotional stress among healthcare workers. In Bulgaria, these global trends have taken on a specific local profile. The pandemic exposed numerous vulnerabilities in the organisational structure of healthcare delivery, equipment availability, and safety protocols.

As part of Eastern Europe, the country was characterised by delayed implementation of certain anti-epidemic measures and low vaccination coverage during the early stages of viral spread. After relatively low numbers of registered cases throughout most of the first pandemic year, a significant epidemic surge was observed at the end of 2020, leading to one of the highest recorded excess mortality rates in Europe.

In addition, an increased incidence of severe and rare infections in our geographical region, such as rhinobranhial-orbital-cerebral mucormycosis (ROCM), has seen during the pandemic. Epidemiologically, these cases occurred in the context of several predisposing factors, including diabetes with hyperglycemia, corticosteroid use, oxygen therapy, and immune dysfunction resulting from viral infection.

All these characteristics also influenced the ENT sector. The current lack of detailed published data from Bulgaria suggests the need for targeted studies to document deviations observed during the pandemic period. These changes represent not only a temporary response but also lay the groundwork for analysing long-term consequences and the adaptation of otorhinolaryngological practice in the post-COVID era.

## 2. AIM AND OBJECTIVES

### 2.1 Aim of the study

This study aims to investigate and analyse the impact of the COVID-19 pandemic on the activity of a specialised tertiary otorhinolaryngology (ENT) clinic in the Republic of Bulgaria by comparing hospital activity before and during the COVID-19 pandemic (2018-2021). The analysis focuses on the number and structure of admitted patients, diagnostic profile, age and sex distribution, and the nature of hospitalisations (elective vs. emergency), as well as on surgical procedures performed in the ENT clinic, particularly tracheostomies.

The aim of the conducted survey study was to analyse the experiences, attitudes, and opinions of physicians working in the field of otorhinolaryngology regarding changes in clinical practice resulting from the pandemic. Although subjective, the collected information may be useful for optimising diagnostic and therapeutic processes and improving the organisation of otorhinolaryngological care.

An additional objective of the present study is to monitor and assess the impact of the COVID-19 pandemic on the incidence and structure of rare but clinically significant complications associated with otorhinolaryngological practice, such as rhino-orbital-cerebral mucormycosis (ROCM). Through the analysis of clinical cases diagnosed and treated for the first time in a tertiary healthcare institution during the pandemic, the study aims to identify specific features in the clinical course, diagnosis, and treatment of this life-threatening condition. The research expands beyond the traditional focus on overall hospital activity and surgical interventions and extends its scope to rare but illustrative examples of the pandemic's impact on clinical otorhinolaryngological practice.

### 2.2 Objectives of the study

1. To analyse the dynamics and structure of inpatient activity in the Department of Otorhinolaryngology for the period 2018-2021 by examining as follows: the total number of hospitalisations, the ratio of elective to emergency admissions, patient demographic characteristics, and nosological distribution according to the International Classification of Diseases, 10th Revision (ICD-10).
2. To assess the impact of the COVID-19 pandemic on ENT inpatient care by comparing indicators from the pre-pandemic period (2018-2019) with those from the pandemic period (2020-2021), to identify significant changes in the volume, seasonal dynamics, and structure of hospitalisations.
3. To identify and analyse all tracheostomies performed by the ENT team, including those carried out on patients from other hospital departments, by examining demographic characteristics, originating departments, and leading diagnoses, and to compare trends before and during the pandemic in the context of international data.
4. To conduct and interpret a national survey among otorhinolaryngologists in Bulgaria aimed at evaluating the organisational, clinical, psycho-emotional, and financial effects of the COVID-19 pandemic on the speciality.
5. To perform a clinical analysis of the three cases of rhino-orbital-cerebral mucormycosis (ROCM) diagnosed during the pandemic and to assess the role of COVID-19 as a

predisposing factor for severe secondary fungal infections, in comparison with international observations and therapeutic recommendations.

### 3. MATERIALS AND METHODS

#### 3.1 Materials

##### 3.1.1 Study design

A retrospective, single-centre, descriptive analysis was conducted to investigate the effect of the COVID-19 pandemic on inpatient activity in a tertiary-level otorhinolaryngology (ENT) clinic within the structure of St. Marina University Hospital, Varna. The study spans from January 1, 2018, to December 31, 2021. The number of hospitalisations and surgical interventions (tracheostomies) performed over four years was examined, equally divided into two pre-pandemic years and two pandemic years associated with airborne droplet infection caused by SARS-CoV-2 (COVID-19).

Tracheostomy serves as a representative marker of the workload and functional role of an ENT unit in the context of intensive and emergency hospital care, particularly during the COVID-19 pandemic. Such an analysis allows for assessment of organisational changes, shifts in clinical priorities, and the adaptive capacity of the unit during healthcare crises.

The study includes an analysis of data related to hospitalisations within the ENT clinic itself and to surgical interventions performed on patients hospitalised in other clinical units of the hospital, where procedures were carried out by the ENT team.

By comparing quantitative and qualitative parameters of inpatient activity, the study aims to identify objective indicators of the pandemic's impact on clinical otorhinolaryngological practice.

The questionnaire development and survey organisation were carried out by a team from the Faculty of Medicine and the Faculty of Public Health at the Medical University "Prof. Dr. Paraskev Stoyanov" - Varna. The questions were grouped into the following groups:

- Assessment of the risk of infection
- Assessment of physicians' level of awareness regarding the pandemic
- Changes in otorhinolaryngological practice with respect to:
  - Work organisation;
  - Structure of ENT morbidity;
  - Changes in the structure of ENT emergencies;
  - Changes in the number and morbidity of pediatric patients;
  - Changes in the number and morbidity of oncological patients;
- Assessment of the financial impact of the pandemic on physicians' income
- Assessment of physicians' stress levels

Additionally, an atypical otorhinolaryngological pathology observed exclusively in the context of the COVID-19 pandemic - rhino-orbital-cerebral mucormycosis (ROCM), was described. This condition represents a rare, rapidly progressive opportunistic fungal infection for this geographical region, characterised by angioinvasive growth and high mortality. Although initial clinical manifestations often resemble rhinosinusitis and orbital complications, ROCM is distinguished by its potential for rapid progression and development of severe complications. This underlies the higher scientific and clinical interest in the condition during the COVID-19 pandemic.

Clinical cases of histologically and microbiologically confirmed ROCM, hospitalised and treated in the ENT clinic during the pandemic period (2021-2022), were analysed. These cases are presented in a separate subsection as illustrative examples of rare but clinically significant secondary complications directly associated with SARS-CoV-2 infection and pandemic-related alterations in immune status.

### 3.1.2 Data sources

Information from 2018–2021 was gathered from the Hospital Information System (Gamma Cod Master), covering registries of admitted and discharged patients, outpatient admission records and discharge summaries, operative logs and surgical intervention registries, as well as annual reports on clinic activity. All data were anonymised before statistical processing.

The national survey was conducted between July 2022 and March 2023 using the SURVS.COM platform. The questionnaire was distributed via the mailing list of the Bulgarian Society of Otorhinolaryngology and Head and Neck Surgery after the society granted written approval. Data extraction and processing were performed after approval by the Ethics Committee of the Medical University of Varna (decision No. 118/23.06.2022).

## 3.2 Methods

The following methodological approaches were applied:

1. Documentary method - used for analysis of the content of scientific articles retrieved from academic databases;
2. Survey method - used to investigate the opinions of practising otorhinolaryngologists;
3. Statistical methods.

### 3.2.1 Analysed indicators

1. Total number of hospitalisations - for each calendar year (2018, 2019, 2020, 2021), the total number of hospitalisations in the ENT clinic was calculated and distributed by calendar month. Data were presented as absolute values and compared using percentages, change indices, tables, and graphical visualisation (line and bar charts). Percentage changes during the pandemic were calculated relative to 2018, 2019, and the mean of the pre-pandemic period.
2. Sex distribution of hospitalised patients - hospitalisations were analysed by sex (male/female) for the period 2018-2021, presented as absolute numbers and relative percentages, with calculated percentage changes compared to the pre-pandemic years and the mean of the pre-pandemic period.
3. Age structure of patients - patients were categorised into the following age groups according to the official registry of the National Centre of Public Health and Analyses of the Bulgarian Ministry of Health: children (0-17 years), adults (18-64 years), and elderly ( $\geq 65$  years).
4. Ratio of elective to emergency hospitalisations - admissions were classified as elective (patients referred by a specialist or general practitioner for planned surgical interventions or conservative inpatient treatment) and emergency (patients admitted via the Emergency Department or the admission-consultation unit of the diagnostic-

consultative block). The proportion of elective versus emergency hospitalisations was analysed.

Diagnostic profile of hospitalisations - the distribution of discharge diagnoses was examined. Diagnoses were coded and grouped into categories according to chapters of the International Classification of Diseases, 10th Revision (ICD-10), arranged alphabetically by code groups. A comparative frequency analysis of the most common diagnostic groups was performed by year and between pre-pandemic and pandemic periods.

5. Analysis of surgical activity with a focus on tracheostomies - the total number of tracheostomies performed in the ENT clinic during 2018-2021 was analysed, comparing pre-pandemic (2018-2019) and pandemic (2020-2021) periods. The analysis included all patients hospitalised in the ENT clinic who underwent tracheostomy, as well as patients from other clinical units (intensive care units, COVID-19 wards, pulmonology, neurology, etc.). The distribution of tracheostomies was examined by clinic/department of hospitalisation, type of anaesthesia (local or general), primary ICD-10 diagnosis, and key demographic characteristics.

### 3.2.2 Statistical analysis

Statistical analysis was performed using specialised software: SPSS v.19, Microsoft Excel 365, R v.4.3.1, and Jamovi v.2.3.28. Descriptive statistical methods were applied, including absolute values (case counts), relative frequencies (percentages), mean, median, and standard deviation (SD) for quantitative variables.

The level of statistical significance was set at  $p < 0,05$ .

Data organisation and visualization were compiled in a structured database using Microsoft Excel, SPSS, Jamovi, and the SURVS.COM platform, comprising the following modules: tables of all hospitalisations by year with demographic and clinical variables; a separate database of tracheostomies with annual breakdown and medical characteristics; grouping of diagnoses by ICD-10 for statistical aggregation; visualization of data through charts, graphs, and tables; and anonymized images of histological specimens, microbiological cultures, PCR testing of tissue samples, and CT and MRI imaging.

Graphical presentation complied with standards for scientific clarity and included line graphs (trends), pie charts (structure), and tables with comparative values.

## 4. RESULTS

### 4.1 Comparative analysis of the investigated indicators for the period 2018-2021

#### 4.1.1 Comparative analysis of the total number of hospitalisations by year (2018-2021)

The total number of hospitalised patients in the ENT clinic by year was as follows: 992 cases in 2018, 981 cases in 2019, 703 cases in 2020, and 575 cases in 2021. The data demonstrates a clearly pronounced decline in the number of hospitalisations during 2020 and 2021, which coincides with the onset and progression of the COVID-19 pandemic.

During the first two years (2018 and 2019), the number of hospitalisations remained stable, with a mean annual value of  $986,5 \pm 7,8$  patients. Following the onset of the COVID-19 pandemic in early 2020, a substantial reduction in hospitalisations was observed. During the pandemic period, hospitalisations decreased to  $639,0 \pm 90,5$  patients, representing an overall reduction of 35,5% compared to the pre-pandemic period.

To assess whether the reduction in hospitalisations during the pandemic period was statistically significant, an independent samples t-test was applied comparing the pre-pandemic and pandemic years:

Period	Mean	SD	n
Pre-pandemic	986,5	7,8	2
Pandemic	639,0	90,5	2

Table 1: Mean number of hospitalisations before and during the pandemic

Despite the small number of observations, the results of the t-test demonstrated a statistically significant difference ( $t=4,84$ ;  $df=2$ ;  $p=0,040$ ), confirming the substantial impact of the pandemic on the volume of ENT hospitalisations.

#### 4.1.2 Comparative analysis of the monthly distribution of hospitalisations (2018-2021)

Mean monthly number of hospitalised patients for 2018 -  $82,7 \pm 9,9$  hospitalisations per month; for 2019 -  $81,8 \pm 9,2$  hospitalisations per month; for 2020 -  $58,6 \pm 30,4$  hospitalisations per month; for 2021 -  $47,9 \pm 9,2$  hospitalisations per month.

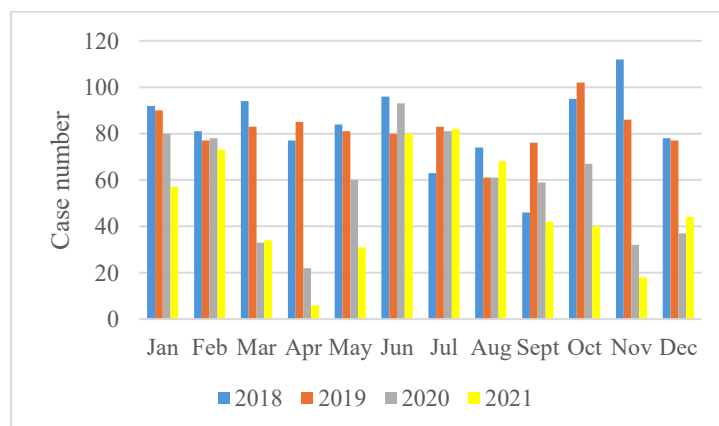


Figure 1: Monthly distribution of the number of hospitalisations in the ENT clinic for the period 2018-2021

A pronounced decline in the mean monthly number of hospitalisations is clearly evident in 2020 and 2021 compared to the two pre-pandemic years. The reduction in 2020 was 29,1% compared to 2018 and 28,4% compared to 2019. In 2021, the decrease was even more substantial - 42,1% relative to 2018 and 41,4% relative to 2019.

Month	Mean number (2018-2019)	Mean number (2020-2021)	Difference	%
January	91,0	68,5	-22,5	-24,7%
February	79,0	75,5	-3,5	-4,4%
March	88,5	33,5	-55,0	-62,1%
April	81,0	14,0	-67,0	-82,7%
May	82,5	45,5	-37,0	-44,8%
June	88,0	86,5	-1,5	-1,7%
July	73,0	81,5	+8,5	+11,6%
August	67,5	64,5	-3,0	-4,4%
September	61,0	50,5	-10,5	-17,2%
October	98,5	53,5	-45,0	-45,7%
November	99,0	25,0	-74,0	-74,7%
December	77,5	40,5	-37,0	-47,7%

Table 2: Comparative analysis of the mean monthly number of hospitalisations for the period 2018-2021

Statistical analyses of monthly differences between the pre-pandemic and pandemic years were performed, including t-tests and analysis of variance (ANOVA). Across the 12 months, hospitalisations decreased by an average of approximately 28,5%, and this reduction was highly statistically significant ( $t\text{-test}=-4,34$ ;  $df=11$ ;  $p \approx 0,0013$ ). A two-factor repeated-measures ANOVA with two factors-“year” (2018-2021) and “month” (January-December) was conducted to assess the influence of both year and month on the number of hospitalisations. The analysis demonstrated the following results: a significant main effect of year ( $F(3,44)=11,92$ ;  $p<0,001$ ), month ( $F(11,44)=2,74$ ;  $p=0,009$ ), and year  $\times$  month interaction ( $F(33,132)=1,98$ ;  $p=0,006$ ).

While the pre-pandemic years exhibited clearly defined seasonality with peaks during the winter months, the pandemic years were characterised by: a marked decline in hospitalisations during spring and winter, partial recovery during the summer months, and a complete disruption of previously established seasonal patterns.

#### 4.1.3 Comparative analysis of patient age distribution for the period 2018-2021

The age structure of hospitalised patients for the period 2018-2021 is presented in three main groups: children under 18 years of age, adults aged 18-64 years, and patients aged over 65 years. The data indicates that the largest proportion of hospitalisations occurred among adults aged 18-64 years, followed by children aged 0-17 years. Patients older than 65 years accounted for less than 20% of all cases.

In 2018, children under 18 years comprised 27,6% of all hospitalised patients. In 2019, the proportion was similar (24,3%), with adults aged 18-64 years representing the largest group (59,6%). Patients aged over 65 years accounted for 13,4% in 2018 and 16,1% in 2019. During 2020 and 2021, the proportion of pediatric patients declined slightly, reaching 20,5% of all hospitalisations in 2021, while the share of elderly patients ( $\geq 65$  years) remained relatively stable, reaching 18,6% in 2021.

A Welch's t-test was performed to compare the pre-pandemic and pandemic periods. A statistically significant decrease in hospitalisations between the pre-pandemic and pandemic periods was identified only in the pediatric group, whereas among adult patients, a downward trend was observed that did not reach statistical significance. This is likely due to the small number of observations and greater variability.

Age group	Mean number (2018-2019)	Mean number (2020-2021)	p-value (t-test)
Children (<18 yrs)	256,0 $\pm$ 25,5	133,0 $\pm$ 21,2	0,0121
Adults (18-64 yrs)	540,0 $\pm$ 63,6	391,5 $\pm$ 58,7	0,136
Adults (>65 yrs)	145,5 $\pm$ 17,7	114,5 $\pm$ 10,6	0,195

Table 3: Results of the t-test for the different age groups of hospitalised patients

#### 4.1.4 Comparative analysis of sex distribution of hospitalised patients for the period 2018-2021

Throughout the entire study period, a relatively even distribution between the sexes was observed, with the number of male patients being slightly higher than that of female patients.

Year	Men	Women	Total
2018	517	475	992
2019	512	469	981
2020	366	337	703
2021	301	274	575

Table 4: Sex distribution of hospitalisations for the period 2018-2021

To determine whether these differences were statistically significant, an independent sample t-test was performed between the two periods. The results were as follows: men ( $t=5,14$ ;  $df=2$ ;  $p=0,116$ ) and women ( $t=5,72$ ;  $df=2$ ;  $p=0,110$ ). These values do not reach statistical significance at the conventional level of  $p<0,05$ . Therefore, the change in sex distribution does not demonstrate a statistically significant difference between the pre-pandemic and pandemic periods.

#### 4.1.5 Comparative analysis of hospitalisations by urgency for the period 2018-2021

All types of emergent cases (within 6 hours, within 24 hours, and after 24 hours) were grouped into a single category of "emergency hospitalisations", while planned admissions were analysed as a separate category (elective hospitalisations).

Year	Elective	% of total	Emergency	% of total
2018	810	81,7%	182	18,3%
2019	741	75,5%	240	24,5%
2020	481	68,4%	222	31,6%
2021	335	58,3%	240	41,7%

Table 5: Distribution of hospitalisations by urgency in the ENT clinic for the period 2018-2021

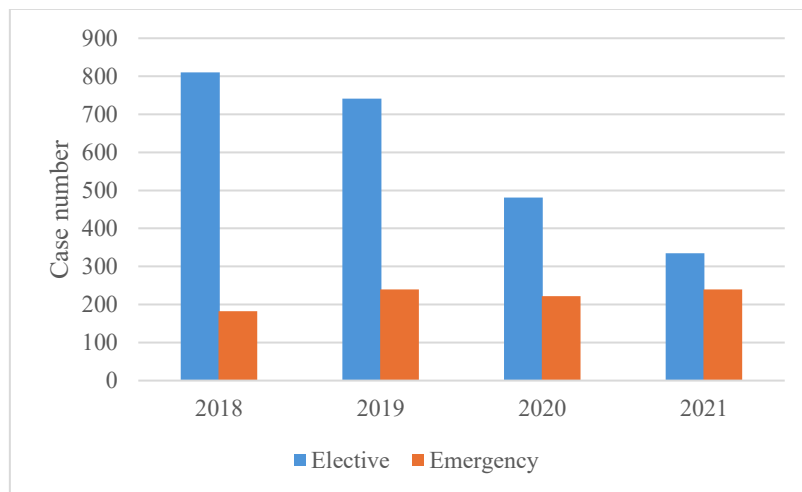


Figure 2: Distribution of hospitalisations by urgency in the ENT clinic for the period 2018-2021

Based on pooled data from the pre-pandemic and pandemic periods, the following mean values were calculated for elective hospitalisations: mean number before the pandemic ( $775,5 \pm 48,8$ ) and mean number during the pandemic ( $408,0 \pm 103,2$ ). For emergency hospitalisations, the respective values were the mean number before the pandemic ( $211,0 \pm 41,0$ ) and the mean number during the pandemic ( $231,0 \pm 12,0$ ).

An independent samples t-test was performed to compare the number of hospitalisations in the two categories between the pre-pandemic and pandemic periods: elective hospitalisations ( $t(2)=2,343$ ;  $p=0,081$ ) and emergency hospitalisations ( $t(2)=-0,664$ ;  $p=0,614$ ). The results indicate that no statistically significant difference was observed, although the  $p$ -value for elective hospitalisations was borderline. The absolute number of emergency hospitalisations remained relatively stable, without a statistically significant difference between the two periods. However, a proportional increase in their share of total admissions was observed—from 18,3% in 2018 to 41,7% in 2021.

#### 4.1.6 Comparative analysis of the distribution of hospitalised patients by diagnosis according to ICD-10 for the period 2018-2021

To assess the statistical significance of differences between the pre-pandemic and pandemic periods, the chi-square ( $\chi^2$ ) test for independence was applied, and corresponding  $p$ -values were calculated for each ICD-10 diagnostic group.

ICD-10	Pre-pandemic (n=1973)	%	Pandemic period (n=1278)	%	$\chi^2$	p
C	197	10,0%	194	15,2%	19,14	<0,001
D	135	6,8%	74	5,8%	1,19	0,276
H	129	6,5%	115	9,0%	7,85	0,005
J	1160	58,8%	597	46,7%	39,44	<0,001
K	13	0,7%	15	1,2%	2,47	0,116
L	104	5,3%	66	5,2%	0,01	0,919
M	33	1,7%	13	1,0%	2,57	0,108
Q	22	1,1%	21	1,6%	1,44	0,230
R	83	4,2%	36	2,8%	4,63	0,031
S	34	1,7%	30	2,3%	1,30	0,254
T	52	2,6%	114	8,9%	56,27	<0,001
Z	2	0,1%	2	0,2%	0,04	0,839
Other (A, B, E, G, I)	9	0,5%	1	0,1%	2,72	0,099

Table 6: Results of the  $\chi^2$  test for independence according to the distribution of hospitalisations in the ENT clinic by ICD-10 diagnostic groups at discharge before and during the COVID-19 pandemic.

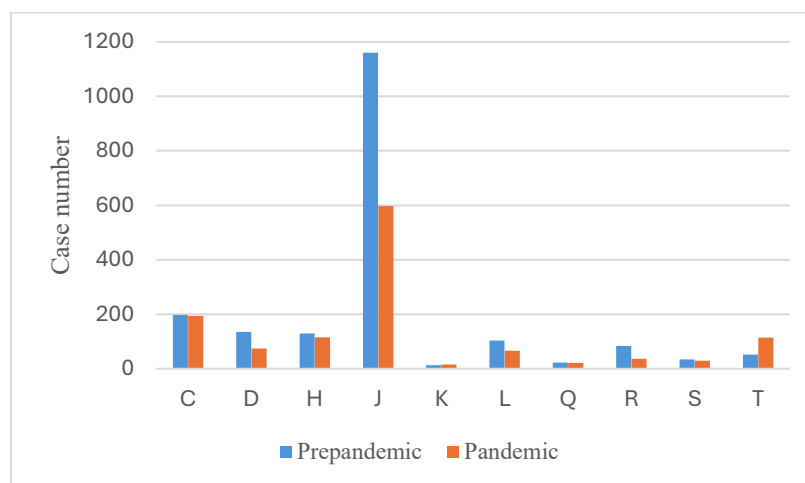


Figure 3: Number of hospitalised patients in the ENT clinic by ICD-10 diagnostic groups for the period 2018-2021

Analysis of diagnoses by ICD-10 classes demonstrates the dominance of Class J (Diseases of the respiratory system). Particularly codes J34 (Other disorders of the nose and nasal sinuses), J35 (Chronic diseases of tonsils and adenoids), and J33 (Nasal polyps). These diagnoses accounted for the main proportion of hospitalisations both before the pandemic (58,8%) and during the pandemic (45,9%). Nevertheless, a statistically significant decline in the share of these conditions was observed during the pandemic ( $\chi^2=39,44$ ;  $p<0,001$ ).

Diagnosis	2018	2019	2020	2021
J34.2 Septal deviation	159	135	101	63
J35.2 Adenoid hypertrophy	83	57	22	18
J35.3 Hypertrophy of tonsils and adenoids	64	57	30	19
J35.0 Chronic tonsillitis	54	29	25	21

Table 7: Most common ICD-10 Class J diagnoses among hospitalised patients in the ENT clinic - number of cases

All diagnoses show a clear downward trend, with the most pronounced reduction observed in adenoid hypertrophy. The chi-square test for independence applied to the four diagnoses across the four years (4×4 contingency table) yielded  $\chi^2=17,92$ ;  $p=0,036$ . To assess the rate of decline for each diagnosis, a Poisson regression model was applied, allowing each diagnosis to have its own slope (interaction term Year × ICD-10). In the model, J34.2 (septal deviation) served as the reference category for comparing all other diagnoses. The overall slope for J34.2 was -0,288, corresponding to an approximate 25% annual decrease in hospitalisations. For the remaining diagnoses, the following results were obtained:

ICD-10	Slope	Incidence Rate Ratio (IRR)	95% CI for IRR	Annual decrease (%)	p-value
J34.2	-0,288	0,75	0,70-0,81	-25,0%	<0,001
J35.0	-0,329	0,72	0,64-0,80	-28,0%	<0,001
J35.2	-0,554	0,57	0,50-0,64	-42,6%	<0,001
J35.3	-0,398	0,67	0,60-0,75	-32,8%	<0,001

Table 8: Poisson regression analysis for the most common ICD-10 Class J diagnoses; note: the independent variable is year, and the dependent variable is the annual number of cases

The analysis demonstrates a statistically significant negative trend for all evaluated diagnoses. The fastest rate of decline was observed for adenoid hypertrophy (J35.2).

In the present study, a quantitative analysis of hospitalisations due to malignant neoplasms of the head and neck was also performed. The total number of oncological hospitalisations (classified as ICD-10 Class C) showed minimal variation over the four years: 95 in 2018, 102 in 2019, 103 in 2020, and 91 in 2021. To assess a potential linear trend, a Poisson regression with year as the independent variable was applied. The model results showed that the slope ( $\beta$ ) for the variable *Year* was -0,0113 ( $p=0,804$ ), which is not statistically significant.

Variable	Coefficient	Standard error	z	P> z	95% CI
Constant	27,309	91,353	0,299	0,765	-151,739 - 206,357
Year	-0,0113	0,045	-0,249	0,804	-0,100 - 0,077

Table 9: Results of the Poisson regression analysis for oncological cases in the ENT clinic for the period 2018-2021; note: year is the independent variable

Malignant neoplasms	2018	2019	2020	2021
Pharynx, oral cavity, and tongue	26	32	32	29
Larynx	55	40	58	42
Nasal cavity and sinuses	5	1	3	2
Esophagus	1	1	0	0
Other	8	28	10	18
Total (Class C)	95	102	103	91

Table 10: Results of the Poisson regression analysis for oncological cases in the ENT clinic for the period 2018-2021; note: year is the independent variable

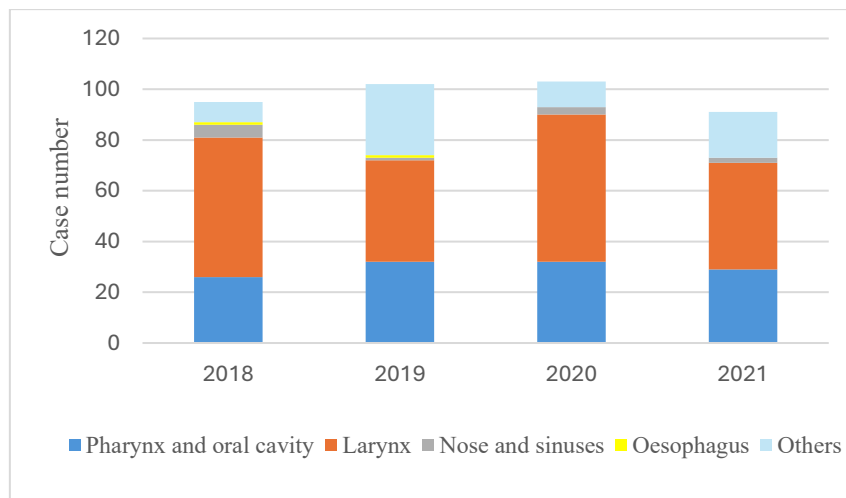


Figure 4: Localisations of HNT for 2018-2021

To assess how the COVID-19 pandemic affected oncological morbidity and access to inpatient care, cases were divided into two periods: pre-pandemic and pandemic.

Head and neck tumours	(2018-2019)	(2020-2021)
Pharynx, oral cavity, and tongue	58	61
Larynx	95	100
Nose and sinuses	6	5
Esophagus	2	0
Other	36	28

Table 11: Number of hospitalisations for oncological diseases in the ENT clinic and distribution by anatomical localisation before and during the COVID-19 pandemic

During the pre-pandemic period (2018-2019), a total of 197 hospitalisations for oncological diseases were recorded, compared with 194 hospitalisations during the pandemic period (2020-2021). The distribution of cases by anatomical localisation shows a stable predominance of pharyngeal and laryngeal tumours in both periods. The remaining localisations (nose and sinuses, oesophagus, and “other”) maintained a secondary share, accounting for approximately one quarter of all cases.

The results of the chi-square ( $\chi^2$ ) test comparing the two periods ( $\chi^2=3,27$ ;  $df=4$ ;  $p\approx 0,51$ ) indicate that there was no statistically significant change in the distribution of tumour localisations during the pandemic compared with the pre-pandemic years. This suggests that the pandemic did not lead to a shift in the focus of diagnosed tumour sites. However, when examining the share of oncological diseases among all hospitalisations, the data show a clear rise in ICD-10 Class C diagnoses during the pandemic - from 10,0% to 15,3% ( $\chi^2=19,14$ ;  $p<0,001$ ). This finding may indicate that, amid constrained healthcare resources, hospital admissions were prioritized for patients with oncological diseases.

The dynamics of admissions were also examined with a focus on urgency for the most common oncological disease and the changes observed during the pandemic. For this purpose, hospitalisations were divided into the following four groups: total number of oncological cases, cases of laryngeal carcinoma, total number of emergency hospitalisations for oncological diseases, and emergency hospitalisations for laryngeal carcinoma. The analysis of these groups was done by using descriptive statistical methods and t-tests.

Over the four years, a total of 391 patients with malignant diseases were hospitalised. The highest number was recorded in 2020 (103 cases), followed by 2019 (102 cases), while the lowest number was observed in 2021 (91 cases). Despite the COVID-19 pandemic, oncological case numbers did not decline in 2020; they remained high, indicating that oncological care was maintained even amid restrictions on elective admissions.

The distribution of patients with oncological diseases across the two study periods is presented in tabular and graphical form.

Indicator	Pre-pandemic (mean)	Pandemic (mean)	t-value	p-value
Total number of hospitalised patients with oncological diseases	98,5	97,0	0,13	0,905
Number of patients with laryngeal carcinoma	47,5	50,0	-0,29	0,788
Total number of emergency hospitalisations for oncological diseases	16,0	40,5	6,68	0,022
Number of emergency hospitalisations for laryngeal carcinoma	10,0	21,5	6,16	0,025

Table 12: Results of the independent samples t-test comparing the pre-pandemic and pandemic periods

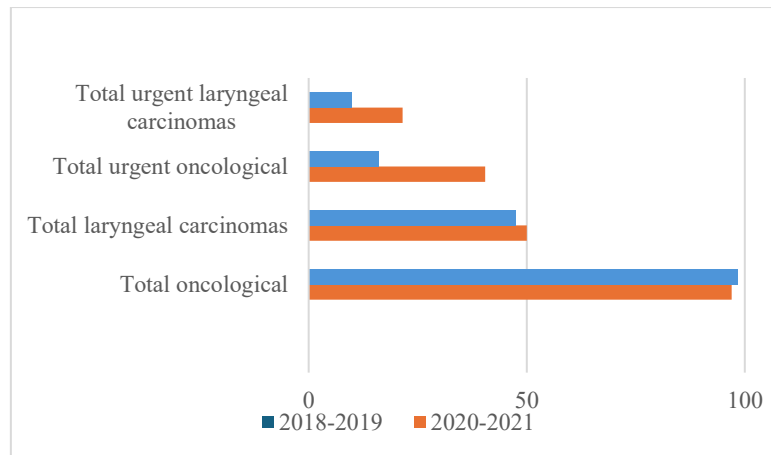


Figure 5: Number of patients with oncological diseases in the ENT clinic - comparison between the pre-pandemic and pandemic periods

The t-test showed no significant difference between the two periods ( $p > 0,05$ ), despite the decline noted in 2021. These results indicate that, despite restrictions, oncological patients continued to seek and receive specialised medical care for diagnosis and treatment.

Laryngeal carcinoma was the most common malignant tumour, accounting for 49,6% of all oncological cases treated in the ENT clinic. A clear contrast was observed in the number of oncological patients admitted on an emergency basis. In the pre-pandemic period, emergency admissions averaged  $16 \pm 0$  cases annually, whereas during the pandemic they rose to 37 cases in 2020 and 44 in 2021, yielding a mean of  $40,5 \pm 4,95$  cases per year. This represents more than a twofold increase and is statistically significant ( $p < 0,01$ ).

The results of the statistical t-test ( $t=6,68$ ;  $p=0,022$ ) demonstrate a significant increase in emergency admissions of oncological patients during the pandemic ( $p < 0,05$ ). A similar trend was observed for laryngeal carcinoma, with emergency hospitalisations increasing from  $10 \pm 0$  cases per year before the pandemic to  $21,5 \pm 3,54$  cases per year during the pandemic. The corresponding t-test ( $t=6,16$ ;  $p \approx 0,025$ ) confirms a statistically significant increase in emergency hospitalisations for laryngeal carcinoma during the pandemic.

To evaluate whether emergency admission rates for laryngeal carcinoma exhibited a linear temporal trend, a logistic regression was conducted using year as a continuous predictor and admission urgency as the binary outcome. The main results of the model are presented below:

Variable	Coefficient	Standard error	z	P> z	95% CI
Constant	-949,34	294,89	-3,219	0,001	-1527,31 to -371,37
Year	0,4697	0,146	3,217	0,001	0,184 to 0,756

Table 13: Results of the logistic regression analysis; note: year as the independent variable and urgency of admission as the dependent binary variable

The model demonstrates a highly statistically significant positive slope ( $\beta=0,4697$ ;  $p=0,001$ ), indicating that the probability of emergency admission for laryngeal carcinoma increases with each passing year. The approximate increase in the odds ratio (OR) is  $e^{0,4697} \approx 1,60$ , corresponding to an approximately 60% increase in the odds of emergency

admission per year. The pseudo  $R^2$  value (0,04481) indicates moderate explanatory power of the model, while the log-likelihood (-117,19) and likelihood ratio test p-value (LLR  $p=0,00091$ ) confirm the adequacy of the regression model.

Data on hospitalised patients in the ENT clinic with benign head and neck tumours show the following values: 63 patients in 2018, 70 patients in 2019, while in 2020 and 2021 their number decreased to 37 patients per year.

Year	Number of hospitalised patients with benign tumours
2018	63
2019	70
2020	37
2021	37

Table 14: Distribution of hospitalised patients with benign diseases for the period 2018-2021

Injuries (Class T) showed an increase during the pandemic ( $\chi^2=56,27$ ;  $p<0,001$ ).

Year	2018	2019	2020	2021
Class T	16	36	47	67

Table 15: Distribution of diagnoses from Class T for the period 2018-2021

A linear regression model was applied with the following structure: number of cases= $-33,080+16,4 \times \text{year}$ . This model suggests that the number of cases increases by 16,4 cases per year. The results of the regression analysis are as follows:  $R$ -squared ( $R^2$ )=0,988; adjusted  $R^2$ =0,982;  $F$ -statistic=166,0; model  $p$ -value=0,00597;  $p$ -value for the “year” coefficient=0,006; year coefficient=16,4; intercept (constant)=-33,080; standard error of the “year” coefficient=1,273; 95% confidence interval=[10,924; 21,876]. The  $R^2$  value of 0,988 indicates that 98,8% of the variance in the number of cases can be explained by the linear time trend. The  $p$ -value for the “year” coefficient (0,006) is well below the conventional significance threshold (0,05), providing strong statistical evidence for the presence of an increasing linear trend.

Data were also analysed for the number of hospitalised patients with haemorrhage and hematoma complicating a procedure (ICD-10 code T81.0). These cases concern patients admitted with acute bleeding unresponsive to outpatient nasal packing and therefore necessitate inpatient treatment. The findings for the four examined years are : 2 cases in 2018, 16 cases in 2019, 12 cases in 2020 and 31 cases in 2021. Comparison across the years reveals a distinct upward trend in the number of post-procedural hematomas.

A retrospective quantitative analysis of hospitalisations due to upper airway bleeding (ICD-10 Class R) was performed. This category includes acute bleeding from anatomical structures of the head and neck, such as epistaxis (nasal bleeding), otorrhagia (ear bleeding), and bleeding from the pharynx, larynx, and trachea. During the four-year study period, the following annual numbers of hospitalisations due to ENT bleeding classified under Class R were recorded: 46 cases in 2018, 37 cases in 2019, 25 cases in 2020, and 11 cases in 2021. The distribution is presented in tabular and graphical form:

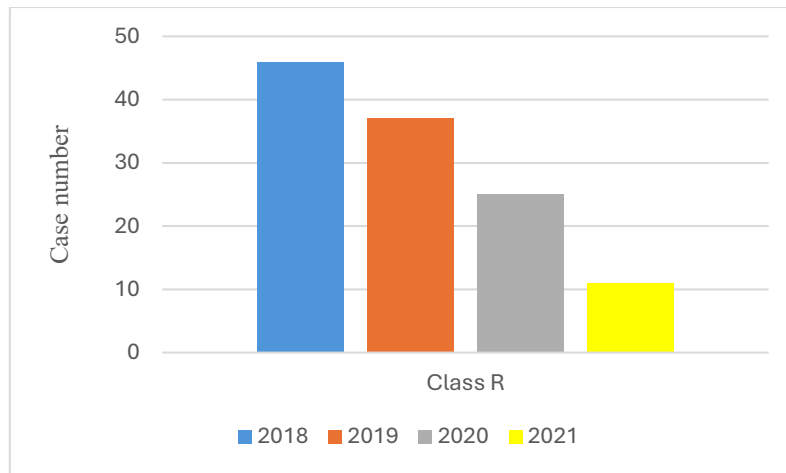


Figure 6: Distribution of hospitalisations due to ICD-10 Class R diagnoses for 2018-2021

Visual inspection confirms the observed patterns: the decline of approximately 72% is gradual, consistent, and sustained. This behaviour suggests the presence of a systemic change and warrants the application of statistical tools to confirm the significance of this trend.

The ordinary least squares (OLS) linear regression method was applied to examine the linear relationship between calendar year and the number of hospitalisations classified under Class R. The model was structured as: number of cases= $b_0+b_1 \times \text{year}$ , where  $b_0$  represents the intercept and  $b_1$  the slope, indicating the average annual change. The regression results show that the number of hospitalisations due to ENT bleeding decreased by an average of 11,7 cases per year, with an exceptionally high  $R^2$  value of 0,991, meaning that 99,1% of the variance in the data is explained by the linear model. The low  $p$ -value for the slope ( $p=0,005$ ) indicates that this trend is statistically significant, despite the small number of observations, suggesting that such a decline is unlikely to have occurred by chance.

Data on the distribution of bleeding according to the anatomical source over the four-year study period are presented below:

Class R	2018	2019	2020	2021
Epistaxis (R04.0)	33	35	19	10
Throat bleeding (R04.1)	5	0	4	1
Other respiratory tract bleeding (R04.8)	1	0	0	0
Total Class R	39	35	23	11

Table 16: Number of hospitalisations due to bleeding from ENT organs for the period 2018-2021

To evaluate the temporal trend, a Poisson regression analysis was applied to model the number of cases as a function of year. The regression results indicate that the coefficient for year was -0,369 ( $p<0,001$ ), demonstrating strong statistical significance and rejection of the null hypothesis of no temporal effect. Exponentiation of this coefficient yields a value of approximately 0,69, indicating that with each passing year, the number of hospitalisations decreased on average by about 31%. This finding points to a systematic and sustained reduction in the frequency of upper airway bleeding during the study period. Epistaxis accounted for the largest proportion of hospitalisations throughout the entire period.

To determine whether the relative distribution among the three diagnostic categories changed over time, a three-way contingency table (3 diagnoses×4 years) was constructed. Application of the chi-square ( $\chi^2$ ) test for independence yielded the following results:  $\chi^2=7,84$ ; degrees of freedom=6;  $p=0,2498$ . Since the  $p$ -value is well above the conventional threshold of 0,05, no statistically significant change in the distribution of cases among the three diagnostic categories over the four years was identified.

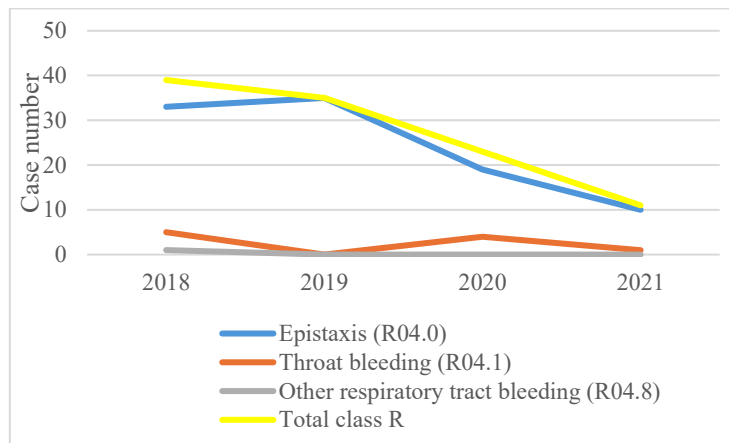


Figure 7: Distribution of hospitalisations due to bleeding from ENT organs for the period 2018-2021

Some ICD-10 groups, such as D, K, L, M, S, and Q, did not show statistically significant differences between the two periods ( $p>0,05$ ), indicating relative stability in their frequency or a smaller contribution to the overall structure of hospitalisations.

#### 4.1.7 Comparative analysis of the main emergency diagnoses in the ENT clinic for the period 2018-2021

During the study period, four leading emergency diagnoses were identified among patients hospitalised in the ENT clinic: epistaxis, foreign bodies in ENT organs, malignant neoplasms, and peritonsillar abscess. Their distribution in the pre-pandemic and pandemic periods is presented above:

Diagnosis	2018 n=18	%	2019 n=24	%	2020 n=22	%	2021 n=24	%	2018-2019	2020-2021	$\chi^2$	p-value
Epistaxis	33	18,1	35	14,6	19	8,6	10	4,2	68	29	31,950 9	0,00023
Foreign bodies in airways	13	7,1	20	11,0	35	15,8	36	15,0	33	71	21,527 9	0,0065412 7
Malignancies	16	8,8	16	6,7	37	16,7	44	18,3	32	81	16,284 3	0,0000545
Peritonsillar abscess	23	12,6	21	8,8	19	8,6	21	8,8	44	40	2,1288 4	0,14455

Table 17: Comparative analysis of the most common diagnoses among patients admitted on an emergency basis to the ENT clinic for the period 2018-2021

Several distinct trends were observed over the study period:

- A significant increase in both the absolute number and relative share of emergency hospitalisations due to malignant diseases, reaching 18,3% in 2021 compared to 8,8% in 2018;
- A steady increase in cases of foreign bodies in the airways, accounting for a stable share of approximately 15% in 2020 and 2021;
- A decrease in emergency cases of epistaxis, from 18,1% in 2018 to only 4,2% in 2021.

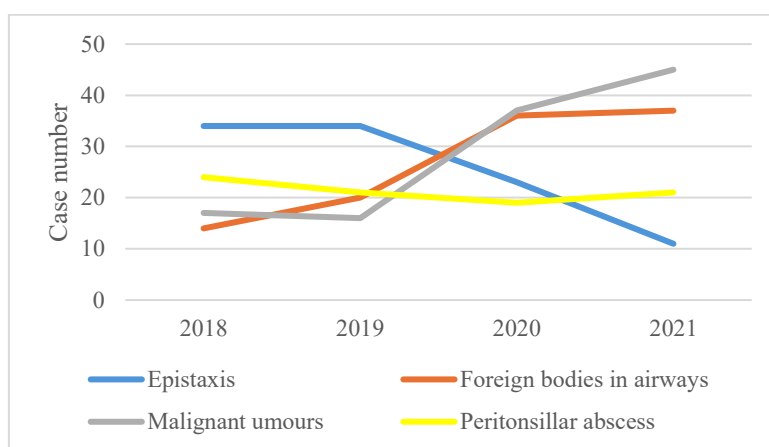


Figure 8: Trend of the most frequent emergency hospitalisations for the period 2018-2021

The results of the applied chi-square ( $\chi^2$ ) test for independence showed that foreign bodies in the airways were significantly more frequent during the pandemic (71 cases vs. 35 cases), with the  $p$ -value also indicating a statistically significant difference ( $\chi^2=21,52$ ;  $p=0,006$ ). Over the four years (2018-2021), a total of 104 cases of emergency hospitalisations due to foreign bodies were recorded. The most pronounced increase was observed for diagnosis T17.1 - foreign body in the nose, particularly during the pandemic years (2020 and 2021), with an increase from 1 case in 2018 to 16 cases in 2021.

A comparative table of emergency foreign body cases in ENT organs by diagnosis and year is presented below.

Diagnosis	2018	2019	2020	2021	Total	%	2018-2019	2020-2021
T17.1 Foreign body in the nose	1	5	9	16	31	29,8%	6	25
T17.5 Foreign body in the bronchus	7	7	13	8	35	33,7%	14	21
T16 Foreign body in the ear	2	4	6	3	15	14,4%	6	9
T17.2 Foreign body in the pharynx	0	2	6	0	8	7,7%	2	6
T17.4 Foreign body in the trachea	2	0	0	2	4	3,8%	2	2
T17.3 Foreign body in the larynx	1	2	1	1	5	4,8%	3	2
T18.1 Foreign body in the oesophagus	0	0	0	6	6	5,8%	0	6

Table 18: Distribution of foreign bodies admitted on an emergency basis to the ENT clinic in absolute numbers and as a percentage of all cases for the period 2018-2021

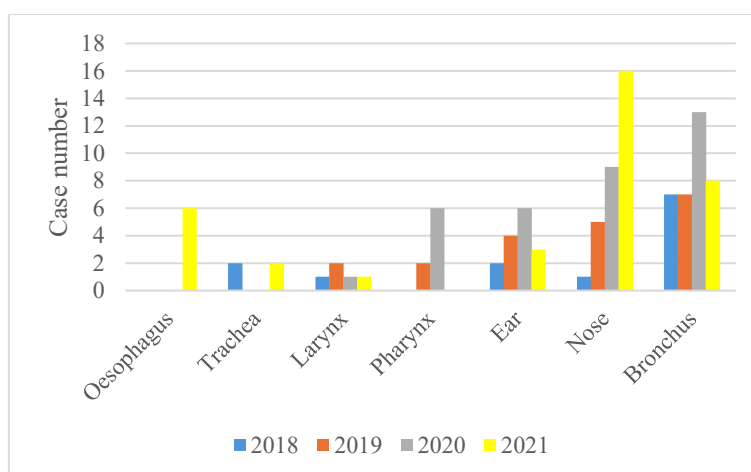


Figure 9: Distribution of foreign bodies according to ICD-10 for the period 2018-2021

Chi-square tests and Fisher's Exact Test (for small expected values) were used to determine the significance of differences between the two periods. With a total of 104 cases during the study period (33 pre-pandemic and 71 pandemic), the overall chi-square test for all diagnoses demonstrated a statistically significant difference between the pre-pandemic and pandemic periods ( $\chi^2=21,52$ ;  $p=0,006$ ). A marked increase in foreign bodies in the nose (T17.1) was observed during the pandemic - 25 cases compared to 6 cases before the pandemic, representing an increase of more than 300%. This difference was statistically significant ( $\chi^2=12,41$ ;  $p<0,001$ ). Particularly noteworthy is the fact that the most common nasal foreign body was a broken swab tip from a nasopharyngeal sampling kit for COVID-19 testing. Although a slight increase in foreign bodies in the bronchi (T17.5) was observed - from 14 cases before the pandemic to 21 cases during the pandemic-this difference did not reach statistical significance ( $p>0,05$ ). Nevertheless, this diagnosis remained the most frequent across

the entire study period. A relatively stable number of foreign bodies in the ear (T16) was observed throughout the study period, with no statistically significant difference between the two periods ( $p>0,05$ ).

The diagnosis of oesophageal foreign body (T18.1) was recorded in the ENT clinic only in 2021 (6 cases), with no cases documented before the pandemic. This reflects changes in diagnostic pathways and new organisational workflows within the hospital. The difference was statistically significant (Fisher's Exact Test:  $p=0,028$ ).

#### 4.1.8 Comparative analysis of tracheostomies performed during the period 2018-2021

##### 4.1.8.1 Total number and dynamics of tracheostomies

Over the four years, a total of 297 tracheostomies were performed, distributed as follows: 86 cases in 2018, 77 cases in 2019, 69 cases in 2020, and 65 cases in 2021. A clear downward trend was observed, with the number of procedures decreasing by nearly 25% from 2018 to 2021.

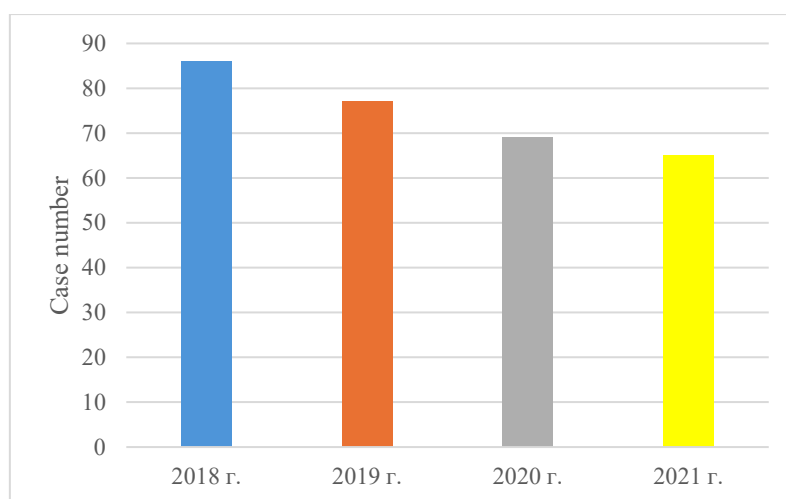


Figure 10: Distribution of the number of tracheostomies performed for the period 2018-2021

##### 4.1.8.2 Diagnostic structure (ICD-10) of patients undergoing tracheostomy

The leading indication for tracheostomy throughout the entire period was respiratory failure (J96.0): 57 cases (66,3%) in 2018, 48 cases (62,3%) in 2019, 42 cases (60,9%) in 2020, and 34 cases (52,3%) in 2021. Despite a slight decrease in relative proportion, respiratory failure remained the dominant indication for the procedure. Oncological diseases of the larynx and pharynx ranked second but showed a declining relative share during the pandemic: 10 cases (11,6%) in 2018, 9 cases (11,7%) in 2019, 4 cases (5,8%) in 2020, and 4 cases (6,2%) in 2021. Neurological conditions (e.g., G12.2 - spinal muscular atrophy, G70.0 - myasthenia gravis, and cerebrovascular events - I61, I63) constituted a stable proportion of indications and were recorded in all years. COVID-19 (U07.1) was first recorded in 2020 with 1 case (1,4%), but increased sharply in 2021 to 14 cases (21,5%).

The total number of tracheostomies performed in the hospital during the period 2018-2021 was 297. In the pre-pandemic period, the ENT clinic team performed 163 tracheostomies, whereas 134 procedures were carried out during the COVID-19 pandemic.

Period	Number	Mean	SD
Pre-pandemic (2018-2019)	163	81,5	6,36
Pandemic (2020-2021)	134	67,0	5,66

Table 19: Descriptive statistics of tracheostomies performed by period (pre-pandemic vs. pandemic)

On average,  $81,5 \pm 6,36$  tracheostomies per year were performed during 2018-2019, compared with  $67,0 \pm 5,66$  per year during 2020-2021. This represents a net reduction of 29 procedures, corresponding to a 17,8% decrease. To determine whether this decline was statistically significant between the pre-pandemic and pandemic periods, an independent samples t-test was performed. The test results showed  $t(2)=3,30$ ;  $p=0,043$ , indicating that the difference reached statistical significance ( $p < 0,05$ ).

#### 4.2 Results of the national survey

The survey was distributed to 241 otorhinolaryngology specialists, of whom 120 (49,8%) completed it. According to the Bulgarian Medical Association's public register at the time of distribution, 249 physicians in the country were actively practising in this speciality.

##### 4.2.1 Demographic characteristics of respondents

Analysis of the age structure of respondents showed that the majority of participants were experienced specialists, while physicians at the early stages of their professional development represented a smaller proportion. The largest age group was 51-60 years, comprising 36 respondents (30,0%), followed by those aged 31-40 years with 34 respondents (28,3%). The 41-50 years age group included 21 participants (17,5%). Respondents younger than 30 years accounted for 15 individuals (12,5%). The smallest group consisted of specialists older than 60 years, totalling 14 respondents (11,7%).

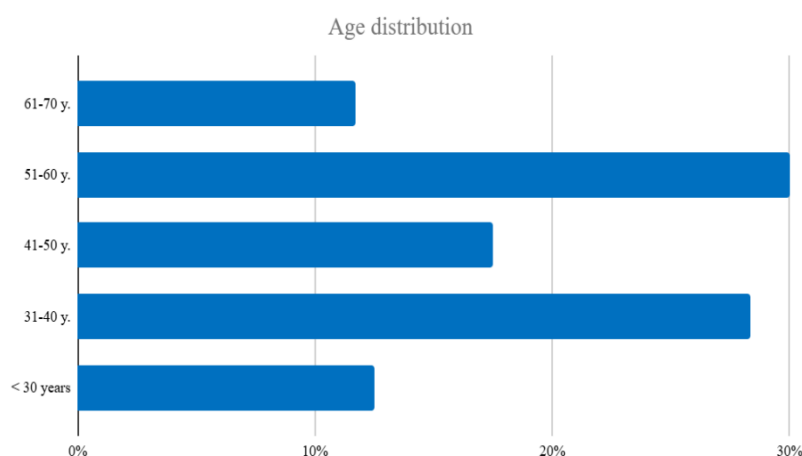


Figure 11: Distribution of respondents by age

A clear predominance of physicians with long-standing experience was observed. Physicians with up to 10 years of professional experience accounted for 27 respondents (22,5%), while those with 11-20 years of experience comprised 26 respondents (21,7%). A

substantially larger share was represented by specialists with more than 21 years of professional practice - 54 respondents (45,0%). Residents constituted the smallest group, with 13 respondents (10,8%).

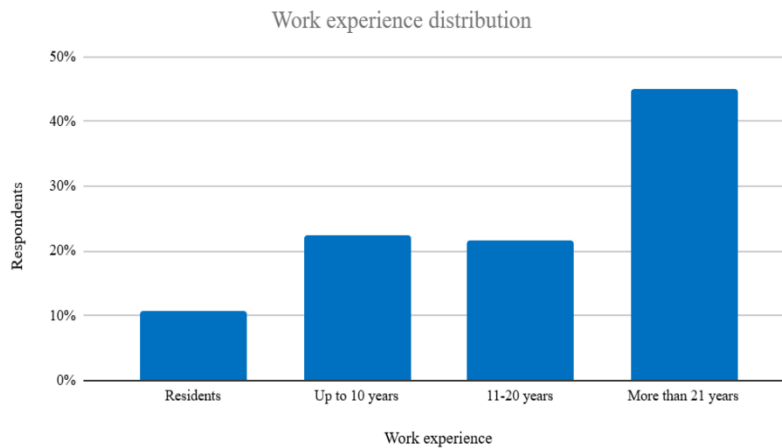


Figure 12: Distribution of respondents by length of professional experience

Analysis of the respondents' workplace distribution shows that the largest proportion was employed in inpatient healthcare facilities - 82 respondents (68,6%). A substantial share also worked in outpatient healthcare facilities - 33 respondents (27,1%). A considerably smaller group consisted of participants who indicated "other" workplaces, accounting for only 5 respondents (4,3%) of all surveyed individuals.

Analysis of professional employment patterns revealed that a significant proportion of respondents practised simultaneously in more than one healthcare institution - 96 respondents (80,0%). This group included 10 respondents (8,6%) who reported that they occasionally practised concurrently in more than one institution. Physicians working in only one healthcare facility accounted for 24 respondents (20,0%).

#### 4.2.2 Assessment of infection risk

##### 4.2.2.1 Comparison of the risk of coronavirus infection among different medical and dental specialities

The largest proportion of respondents considered their risk to be higher compared with that of radiologists - 84 respondents (70,0%), and ophthalmologists - 74 respondents (61,7%). A substantial proportion also perceived paediatricians as being at lower risk - 63 respondents (52,5%). A similar trend was observed with respect to general practitioners, with 59 respondents (49,2%) considering them less exposed, while 51 respondents (42,5%) assessed their risk as comparable. Regarding emergency medicine physicians, the prevailing opinion was that their probability of infection was comparable to that of otorhinolaryngologists - 61 respondents (50,8%), whereas 31 respondents (25,8%) perceived them as less exposed. Dentists stood out with the highest proportion of responses indicating an equal level of risk - 91 respondents (75,8%), suggesting that respondents perceive them as having a similar exposure profile due to work in the upper respiratory tract and oral cavity.

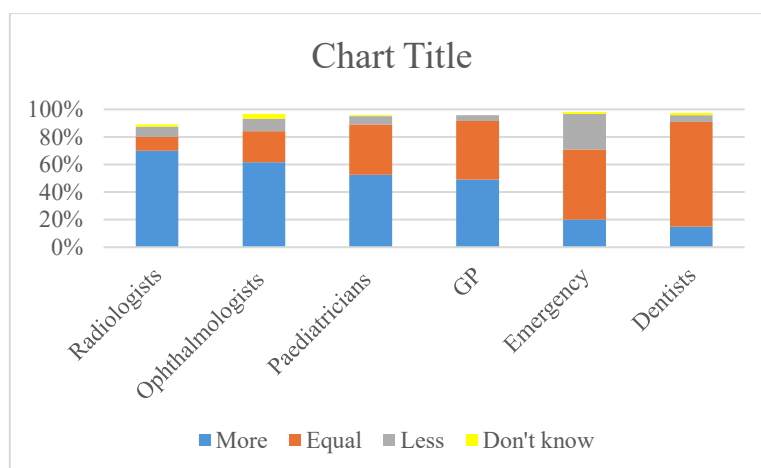


Figure 13: Comparative chart of the risk of COVID-19 infection among different medical and dental specialities

#### 4.2.2.2 Assessment of the probability of coronavirus infection

The vast majority of surveyed otorhinolaryngologists assessed the risk of infection as high - 116 respondents (96,7%). Only 4 respondents (3,3%) perceived the probability of infection as low.

The results of the chi-square ( $\chi^2$ ) test for independence revealed a statistically significant association between the perceived risk of COVID-19 infection and professional experience ( $\chi^2(3)=14,25$ ;  $p=0,0026$ ), indicating that risk perception among otorhinolaryngologists varies substantially according to the length of professional service.

Perceived risk of COVID-19 infection	Work experience								Chi-square statistic $\chi^2$ (df)	p-value
	<10 y.		11-20 y.		>21 y.		residents			
	n	%	n	%	n	%	n	%		
Low risk	4	3,3	0	0	0	0	0	0	14,25 (3)	0,0026
High risk	23	19,2	26	21,7	54	45	13	10,8		

Table 20: Characteristics of the statistically significant association between perceived risk of infection and work experience. n=number;  $\chi^2$ =chi-square test; df=degrees of freedom; p=probability

The responses of the surveyed otorhinolaryngologists regarding the probability of COVID-19 infection in different compartments of the professional and social environment reveal clear trends. The largest proportion of respondents -71 (59,2%) - identified outpatient practice as the primary setting associated with a high risk of infection. A substantial number of physicians also considered the emergency department to be an area of potential danger - 25 (20,8%), while 24 (20,0%) believed that the highest risk occurs outside the hospital environment.

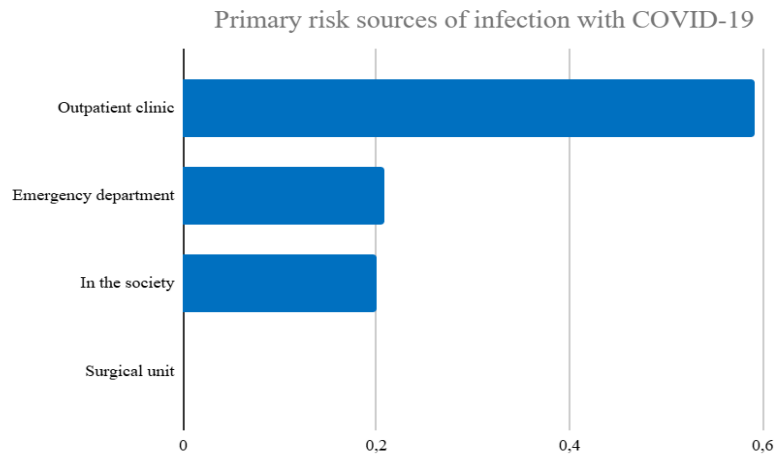


Figure 14: Primary risk sources of infection with COVID-19

The analysis of otorhinolaryngologists' opinions regarding the highest-risk activities for COVID-19 infection in their clinical practice demonstrates clearly dominant procedures. The largest proportion of respondents - 72 (60,0%) - identified routine ENT examination as the main source of potential exposure. The second most frequently reported activity was the performance of tracheostomy and the care of tracheostomized patients, indicated by 24 (20,0%) participants.

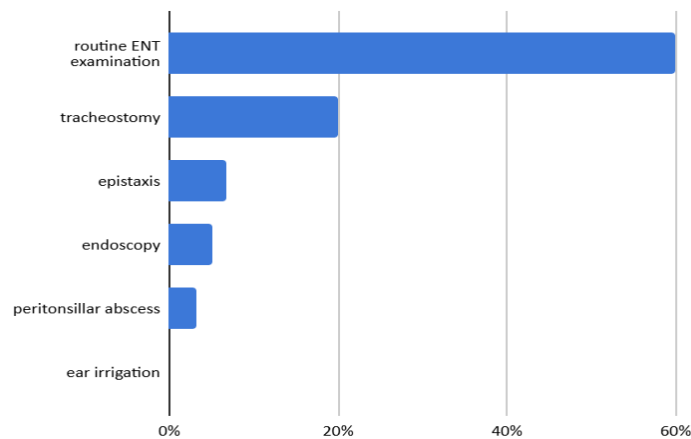


Figure 15: Assessment of the risk of COVID-19 infection associated with different otorhinolaryngological procedures

A considerably smaller proportion of respondents identified other procedures as high risk. Control of epistaxis was indicated by 8 (6,7%) physicians, endoscopic examinations by 6 (5,0%), and “other activities” also by 6 (5,0%). Within the category of “other activities,” indirect laryngoscopy was specified, and one respondent indicated that all of the listed procedures were considered risky. Drainage of a peritonsillar abscess was assessed as high risk by 4 (3,3%) specialists. Notably, none of the respondents identified external auditory canal irrigation or microscopic ear suction as posing a significant risk of infection (0,0%).

#### 4.2.3. Awareness of otorhinolaryngologists regarding the COVID-19 pandemic

The assessment of the awareness of otorhinolaryngologists in Bulgaria regarding the COVID-19 pandemic demonstrates a predominantly positive attitude. The majority of respondents - 75 (62,9%) - self-identified as being sufficiently informed about the course of the pandemic and the associated professional challenges. A considerably smaller proportion - 12 (10,0%) - reported feeling uninformed, while 12 (8,6%) stated that they were unable to assess their level of awareness. Of particular interest are the responses related to perceived information overload. Five respondents (4,3%) believed they had been overexposed to reliable information, whereas 16 (14,3%) reported being overexposed to misinformation.

The analysis of the information sources used during the COVID-19 pandemic reveals clearly defined preferences among otorhinolaryngologists. The most frequently used resource was scientific literature - 86 respondents (71,4%) reported scientific publications, while 26 (21,4%) indicated that they used them occasionally.

Source	Often (%)	n	Sometimes (%)	n	Rarely (%)	n	Not used (%)	n
Scientific literature	71,4%	86	21,4%	26	7,1%	9	0,0%	0
Institutional websites	61,4%	74	25,7%	31	12,9%	15	0,0%	0
Colleagues	65,7%	79	22,9%	27	10,0%	12	1,4%	2
Professional communities	42,9%	51	24,3%	29	28,6%	34	4,3%	5
Social networks	24,3%	29	20,0%	24	32,9%	39	22,9%	27
Television, radio, and digital media	32,9%	39	30,0%	36	32,9%	39	4,3%	5

Table 21: Distribution of information sources regarding the COVID-19 pandemic

#### 4.2.4. Changes in work organisation and the structure of otorhinolaryngological diseases

##### 4.2.4.1. Work organisation

The analysis of the COVID-19 pandemic's impact on work organisation among Bulgarian otorhinolaryngologists demonstrates clear structural changes. A substantial majority of respondents - 87 (72,9%) - reported that a significant change had occurred in the organisation of their work process. Approximately one-fifth of those surveyed - 26 (21,4%) - indicated that the changes were minimal. Only 7 respondents (5,7%) stated that no change had occurred in the organisation of their work. A variety of organisational and clinical strategies were implemented to reduce the risk of COVID-19 infection during professional activities. The most frequently implemented measure was pre-examination triage based on a COVID-19-focused medical history, reported by 45 respondents (37,1%). An equal proportion - 45 respondents (37,1%) - reported restricting the performance of pharyngoscopy and laryngoscopy to cases with symptoms and specific clinical indications only. Other commonly adopted measures included working solely by prearranged schedules with booked appointments, reported by 36 participants (30,0%), and the use of a protective barrier between physician and patient during examinations, reported by 43 respondents (35,7%). Some specialists integrated remote approaches into their practice: 15 respondents (12,9%) conducted preliminary triage by telephone, and 21 (17,1%) provided diagnosis and treatment via telephone consultation when

feasible. A smaller proportion of respondents - 5 (4,3%) - avoided examining patients with symptoms suggestive of COVID-19.

The introduction and use of new personal protective equipment (PPE) during the COVID-19 pandemic played a substantial role in the organisation and safety of clinical practice in otorhinolaryngology. The highest proportion of respondents - 108 (90,0%) - reported using gloves, making them the most widely adopted protective measure. This was followed by surgical masks, reported by 99 participants (82,9%), and masks with a higher level of filtration (FFP2 or N95), which were used by 91 physicians (75,7%). A considerable proportion of respondents also introduced additional barrier protective equipment: protective goggles - 93 (77,1%), face shield - 86 (71,4%), and gowns - 87 (72,9%).

Used	Yes	No
%	n	%
Surgical mask	82,9%	99
FFP2 or N95 mask	75,7%	91
Protective goggles	77,1%	93
Face shield	71,4%	86
Gown	72,9%	87
Protective suit	50,0%	60
Cap	62,9%	75
Gloves	90,0%	108

Table 22: Distribution of personal protective equipment used during the COVID-19 pandemic

#### 4.2.4.2 Impact of the COVID-19 pandemic on the structure of otorhinolaryngological morbidity

Regarding the pandemic's impact on clinical activity, 55 respondents (45,8%) reported a reduction in patient numbers; 31 (25,8%) indicated an increase, and 34 (28,3%) observed no change. Analysis of otorhinolaryngologists' impressions regarding the number of patients with acute respiratory diseases (ARDs) of non-COVID-19 origin during the pandemic revealed clear trends. More than half of the respondents - 65 (54,2%) - reported a decrease in the number of such patients. At the same time, 28 respondents (23,3%) reported an increase in patients with acute respiratory infections. In 27 respondents (22,5%), the number of patients with ARDs remained unchanged.

#### 4.2.4.3 Changes in the structure of otorhinolaryngological emergencies

Analysis of otorhinolaryngologists' opinions regarding the dynamics of emergency cases in their practice during the COVID-19 pandemic showed that 29 respondents (24,2%) observed an increase in emergency conditions. In the majority of respondents - 72 (60,0%) - no change in the frequency of emergency cases was reported, while 19 physicians (15,8%) indicated that they were unable to assess whether a change had occurred. Analysis of data concerning the most common emergency conditions in otorhinolaryngological practice during the COVID-19 pandemic showed that bleeding and acute respiratory failure were among the most frequent reasons for emergency consultations, each reported by 58 respondents (48,6%). This was followed by sudden hearing loss, identified as an emergency problem by 41

respondents (34,3%). Abscesses were reported by 22 respondents (18,6%), while foreign bodies were identified as an emergency issue by 17 physicians (14,3%). The same proportion - 17 respondents (14,3%) - stated that they were unable to assess which emergency conditions were most common. The category “other” was selected by 21 respondents (17,1%), suggesting the presence of rarer or practice-specific emergency cases.

#### 4.2.4.4 Changes in the number and morbidity of pediatric patients

Analysis of otorhinolaryngologists’ impressions regarding changes in the number of pediatric patients who sought specialised care during the COVID-19 pandemic reveals clear trends. The largest proportion of respondents - 53 (44,3%) - reported a decrease in the number of pediatric patients. According to 48 participants (40,0%), the number of pediatric patients remained unchanged. A smaller proportion - 19 respondents (15,7%) - reported an increase in the number of pediatric patients during the pandemic.

#### 4.2.4.5 Changes in the number and morbidity of patients with oncological diseases

Otorhinolaryngologists’ opinions regarding the impact of the COVID-19 pandemic on the diagnosis and treatment of patients with oncological diseases indicate that 82 respondents (68,6%) believe that delays occurred in these processes. According to 19 participants (15,7%), no delays were observed, whereas an equal number (n=19; 15,7%) reported being unable to determine whether the pandemic influenced the timing of diagnosis and treatment in oncological patients.

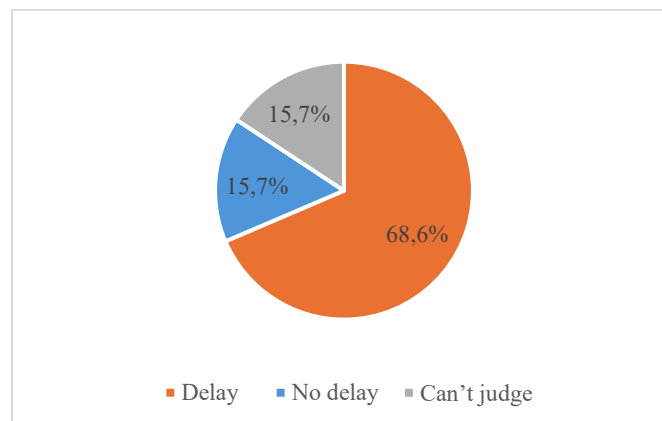


Figure 16: Changes in the diagnosis and treatment of patients with oncological diseases during the COVID-19 pandemic

#### 4.2.5 Assessment of the financial impact of the pandemic on physicians’ income

Analysis of the financial impact of the COVID-19 pandemic on physicians’ income indicates notable differences across respondents. The largest proportion - 47 (39,2%) - reported no change in their income during the pandemic. At the same time, 42 respondents (35,1%) reported an increase in their income. A large share of them - 33 (27,5%) - attributed this to secondment to COVID-19 wards and the accompanying financial incentives. In contrast, 31 physicians (25,8%) indicated that their income had decreased during the pandemic.

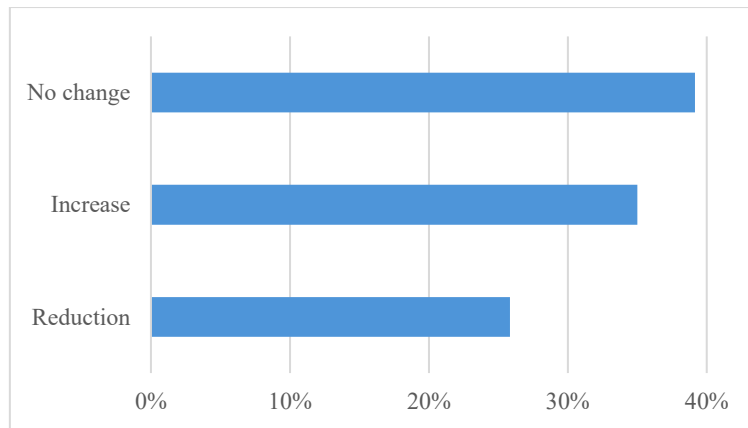


Figure 17: Financial impact of the COVID-19 pandemic on physicians' income

The conducted  $\chi^2$  test demonstrated a statistically significant association between the financial impact of the pandemic on income and the professional experience of otorhinolaryngologists ( $\chi^2(9)=44,0$ ,  $p<0,001$ ). Respondents were categorised into four groups based on their years of professional experience: Group 1 ( $\leq 10$  years), Group 2 (11-20 years), Group 3 ( $>21$  years), and Group 4 (residents). Data analysis showed that income stability was most frequently reported by 47 respondents (39,1%), predominantly from Groups 1 and 2. A decrease in income was most commonly observed among 31 participants (25,8%), mainly from Group 3 ( $>21$  years of professional experience). An increase in income related to work in COVID-19 wards was reported primarily among specialists from Group 1 ( $\leq 10$  years) and residents (Group 4). At the same time, 9 respondents (7.5%) from Group 3 ( $>21$  years) reported an increase in income as a result of specialised otorhinolaryngological activity.

Financial impact of the COVID-19 pandemic	Work experience								Chi-square statistic $\chi^2$ (df)	p-value
	Group 1 (<10 y.)		Group 2 (11-20 y.)		Group 3 (>21 y.)		Group 4 (residents)			
	n	%	n	%	n	%	n	%		
Increased income due to ENT activity	0	0	0	0	9	7,5	0	0	44,0 (9)	<0,001
Increased income due to work in COVID-19 facilities	9	7,5	3	2,5	10	8,3	11	9,2		
Decreased income	3	2,5	9	7,5	18	15	1	0,8		
No change in income	15	12,5	14	11,7	17	14,2	1	0,8		
Total	27	22,5	26	21,7	54	45	13	10,8		

Table 23: Characteristics of the statistical association between the financial impact of the COVID-19 pandemic on otorhinolaryngological practice and the professional experience of otorhinolaryngologists; note: n=number;  $\chi^2$ =chi-square test; df=degrees of freedom; p=probability

These results indicate that mid-career specialists were exposed to greater financial pressure during the pandemic, whereas younger physicians and those directly involved in COVID-19 activities more frequently reported increased income. The performed  $\chi^2$  test of

independence revealed a statistically significant association between financial impact and work environment ( $\chi^2(3)=11,7$ ,  $p=0,0086$ ).

Analysis of otorhinolaryngologists' income in relation to professional experience shows a clear trend influenced both by experience and by place of work. Additional analysis revealed significant differences by work setting. Hospital-based otorhinolaryngologists reported decreased income far more frequently - 65 (54,2%) - compared with 22 (18,3%) specialists in outpatient practice. Conversely, no change in income was noted by 20 hospital physicians (16,7%) versus 8 (6,7%) working in outpatient settings.

Financial impact of the COVID-19 pandemic	Workplace setting				Chi-square statistic $\chi^2$ (df)	p-value
	Hospital-based		Outpatient-based			
	n	%	n	%		
Increased income due to ENT activity	2	1,7	7	5,8	11,68 (3)	0,0086
Increased income due to work in COVID-19 facilities	24	20	9	7,5		
Decreased income	21	17,5	10	8,3		
No change in income	37	30,8	10	8,3		
Total	84	70	36	30		

Table 24: Characteristics of the statistical association between the financial impact of the COVID-19 pandemic on otorhinolaryngological practice and work setting; note: n=number;  $\chi^2$ =chi-square test; df=degrees of freedom; p=probability

Concerning direct involvement in the care of COVID-19 patients, the data indicate that 92 respondents (76,6%) worked in COVID-19 wards, 6 (5,0%) in outpatient COVID-19 facilities, and 1 (0,8%) in vaccination centres. An additional 19 respondents (15,8%) provided consultations or interventions when needed, whereas 28 (23,3%) did not participate directly in COVID-related activities. Taken together, the findings indicate that both professional experience and workplace setting played a decisive role in shaping the pandemic's financial impact on physicians. Younger specialists and residents, as well as those assigned to COVID-19 units, had greater access to financial incentives, while more experienced hospital-based physicians experienced comparatively greater financial losses.

#### 4.2.6 Assessment of physicians' stress levels

Analysis of stress levels among otorhinolaryngologists during the COVID-19 pandemic shows that the majority of respondents experienced substantial psycho-emotional burden. The largest proportion of participants - 44 respondents (3,6%) - reported a high level of stress, while an additional 34 respondents (28,3%) indicated a very high level of stress. This means that nearly two-thirds of specialists experienced serious psycho-emotional strain during the

pandemic. A moderate level of stress was reported by 28 participants (23,3%), whereas a low level of stress was reported by 11 respondents (9,1%). Only 3 physicians (2,5%) reported that they had not experienced stress during the examined period.

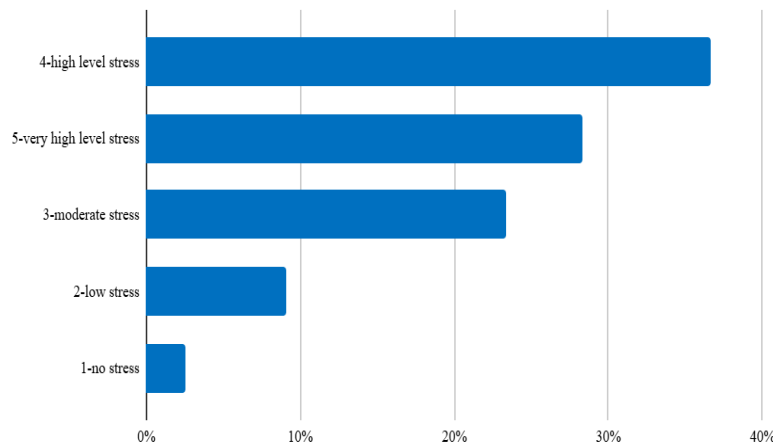


Figure 18: Assessment of stress levels among otorhinolaryngologists using a 5-point scale

Using crosstabulation, an association was identified between stress level and professional experience among otorhinolaryngologists during the COVID-19 pandemic, showing a statistically significant relationship ( $\chi^2(12)=22,9; p=0,029$ ). Only 3 physicians (2,5%) reported that they had not experienced stress during the period examined. The highest proportion of respondents indicating a very high level of stress was observed among physicians with more than 21 years of professional experience - 13 individuals (10,8%). This was followed by specialists with 11-20 years of experience (8 respondents; 6,7%) and by the youngest group with less than 10 years of experience (9 respondents; 7,5%). Among residents, 4 respondents (3,3%) reported experiencing very high stress. A high level of stress was most frequently reported by physicians with more than 21 years of experience - 18 respondents (15,0%). In the group with 11-20 years of experience, this proportion was 13 respondents (10,8%), while among the youngest physicians it was 6 respondents (5,0%), and among residents 7 respondents (5,8%). A moderate level of stress was observed mainly among physicians with less than 10 years of experience - 12 respondents (10,0%)-and those with more than 21 years of experience - also 12 respondents (10,0%), whereas in the other groups this proportion was lower. A low level of stress was reported primarily by physicians with more than 21 years of experience - 9 respondents (7,5%)-and by those with 11-20 years of experience - 2 respondents (1,7%). No stress was reported only by two physicians with more than 21 years of experience (1,7%) and one resident (0,8%).

These results emphasise that more experienced specialists were exposed to higher levels of stress during the pandemic, whereas the lowest stress levels were observed mainly among residents and physicians with the shortest professional experience.

Stress level	Work experience								Chi-square statistic $\chi^2$ (df)	p-value
	Group 1 (<10 y.)		Group 2 (11- 20 y.)		Group 3 (>21 y.)		Group 4 (residents)			
	n	%	n	%	n	%	n	%		
1- no stress	0	0	0	0	2	1,7	1	0,8	22,9 (12)	0,029
2- low stress	0	0	2	1,7	9	7,5	0	0		
3- moderate stress	12	10	3	2,5	12	10	1	0,8		
4- high stress	6	5	13	10,8	18	15	7	5,8		
5- very high stress	9	7,5	8	6,7	13	10,8	4	3,3		
Total	27	22,5	26	21,7	54	45	13	10,8		

Table 25: Characteristics of the statistical association between stress level and professional experience among otorhinolaryngologists. Statistically significant differences ( $p < 0.05$ ) were observed between stress level categories and professional experience; note: n=number,  $\chi^2$ =chi-square test; df=degrees of freedom; p=probability

The relationship between stress level and the workplace during the COVID-19 pandemic was also examined and demonstrated a statistically significant association ( $\chi^2$  (4)=12,4;  $p=0,015$ ). The data indicate that physicians working in hospital settings reported significantly higher stress levels compared with those working in outpatient care. The largest proportion of hospital-based physicians - 34 (28,3%) - reported a high level of stress, while 23 (19,2%) reported a very high level of stress.

Among outpatient specialists, the corresponding proportions were 10 respondents (8,3%) reporting high stress and 11 respondents (9,2%) reporting very high stress, which is considerably lower than among hospital physicians.

A moderate level of stress was reported by 21 hospital physicians (17,5%) and 7 outpatient specialists (5,8%). A low level of stress was reported mainly by outpatient physicians - 8 respondents (6,7%), compared with only 3 respondents (2,5%) in hospital settings. No stress was reported exclusively by three hospital physicians (2,5%), while no such cases were recorded among outpatient specialists.

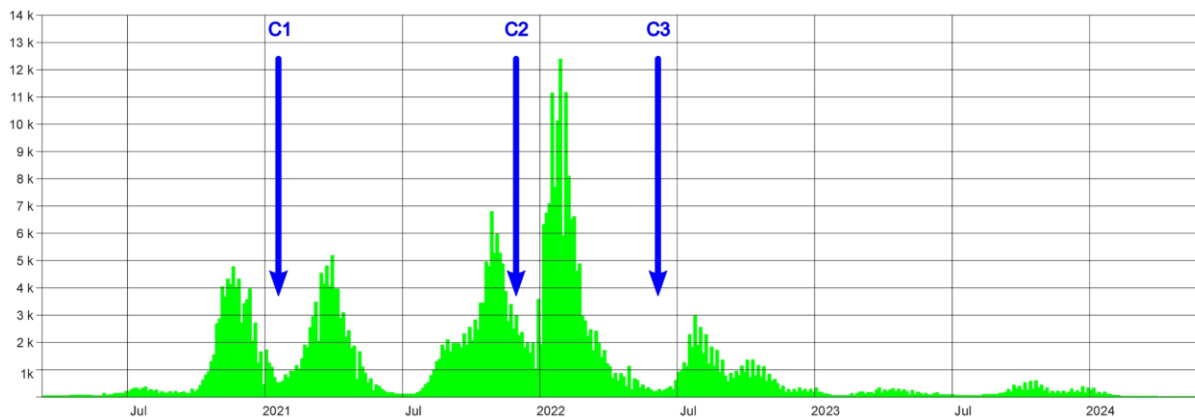
Stress level	Workplace settings				Chi-square statistic $\chi^2$ (df)	p-value
	Hospital-based		Outpatient-based			
	n	%	n	%		
1- no stress	3	2,5	0	0	12,4 (4)	0,015
2- low stress	3	2,5	8	6,7		
3- moderate stress	21	17,5	7	5,8		
4- high stress	34	28,33	10	8,3		
5- very high stress	23	19,2	11	9,2		
Total	84	70	36	30		

Table 26: Characteristics of the statistical association between stress level and work environment. Statistically significant differences ( $p < 0,05$ ) were observed between stress level categories and workplace.; note: n=number;  $\chi^2$ =chi-square test; df=degrees of freedom; p=probability

These results clearly emphasise that working in a hospital environment during the pandemic was associated with higher levels of psycho-emotional stress among otorhinolaryngologists, compared with their colleagues in outpatient care.

### 4.3. Mucormycosis

During the COVID-19 pandemic, in the period between January 2021 and May 2022, three cases of rhino-cerebral mucormycosis (ROCM) were diagnosed and treated for the first time in the Department of Otorhinolaryngology (two men and one woman). The mean age of the patients was  $60,3 \pm 17,8$  years (range: 40-73 years). All patients had a history of COVID-19 infection and concomitant metabolic disorders, specifically type II diabetes mellitus.



*Figure 19: Incidence of COVID-19 cases and waves in Bulgaria based on data from the COVID-19 Single Information Portal in Bulgaria.; note: C1 - presentation of the first case; C2 - presentation of the second case; C3 - presentation of the third case*

#### Case 1

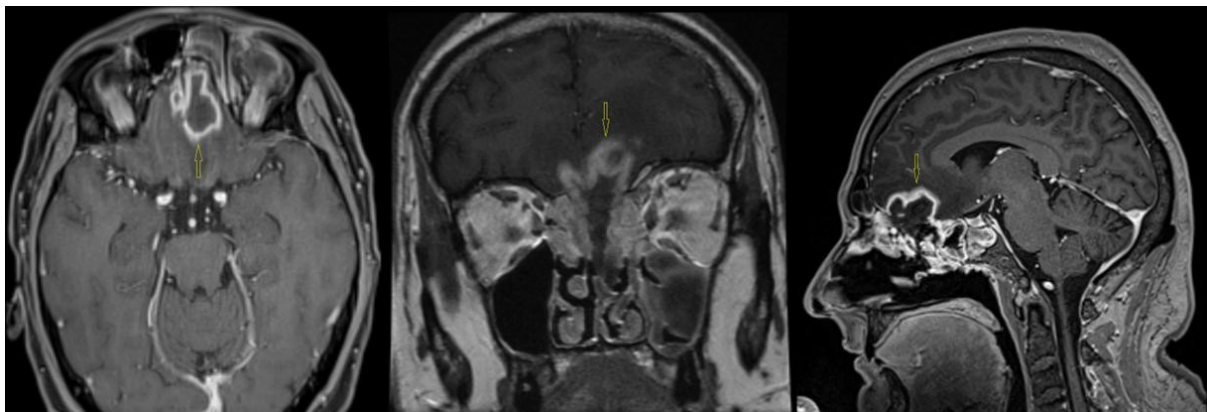
In January 2021, a 40-year-old man was admitted with a two-year history of type II diabetes mellitus, with good glycemic control, treated with a combination drug (sitagliptin/metformin hydrochloride 50/850 mg twice daily). Two months before admission, the patient had suffered from COVID-19 infection with bilateral pneumonia, treated with levofloxacin, ceftriaxone, meropenem, fluconazole, dexamethasone, and oxygen therapy. He had not been vaccinated against COVID-19.

Current complaints included rhinorrhea, severe headache, and diplopia. Endoscopy of the upper airways demonstrated an atypical black and necrotic left middle nasal turbinate, with minimal changes in the surrounding structures.



*Figure 20: Endoscopic view of the mummified left nasal turbinate (Case 1)*

Imaging studies (CT and MRI) revealed pansinusitis involving the left maxillary and sphenoidal sinuses and multiple ethmoidal cells, osteolysis of the lamina cribrosa, and bilateral frontal lobe abscesses.



*Figure 21: MRI post-contrast evaluation (AX T1 VIBE DIX+C, COR T1 VIBE DIX+C u SAG 3DT1+C); A: axial, B: coronal, C: sagittal plane showing cerebral abscess (arrows) with perifocal oedema, and left-sided pansinusitis (Case 1)*

A middle turbinectomy, ethmoidectomy, nasal debridement, and drainage of the brain abscess through the lamina cribrosa were performed. Microbiological examination of nasal secretions demonstrated the presence of *Staphylococcus aureus*. Initial histology revealed granulation tissue rich in neutrophils, lymphocytes, and macrophages; however, a retrospective histological review with additional staining identified typical *Mucorales* hyphae, confirming the diagnosis of mucormycosis.

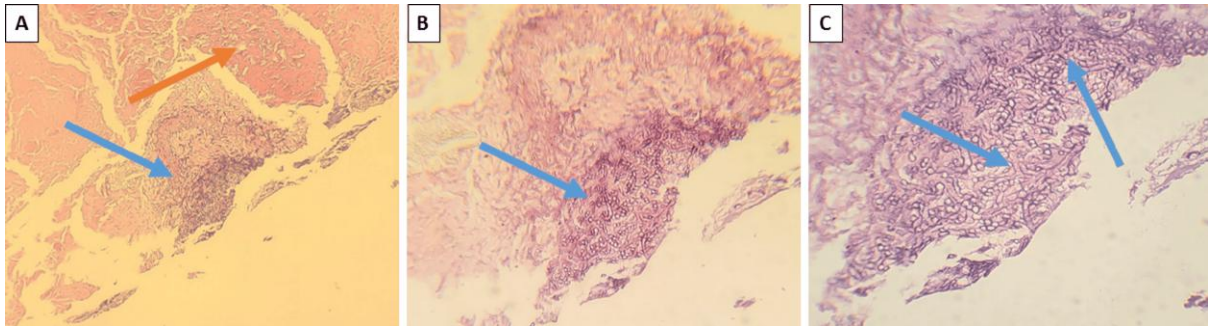


Figure 22: Histopathological findings; A - necrotic tissue (orange arrow) and perivascular hyphae (blue arrow), H&E stain, original magnification  $\times 40$ ; B - broad, pauciseptate hyphae (arrow), H&E stain, original magnification  $\times 100$ ; C - pauciseptate hyphae with irregular  $90^\circ$  branching (arrows), H&E stain, original magnification (Case 1)

No antifungal therapy was administered. The postoperative course was uneventful, and follow-up endoscopic examinations revealed no necrotic tissue in the nasal cavity.

#### Case 2

A 68-year-old woman with type II diabetes mellitus and poor glycemic control, treated with metformin, was admitted in December 2021 to the ENT department with complaints of nasal obstruction, pain, swelling, redness, collapse of the nasal dorsum, and oedema and hyperemia of the orbital region. Three months earlier, the patient had suffered from COVID-19 with bilateral pneumonia, treated with antibiotics and corticosteroids. She was hospitalised twice consecutively for coronavirus infection and treated with cefoperazone, levofloxacin, amoxicillin/clavulanic acid, meropenem, and corticosteroids. During these hospitalisations, severe hyperglycemia ( $>50,0$  AU/ml) and renal failure were documented. No oxygen therapy was administered. The patient was not vaccinated against COVID-19.

Endoscopic examination revealed abundant crusts in the nasal cavity. CT imaging demonstrated chronic pansinusitis with extensive bone defects involving the ethmoidal cells, nasal septum, lamina papyracea, and hard palate, as well as a small orbital abscess.

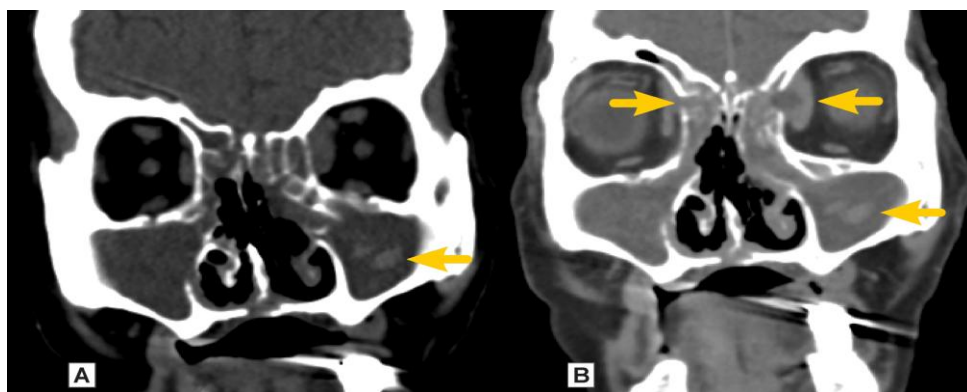
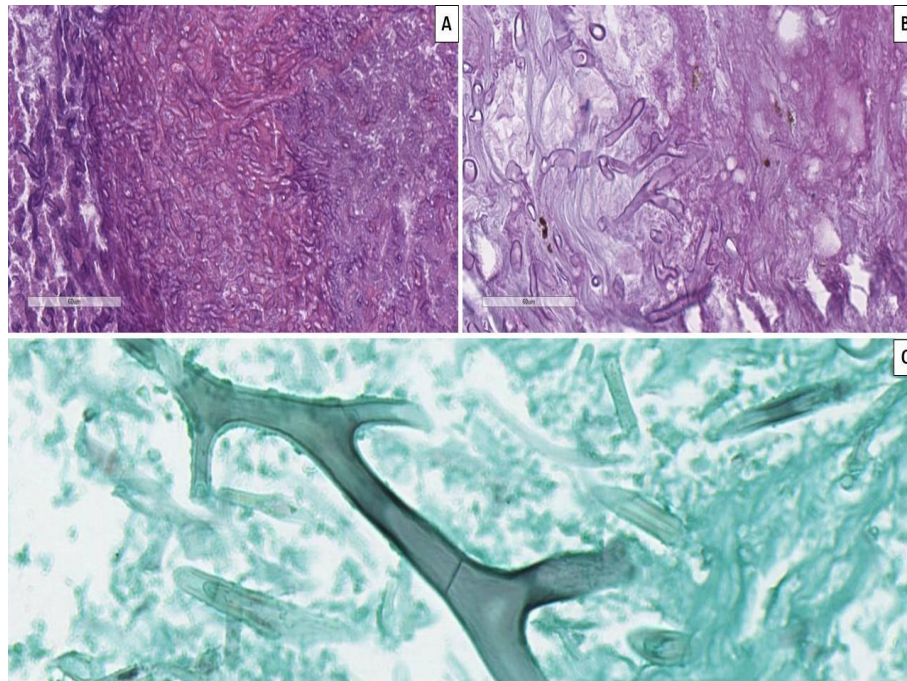


Figure 23: (A)- CT findings in coronal plane showing hyperdense regions in maxillary sinus (arrow); (B) – postcontrast CT showing no significant contrast enhancement of the region and thinning and osteolysis of the medial wall of the right orbit with some fluid collection (arrow) (Case 2)

Endoscopic surgical treatment was performed, including aggressive debridement, ethmoidectomy, and medial maxillectomy. Histopathological examination confirmed mucormycosis with angioinvasion, and microbiological culture isolated *Enterobacter cloacae*.

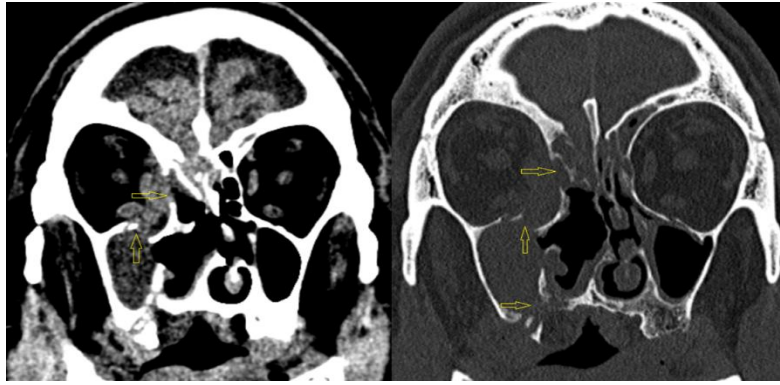


*Figure 24: Histopathological features of mucormycosis; (A) - hematoxylin-eosin staining, original magnification  $\times 400$ ; (B) – fungal microorganism septae and branching seen in PAS stain, original magnification  $\times 400$ ; (C) - fungal microorganism septae and branching, Grocott stain, original magnification  $\times 400$  (Case 2)*

Due to a temporary shortage of amphotericin B in the country, antifungal therapy was not administered. Postoperatively, minimal fistulization to the skin occurred in the region of the nasal root. The patient was discharged and subsequently lost to follow-up. At reassessment 3,5 years later, the patient presented with severely impaired nasal breathing and deformity of the external nose, but was in good general condition.

### Case 3

A 73-year-old man was admitted in April 2022. He had not been vaccinated against COVID-19. Imaging studies revealed destruction of the walls of the right maxillary sinus, involvement of the pterygoid processes, pterygopalatine fossa, ethmoidal labyrinth, and frontal sinus, as well as erosion of the orbital wall with a subperiosteal abscess. Findings also indicated intracranial extension into the anterior cranial fossa with meningeal involvement and the presence of an oroantral fistula.



*Figure 25: Figure 30: Native CT findings; (A)- native CT and (B)- native CT showing the right maxillary sinus filled with fluid-equivalent content, osteolysis of the superior wall toward the right orbit (arrow), osteolysis of the medial orbital wall (arrow), and an oroantral fistula (arrow) (Case 3)*

Endoscopic sinus surgery was performed with the removal of all necrotic tissues, resulting in the formation of a large septal defect. Histological and microbiological examinations, as well as PCR analysis, confirmed the diagnosis of mucormycosis. Due to good local recovery and absence of systemic manifestations, antifungal therapy was not administered.

## 5. DISCUSSION

### 5.1. Analysis of the activity of the Department of Otorhinolaryngology

#### 5.1.1. Reduction in the total number of hospitalisations

The results demonstrated a pronounced reduction in hospitalisations during 2020 and 2021 compared with the pre-pandemic years. Several main factors contributed to this decline. On the one hand, there were restrictions on hospital activity. During 2020 and 2021, elective admissions were repeatedly suspended at a national level, particularly during the peaks of the pandemic waves. These measures were also reflected in regional restrictions implemented by the hospital administration. In 2020, elective hospital activity was prohibited on 81 out of 366 calendar days, corresponding to 22%, or slightly less than one quarter of the entire year. In 2021, this proportion increased to 50%, with 182 days of lockdown compared to 183 days of unrestricted elective activity.

A change in patient behaviour was also observed. Many patients postponed seeking medical care due to fear of infection in a hospital environment. Additionally, a substantial portion of hospital resources was redirected toward COVID-19 pathology. Part of the ENT bed capacity and staff were reassigned to COVID-19 units, which limited the capacity for hospitalisations due to otorhinolaryngological diseases. Furthermore, a reduction in the incidence of non-COVID respiratory infections was observed. Due to anti-epidemic measures, there was an overall decline in the spread of upper respiratory tract infections, which also resulted in fewer hospitalisations. This effect was most evident in early 2020, when the most severe restrictions were imposed across the country.

Similar findings have been reported in international studies. For example, a study from Italy reported a 78% reduction in elective otorhinolaryngological hospitalisations during the spring of 2020 (Gallo et al. 2020). Comparable data has also been published by university hospitals in Spain, Germany, France, and the United States, where routine ENT activity was reduced to a minimum during lockdowns (Herranz-Larrañeta et al. 2021; Mayo-Yáñez et al. 2021; Hervochon et al. 2020; Wolpert et al. 2024; Krishnan et al. 2023). A dramatic decline in routine otolaryngological infections was reported by Mettias B. et al. in the United Kingdom and by Cui Chong et al. in China (Mettias et al. 2023; Cui et al. 2020).

After the first pandemic wave, the number of hospitalisations and consultations gradually returned to previous levels, indicating adaptation of the healthcare system (Owen et al. 2024). Our results confirm the globally observed decline in ENT hospitalisations during the COVID-19 pandemic. They are supported by robust objective evidence and align with the broader international context of the pandemic.

#### 5.1.2. Seasonal and monthly dynamics of hospitalisations before and during COVID-19

“St. Marina's Hospital” - Varna during the study period. In 2018 and 2019, a typical seasonal pattern of hospitalisations was observed. This pattern is characteristic of ENT clinics in temperate climate regions (Hawkes et al. 2021; Moriyama et al. 2020). A study conducted at the University Hospital of Leicester, United Kingdom, demonstrated a seasonal peak in ENT infection-related hospitalisations during the winter months (Mettias et al. 2023). Similar results

were reported in Germany by Seidel et al., who demonstrated increased outpatient and inpatient ENT activity in late autumn and winter (Seidel et al. 2025).

With the onset of the pandemic, this pattern was significantly disrupted, with a marked decline in hospitalisations during spring and winter, periods associated with the highest epidemic pressure. The  $\chi^2$  test used in our study to compare monthly data between the pre-pandemic period (2018-2019) and the pandemic period (2020-2021) yielded  $p < 0,001$ , confirming a statistically significant decrease. Individual monthly comparisons using the t-test showed the strongest effect during April-May.

Similar trends have been reported in the international literature. Patel et al. conducted a study between 1 March and 31 May in 2019 and 2020 across two tertiary healthcare centres covering Manhattan, the Bronx, Queens, and Long Island (USA), including 10,162 documented cases. The results showed a significant reduction in patients presenting with acute otorhinolaryngological complaints in 2020 compared with the corresponding period in 2019. The proportion of emergency department visits related to ENT complaints decreased by a substantial 61,4% (Patel et al. 2021).

In Germany, Kapsner et al. conducted a retrospective study across 18 university hospitals and reported a 35% reduction in hospitalisations during weeks 1-4 of the first lockdown in 2020 compared with the same period in 2018, and a 30,3% reduction during weeks 5-8 (35).

Several studies confirm the global nature of these changes. Qatanani et al. used the COVID-19 TrinetX database (Cambridge, Massachusetts, USA), a rapidly expanding global network of electronic medical records (EMR) containing extensive data on over 90 million patients from 67 healthcare organisations in the United States. Their study included data on 2 005 796 otorhinolaryngological surgical procedures performed in 45 medical organisations. Comparison of the mean monthly procedural volume during the pandemic period (2020-2021) with the corresponding seasonal values from the pre-pandemic years (2018-2019) revealed a statistically significant decline across all seasons. Annual analysis showed that the volume of ENT surgical activity decreased markedly in every season following the onset of the pandemic, with the most pronounced decline during the first COVID-19 wave, namely between late 2019 and spring 2020 (Qatanani et al. 2022).

A German study involving two specialised care centres and 11 277 cases reported a significant reduction in ENT emergency department visits in southwestern Germany during the second quarter of 2020 compared with the same period in 2019 - 30,8% fewer emergency visits and a 37,8% reduction in hospitalisations. The most pronounced decline was observed in inflammatory conditions: skin infections (-51,2%), tonsillitis (-55,6%), sinusitis (-59%), and acute otitis media (-70,4%) (Wolpert et al. 2024).

In 2021, Wright et al. reported a reduction in hospitalisations in the United Kingdom and Northern Ireland. Specifically, for March, April, and May 2020 compared with the same period in 2019, the reductions were 59%, 94%, and 91%, respectively.

In a study conducted at Rush University, Chicago, the mean number of ENT consultations before the pandemic (June 2019-February 2020) was  $1,67 \pm 0,24$  per day, while during the first COVID-19 wave (March-May 2020) this number sharply decreased to  $0,86 \pm 0,33$  per day, representing a statistically significant reduction ( $p < 0,01$ ) (Owen et al.

2024). Herranz-Larrañeta et al. reported an almost 50% reduction in patients seeking specialised ENT care in Spain during the first pandemic wave (March-May 2020).

The disrupted seasonal pattern and the decline in monthly hospitalisations have significant clinical and organisational consequences for patients and the healthcare system. Patients with chronic conditions or requiring elective interventions postponed treatment, leading to deterioration of clinical status and an increase in emergency admissions. This phenomenon is also observed in the present study, where the proportion of emergency hospitalisations increased from 18,3% in 2018 to 41,7% in 2021.

### 5.1.3. Change in the structure of emergency care

In 2021, the University of Cambridge published a report from an in-depth study analysing data on the number of emergency otorhinolaryngology cases during the lockdown imposed in the United Kingdom as a result of the COVID-19 pandemic. The results reported by Stansfield et al. clearly demonstrate that during the period March-June 2020, there was a sharp decline in emergency ENT hospitalisations, with the number of emergency admissions decreasing by up to 90% compared with the same period in 2019 for certain diagnoses. This reduction was explained not only by quarantine measures and the cancellation of elective surgeries, but also by a substantial change in patient behaviour, as patients often postponed seeking medical care due to fear of infection in a hospital environment (Stansfield et al., n.d.).

Similar results have been reported from Germany. Beisel et al. conducted a retrospective study across several ENT clinics and found that the overall number of emergency visits to ENT departments decreased by 42,2% during the first months of the pandemic (spring-summer 2020) compared with the corresponding period of the previous year. In addition, the authors noted a particularly marked reduction in patients with inflammatory diseases of the upper respiratory tract, such as sinusitis, tonsillitis, and otitis. This was attributed both to social isolation and mask wearing, as well as to limited access to primary care consultations and specialist referrals. A similar percentage reduction in emergency ENT diagnoses was also reported by Bulut et al., who found that epistaxis was the most common emergency diagnosis before the pandemic and remained so during the pandemic. Sapountzi et al. likewise reported a markedly reduced level of emergency ENT activity in Greece. In their study, the number of emergency cases in 2020 was compared with the period 2013-2019, revealing a reduction of up to 73%. The authors also emphasised that this decline may lead to delayed diagnosis of more serious conditions, including head and neck malignancies.

The French experience also confirms these trends. Carré et al. analysed data on pediatric emergency ENT consultations and procedures in Paris, France, and found a 54% decrease in consultations and a 33% reduction in emergency surgical interventions in children.

Despite these international findings, our study within the ENT clinic indicates that the number of emergency hospitalisations remained relatively stable. This suggests that despite the crisis and the overall reduction in elective activity, the need for emergency medical care in otorhinolaryngology did not decrease but, in certain aspects, may have even increased. Similar observations have been reported in other studies. For example, Hughes et al. analysed the number of ENT consultations at their university hospital affiliated with Syracuse University (NY) and found an increase in emergency consultations over a longer time period (2014-2021).

They noted that although the pandemic led to an initial decline, in the longer term, there was a recovery and even an increase in demand for emergency ENT care (Hughes et al., n.d.).

Comparable findings have also been reported from Israel. At Tel Aviv University, Tsur et al. documented an increase in the number of emergency pediatric consultations at the Schneider Children's Medical Centre. The authors noted that the pediatric population may not have been fully subject to the elective-care restrictions introduced during the pandemic.

#### 5.1.4. Diagnostic profile of hospitalised patients

Many international publications report a regressive trend in oncological cases during the pandemic. The medical literature describes a retrospective cohort study conducted at a university hospital among patients with newly diagnosed head and neck squamous cell carcinoma (HNSCC) during the period September 2019 - September 2020, divided into two groups: before and during the first six months of the COVID-19 pandemic. During the pandemic period, a 22% decrease in the number of newly diagnosed cases was observed. On the other hand, despite a similar time to diagnosis and treatment in both periods, advanced-stage tumours (T3/T4) and larger tumour sizes were significantly more frequent during the pandemic. This suggests that patients sought medical care later, resulting in a worse prognosis (Solis et al. 2021; Barsouk et al. 2023).

In a cross-sectional study published in *JAMA Otolaryngology - Head & Neck Surgery*, a decline from 11,6 to 10,8 cases per 100,000 population of early diagnosed head and neck cancer (HNC) was observed between 2019 and 2020. This represents a 7,9% reduction, with the largest decrease (14,3%) recorded for laryngeal carcinoma. An analysis of the U.S. National Cancer Database (2021) published by Stanford University identified a 9,1% decrease in newly diagnosed head and neck cancers. An even greater decline (12,4%) was observed in the number of patients who received surgical treatment during the first phase of the pandemic.

Other authors have reported a reduction of over 50% in new tumour cases per month during COVID-19 (4,8 cases per month) compared with the pre-COVID cohort (10,9 cases per month) (Crossley et al. 2022). Decker (2023) reported an average 23% decrease in all newly diagnosed cancers during the coronavirus crisis. When analysed by anatomical site, reductions were 50% for head and neck malignancies, 46% for breast cancer, 35% and 47% for colon and rectal cancer, respectively. The decrease in melanoma reached 65%.

An analysis of hospitalisation trends for malignant diseases in the ENT clinic indicates that during the first pandemic year (2020), the number of oncological patients did not decline; instead, it remained slightly higher than in preceding years. Comparable findings have been reported by other authors. A Polish study, for example, documented a higher incidence of laryngeal and laryngopharyngeal carcinomas during the pandemic period - 75% compared with 63% before COVID-19 (Pietruszewska et al., 2022).

At the same time, our data demonstrates a statistically significant increase in emergency oncological hospitalisations, including patients with laryngeal carcinoma admitted on an emergency basis ( $p < 0,05$ ). This is an alarming trend, likely reflecting both delayed presentation and more advanced disease at admission. Regarding the time from symptom onset to diagnosis, data reported by Pietruszewska et al. (2023) show that before the pandemic, 66% of patients reported symptoms lasting more than one month, whereas during the pandemic this proportion increased to 78% ( $p = 0,04$ ), suggesting a delay in the diagnostic process.

Although the overall number of oncological cases in our study did not differ significantly between the two analysed periods, the pronounced rise in emergency oncological hospitalisations in 2020-2021 strongly suggests a shift in healthcare-seeking behaviour. Laryngeal carcinoma, one of the most common malignant tumours in otorhinolaryngology, also demonstrates an increased number of emergency admissions, from an average of 10 per year before the pandemic to 21,5 per year during the pandemic years.

It is important to emphasise that even under pandemic conditions, adequate oncological care was maintained at the ENT Clinic of St. Marina University Hospital, Varna. This reflects good organisation, an effective triage system, and a responsible clinical strategy prioritising emergency and oncological cases. Such an approach has been strongly recommended by professional associations such as the European Head and Neck Society (EHNS) and the American Academy of Otolaryngology - Head and Neck Surgery (AAO-HNS), which issued early pandemic guidelines to ensure continuity of oncological care.

The dynamics of emergency presentations for other common otorhinolaryngological diagnoses during the pandemic are also not unidirectional. In a study by Elli et al. conducted in Italy, emergency ENT consultations and hospitalisations were analysed in the context of the COVID-19 pandemic. The authors found a substantial reduction in the number of visits compared with the same periods in the previous two years - 68,2% compared with 2018 and 62,16% compared with 2019. The most pronounced decline was observed between March 23 and 30, 2020, when visits dropped by 89% compared with 2019 and 91% compared with 2018. This period coincided with the peak COVID-19 incidence in the Lombardy region. The most affected categories were facial trauma (70% reduction), foreign bodies in the aerodigestive tract (68% reduction), infectious and inflammatory conditions such as acute tonsillitis, otitis, pharyngitis, and abscesses (59% reduction), as well as epistaxis (47% reduction) (Elli et al. 2020).

Aggregated data from a systematic review by Munchel et al. from the Medical University of South Carolina includes 14 studies evaluating the impact of the COVID-19 pandemic on otorhinolaryngological pathology in emergency department settings. Among the analysed studies, ten were conducted in general emergency departments, three in paediatric emergency departments, and one focused specifically on a geriatric population aged over 65 years. The total number of included patients was 13790, of whom 68,5% were from the pre-lockdown period and 31,5% after lockdown implementation. Meta-analysis of proportions revealed significant changes in the otorhinolaryngological profile of patients seeking emergency care. A slight decrease in abscess cases was observed (to 1,52%). Conversely, the frequency of epistaxis increased from 12,5% before the pandemic to 16,9% afterward. The number of foreign body cases also increased, from 5,8% pre-lockdown to 9,2% during lockdown. Although the anatomical location of foreign bodies was not specified in the reviewed studies, a notable increase in incidents involving ingestion of batteries and magnets in children was reported - a trend likely related to prolonged time spent at home during lockdown. Additionally, the frequency of acute respiratory failure increased from 8,2% to 9,9%, although the underlying causes of this change were not specified in the analysed sources.

Allen et al. reported that in 2020, there was a significant decrease in the overall number of emergency cases compared with 2019. Despite this overall decline, an increase in nasal fracture cases was noted, which the authors associated with a higher incidence of domestic

violence during the pandemic. An increase in cases of foreign bodies in the nose was also observed, although the specific type of foreign body was not detailed. According to our experience, this often involved retained fragments of nasopharyngeal swabs used for coronavirus testing. During the pandemic, the most frequently performed otorhinolaryngological procedure in Bulgaria was the collection of a nasopharyngeal swab for COVID-19 diagnosis (Milcheva et al. 2022).

Bucher et al. conducted a study in Switzerland and reported an overall 44% reduction in all emergency otorhinolaryngological consultations. Specifically, a decrease was noted in cases of epistaxis, malignant tumours, foreign bodies, and abscesses, which corresponds to the categories examined in our study. In contrast, Campagnoli et al. reported data from Italy showed a 25% increase in foreign body cases during the pandemic, a finding that closely aligns with our results. At the same time, the frequency of epistaxis decreased. Information regarding malignant tumours and abscesses was not included in their study, as these conditions were not among the four most common diagnoses in the investigated department.

In the United Kingdom and Northern Ireland, Wright et al. presented aggregated data comparing March-May 2020 with the same months in 2019 and identified a decline in epistaxis cases. This was attributed, on the one hand, to the application of Rapid Rhino nasal packing directly in emergency departments in accordance with updated national guidelines during the COVID-19 crisis in the UK. On the other hand, the reduced number of epistaxis cases was partly due to the suspension of elective rhinological surgeries and the significantly lower rate of postoperative complications requiring emergency intervention. A decrease was also observed in the frequency of peritonsillar abscesses, head and neck malignancies, and foreign bodies.

Dehbidi Assadzadeh et al. compared the pandemic period with the two years preceding it and reported a statistically significant increase in foreign body cases in ENT organs among children. Interesting observations were reported by Festa et al. and Pizzol et al., who described an increase in battery ingestion in children as a consequence of isolation. According to Festa et al., the overall number of foreign body cases in the UK increased 2,5-fold. Klein et al. confirmed this trend, noting an increase in all ingested foreign body cases during the pandemic, with a particularly high incidence of battery ingestion.

Under conditions of reduced contact between children and limited exposure to respiratory pathogens, the observed reduction in the frequency of exacerbations of chronic conditions is a logical consequence. This phenomenon highlights the important role of external factors-social, behavioural, and organisational influencing the frequency and dynamics of ENT pathology. Anti-epidemic measures aimed at limiting the spread of SARS-CoV-2 also led to an unintended but beneficial reduction in the circulation of other respiratory viruses, including influenza, RSV, adenoviruses, and others (Principi et al. 2023). Analyses published in the international literature demonstrate a significant decline in infectious diseases among children during the pandemic, which logically results in fewer exacerbations of chronic inflammatory ENT conditions and, consequently, fewer hospitalisations (Patel et al. 2021; Hartnett et al. 2020).

Nevertheless, the decline in pediatric elective hospitalisations does not imply the disappearance of pathology but rather a temporary suppression of its manifestation and reduced access to surgical treatment. With the reopening of schools and the return to normal social

activity, these cases will likely increase again, which must be considered when planning resources and capacity in ENT departments in the post-pandemic period.

This is further supported by numerous international studies reporting a significant reduction in emergency department visits and outpatient consultations during the pandemic, even for conditions requiring surgical treatment. The most pronounced decline was observed in children under 14 years of age (Hartnett et al. 2020).

An interesting paradox observed in some hospitals, including our clinic, is the persistence of the frequency of certain ENT diagnoses despite the overall decline in hospitalisations. The most common diagnoses among patients treated in the ENT clinic remained unchanged compared with previous years. Deviated nasal septum, adenoid hypertrophy, and chronic tonsillitis continued to dominate among nosological entities requiring hospitalisation. Adenoid hypertrophy (J35.2) showed the most pronounced decline. This decrease is particularly concerning given the age profile of affected patients—primarily children and the potential impact on their development and health in the absence of timely treatment. Adequate management of adenoid hypertrophy is crucial for preventing recurrent infections, hearing problems, rhonchopathy, obstructive sleep apnea, and disturbances in sleep and development.

Comparable downward trends were also observed for tonsillar and adenoid hypertrophy (J35.3) and chronic tonsillitis (J35.0). A slower but steady decline was noted for J34.2 (deviated nasal septum). This may be explained by the broader clinical applicability of this diagnosis, encompassing both adults and children, as well as the ability of some patients to insist on treatment, particularly in cases of severe nasal obstruction that significantly impairs quality of life.

A comparison of our results with international studies is noteworthy. Several independent investigations conducted in different countries confirm a marked reduction in symptoms related to adenoid and tonsillar hypertrophy in children during lockdowns. Gelardi et al. followed 120 children scheduled for adenotonsillectomy before and during pandemic isolation in Italy and found significant symptom improvement, with mean symptom scores decreasing from 6,7 to 4,1 ( $p < 0,0001$ ). The authors emphasise that even without surgical intervention, symptoms improved markedly during isolation, suggesting a key role of infectious pathogens in the pathogenesis and dynamics of these conditions.

These findings are supported by a study by Zwierz et al., which examined 60 children aged 3-6 years awaiting surgery for adenoid hypertrophy. After a period of isolation due to anti-epidemic measures, 92% of parents reported improved nasal patency, and 63% of children stopped snoring. Objective data from follow-up endoscopic examinations showed a mean reduction in adenoid size of 5,4%, most pronounced in children with grade III adenoid hypertrophy. The authors concluded that limited social exposure and reduced infection rates stabilise the nasopharyngeal microbiome and reduce chronic inflammatory stimulation leading to adenoid hypertrophy and tissue enlargement.

Two independent clinical studies reach similar conclusions: isolation measures during the pandemic led to a significant reduction in symptoms and the need for surgical treatment in patients with adenoid hypertrophy and related conditions. The present results call into question the traditional approach to the surgical management of adenoid hypertrophy, particularly in children. The practice of “waiting on a surgical list” during the pandemic may have proven not

only an inevitable organisational solution, but also an opportunity to observe the natural course of the condition under conditions of reduced viral and bacterial load. This opens a discussion on refining the indications for adenoidectomy and tonsillectomy, as well as on developing non-invasive strategies for symptom control, especially during periods of low circulation of respiratory infections.

The data demonstrate a convincing overall decline in the frequency of hospitalisations due to bleeding from the respiratory tract during the pandemic period. This systematic decrease can be interpreted through several possible clinical and organisational perspectives:

1. Increase in outpatient management - a likely trend toward broader control of bleeding conditions in the outpatient setting.
2. Restriction of hospital admissions during the COVID-19 pandemic, especially in 2020-2021, when many emergency conditions were managed conservatively or referred only if life-threatening.
3. Shift in diagnostic coding - cases that would previously have been classified under Class R may have been recorded under other diagnostic codes, such as trauma, neoplasms, or infectious conditions.
4. Stricter admission criteria - under the resource constraints characteristic of the pandemic period, hospitalisations were often limited to severe and life-threatening conditions.

Due to the forced suspension of functional endoscopic sinus surgery (FESS), there was a broader implementation of monoclonal antibodies for the treatment of chronic rhinosinusitis, with excellent results. Biological therapy has become established as a significant therapeutic alternative in borderline and severe cases of chronic rhinosinusitis with nasal polyposis, particularly when standard treatment (including FESS) fails to provide sustained disease control. This supports observations of increased interest in and use of biological therapies during the COVID-19 period, when surgical interventions were often restricted and the need for safe, non-surgical, and effective treatments increased (Low et al. 2024; Galletti et al. 2023; Gerstacker et al. 2023; Blaiss et al. 2024).

#### 5.1.5. Tracheostomy - Local Trend versus Global Practice

Before the pandemic, meta-analyses and randomised clinical trials supported the benefits of early tracheostomy. One such meta-analysis by Andriolo et al. (2015), including eight randomised trials comparing the timing of tracheostomy in critically ill patients, found that tracheostomy performed within 10 days after intubation was associated with significantly lower mortality. In addition, patients who underwent early tracheostomy were discharged from intensive care units more rapidly by day 28. Thus, even before the pandemic, a consensus had been forming regarding the potential advantages of early tracheostomy in patients with severe respiratory failure, including reduced risk of ventilator-associated pneumonia, facilitated mechanical ventilation, improved airway care, and faster weaning from ventilatory support. However, Siempos et al. found no difference in mortality between patients undergoing very early tracheostomy (within 48 hours) and those undergoing late tracheostomy after 15 days of intubation.

Tracheostomy was the most common surgical procedure performed in infected patients during the SARS epidemic. The emergence of SARS-CoV-2 posed major challenges to

healthcare systems and led to a rapid increase in the number of ICU patients requiring mechanical ventilation. Although mortality from SARS-CoV-2 is lower compared with SARS-CoV-1, the proportion of critically ill patients requiring invasive ventilation remains substantial due to the development of acute respiratory distress syndrome (ARDS) (Tay et al. 2020; Yang et al. 2020). According to Mechem et al., this proportion reaches up to 42%. This once again placed tracheostomy at the centre of intensive care and surgical management of COVID-19 patients. According to McGrath et al., during the pandemic, tracheostomy became a key procedure for prolonged ventilation in patients with severe COVID-19, alongside the development of protocols for its safe performance.

Studies from the pre-pandemic period indicate that approximately 13% of patients with ARDS undergo tracheostomy (Bellani et al. 2016; Abe et al. 2018). During the pandemic, however, the need for prolonged ventilation and the burden on intensive care structures led to a reassessment of the timing of the procedure and more frequent indications for its use.

Some of the largest hospitals in the United States, the United Kingdom, Spain, and Italy reported an increase in tracheostomies in their ICUs during peaks of infection. Angel et al. described the successful application of modified protocols for early percutaneous tracheostomy performed between days 7 and 10 after intubation. Chao et al. reported that up to 50% of COVID-19 patients requiring prolonged ventilation underwent tracheostomy, resulting in faster ventilator weaning and shorter hospital stays.

According to an international study involving 59 healthcare institutions in 26 countries, the optimal timing for tracheostomy in COVID-19 patients varies widely, from 3 to 28 days after intubation (Bier-Laning et al. 2021). Only four countries recommend performing the procedure before day 14. Most protocols (n=18), however, avoid specifying strict timeframes and favour an individualised approach, such as “waiting until the active infection has passed,” “only when necessary,” or “after viral negativity.” Among the protocols that do specify timing (n=43), 91% recommend tracheostomy no earlier than 14 days after the initiation of mechanical ventilation. These recommendations reflect concerns about the risk of aerosol transmission of SARS-CoV-2 during the procedure and the need to protect healthcare personnel by delaying intervention during the active phase of infection.

A study conducted in Spain by Martin-Villares et al., including 1890 COVID-19 patients across 120 hospitals between March and May 2020, reported that 16,4% of intubated patients underwent tracheostomy, the highest documented rate in Spanish practice to date. The study involved 254 otorhinolaryngologists and highlighted the sharp increase in surgical interventions during the pandemic.

A similar trend has been observed in Italy. Merola et al. analysed the frequency of tracheostomies in eight intensive care units between March and May 2024. The data showed a rate of 9,1% among mechanically ventilated patients, or 1,8 procedures per 1000 hospitalisation days. This confirms that even after the peak of the pandemic, the frequency of tracheostomies remains higher than pre-pandemic levels.

Significant changes have also been observed among patients with head and neck tumours. A Polish multicenter study involving four university hospitals compared two identical time periods before and during the pandemic, September 2019/2020 and 2020/2021. A total of 136 patients with head and neck cancer were included. The mean frequency of tracheostomies increased from  $1,8 \pm 1,1$  before the pandemic to  $3,8 \pm 2,8$  during it. An increase in cases of

emergency dyspnea was identified, attributed to advanced disease stage at diagnosis, likely due to delayed medical consultation. At the same time, a reduction in procedures performed under general anaesthesia was observed—from 64% to 56% in patients with laryngeal tumours, probably related to patients' clinical condition and difficulties in performing standard intubation (Pietruszewska et al. 2022).

Additional data from Batra et al. also support this trend. A prospective study of patients with head and neck cancer (HNC) operated on during the pandemic demonstrated an increase in elective tracheostomies from 6,7% before the pandemic to 28,6% during it. This reflects a change in surgical strategy aimed at securing the airway and minimising aerosol spread during operations in potentially infected patients.

In contrast to the observations cited above, our study reveals an opposite trend. In the hospital where the present analysis was conducted, a reduction in the number of tracheostomies performed during the pandemic period was observed. This decline can be explained by several possible factors. First, the postponement or suspension of elective surgeries, including in patients with oncological diseases for whom elective or emergency tracheostomy is often indicated. Second, a change in protocols for the management of respiratory failure, namely the avoidance of early tracheostomy. Despite the existence of international safety protocols applied in Western countries, in Bulgaria, there was initially a significant delay or avoidance of the procedure due to concerns about aerosolisation and risk to the medical team. According to Takhar et al., many hospitals in Europe adapted their techniques by using high-level personal protective equipment and minimally invasive approaches. In Bulgaria, however, logistical difficulties and staff shortages during the most heavily burdened periods likely limited the feasibility of implementing these approaches.

Third, another possible explanation for the observed reduction in tracheostomies in our setting is a change in the patient profile. While in the international series, COVID-19 patients undergoing tracheostomy were predominantly intubated for more than 10 days, in our institution, a significant proportion of critically ill COVID-19 patients died before reaching indications for tracheostomy and therefore did not proceed to surgical treatment. According to McGrath et al., mortality among critically ill COVID-19 patients in Europe and the UK exceeds 50%, mirroring the findings of Chinese authors. A comparison with international data from Spain is noteworthy: Sancho et al. reported that more than 20% of hospitalised COVID-19 patients in intensive care underwent tracheostomy. Such rates were not reached in our centre, reflecting a different patient flow and case mix.

In addition to clinical and logistical factors, ethical considerations must also be taken into account. Tracheostomy in patients with an uncertain prognosis or end-stage organ failure was often avoided to prevent the additional risk associated with transporting the patient to a COVID-designated surgical unit. During such transfers (to the operating room and back), ventilation via portable ventilators was frequently compromised, posing a high risk to patients. This led to stricter patient selection for tracheostomy, particularly under conditions of system overload. As a result of long-standing experience and a consensus among anesthesiologists, intensivists from various specialities, and otorhinolaryngologists, tracheostomy has traditionally been performed in the operating room. The present data provide a basis for reconsidering this approach.

Another important aspect to note is the lack of clear national guidelines for performing tracheostomies in COVID-19 patients in Bulgaria during the early stages of the pandemic. This resulted in variability in practice between hospitals and uncertainty in decision-making. In contrast, in countries such as the United Kingdom, consensus documents were developed early in the pandemic by leading professional societies (e.g., ENT UK, Intensive Care Society), which had a significant impact on standardising clinical practice (Brendan A. McGrath et al. 2020).

## 5.2. Risks and Challenges in Otorhinolaryngological Practice During COVID-19

### 5.2.1. Analysis and Interpretation of Data from the National Survey

The analysis of the respondents' age structure and professional experience showed that the study was dominated by specialists with long-standing professional experience, with the largest proportions represented by physicians aged 51-60 years and those with more than 21 years of experience in the speciality. This indicates active participation of well-established professionals in the survey, whereas younger physicians and residents were represented to a lesser extent.

The distribution of participants by workplace further confirms this trend. The largest number of surveyed specialists work in hospital-based healthcare facilities. These findings suggest that hospital-based physicians demonstrated higher responsiveness and engagement in completing the survey, likely reflecting both their greater professional workload during the pandemic and their more direct involvement in the diagnosis and treatment of COVID-19 patients and ENT-related complications.

The lower level of participation among physicians working in outpatient care can be explained by several factors. On the one hand, these specialists were less frequently involved in the direct management of patients with confirmed COVID-19 infection, as a significant proportion of cases were referred to hospitals. On the other hand, their workload differed within outpatient practice. The pandemic led to a temporary reduction in routine preventive and elective consultations, which may have influenced perceived risk and motivation to participate in the study. Additionally, the smaller organisational capacity of outpatient facilities and differences in access to information may also explain their lower response rate.

The majority of practising otorhinolaryngologists reported working at more than one workplace. These data indicate a clearly expressed tendency toward professional mobility among ENT specialists and the combination of employment across different healthcare settings. This can be explained by the need to secure additional employment and income and by the desire to expand clinical experience and access a broader patient population.

When assessing the risk of infection, otorhinolaryngologists identified dentists and emergency physicians as the professional groups with the closest level of infection risk to their own. This can be attributed to the shared characteristics of their clinical practice, which involve frequent and prolonged close contact with patients' upper airways, as well as procedures associated with aerosol generation. During the pandemic, these factors were decisive in determining the high degree of exposure and the perceived increased risk of infection. Almost all ENT specialists in the country perceived their professional practice during the early stages of the pandemic as being associated with a substantial risk of exposure and infection. The high

proportion of respondents who assessed the probability of infection as high reflects both the specific nature of ENT clinical activity, characterised by proximity to the upper respiratory tract, and the limited access to personal protective equipment, as well as the lack of knowledge regarding viral transmission mechanisms during the first months of the pandemic.

Similar perceptions have been documented in numerous international studies. Research from Italy, Spain, and the United States shows that otorhinolaryngologists were considered and likewise self-identified as one of the highest-risk medical groups due to frequent contact with the upper airways and participation in aerosol-generating procedures (Anagiotos and Petrikkos 2020; Grag and Kumar Shubhanshu 2022; Yu et al. 2020; Tysome and Bhutta 2020). Globally, ENT specialists and dentists were consistently ranked among the professional categories with the highest perceived risk, which aligns with the findings of the present Bulgarian study.

Nearly half of the respondents stated that they did not believe they could effectively protect themselves from infection. The high degree of uncertainty among Bulgarian ENT specialists during the studied period is thus clearly evident. The fact that the majority of respondents either doubted the effectiveness of protective measures or were uncertain can be explained by several key factors: the limited availability of personal protective equipment in the early stages of the pandemic, the high frequency of work in aerosol-generating settings, direct contact with the upper airways, and the absence of established safety protocols during the initial months of the pandemic. Similar attitudes have been observed internationally. Studies from European Union countries indicate that a significant proportion of healthcare professionals experienced feelings of vulnerability and insufficient protection even when using available protective equipment (Kroneman et al. 2024; Ralli et al. 2020). In the United States, Workman et al. likewise reported that otorhinolaryngologists perceived their interventions, especially endoscopic procedures, as high-risk and considered protective measures inadequate under conditions of equipment shortages (Sharma and Bhardwaj 2020). Comparable findings have also been reported in India, where studies revealed high levels of anxiety and doubts regarding the effectiveness of personal protective measures among ENT specialists. In this context, the Bulgarian results fit into the global picture, which identifies otorhinolaryngologists as one of the physician groups with the highest perceived risk and simultaneously the lowest confidence in the full effectiveness of available protective equipment. This underscores the need for systematic provision of resources and standardised training for work under pandemic conditions, in order to minimise subjective insecurity and ensure better protection of specialists.

Notably, none of the respondents identified the operating room as a location associated with an increased risk of infection. This is likely due to stricter infection control protocols and the mandatory use of high-grade personal protective equipment during surgical procedures, which limit staff exposure. The results emphasise that outpatient practice was perceived as the highest-risk environment by ENT specialists. This perception can be explained by frequent and close contact with a large number of patients, often without prior COVID-19 screening, as well as by diagnostic and therapeutic procedures involving the upper airways that generate aerosols. The second most frequently cited high-risk activity was tracheostomy and the care of tracheostomized patients. At the same time, a considerable proportion of physicians also expressed concern about the risk of infection in the community, reflecting the widespread

circulation of the virus during that period and the perceived difficulty of achieving effective personal protection outside the clinical environment.

Overall, the survey data clearly demonstrate that the highest perceived COVID-19 risk among otorhinolaryngologists was associated with routine daily examinations and procedures involving direct access to the airways. This highlights the need for particular attention to protective protocols in outpatient practice and during high-risk procedures such as tracheostomy.

### 5.2.2. Awareness Regarding the COVID-19 Pandemic

The majority of respondents reported feeling sufficiently informed, relying primarily on scientific publications, institutional websites, and colleagues as their main and most reliable sources of information. Social media and mass media played a secondary role. This highlights a clear preference for access to credible and professionally validated information. Of particular interest is a small proportion of respondents (14.3%) who stated that they felt overexposed to misinformation. This group reflects a significant challenge related to the “infodemic”, a phenomenon widely observed during the COVID-19 crisis, in which large volumes of contradictory or inaccurate information complicate clinical judgment and professional practice. Zarocostas describes the “infodemic” as one of the greatest challenges for healthcare professionals, as the abundance of conflicting data often leads to confusion and increased anxiety within the medical community. In this context, the Bulgarian results align with the global picture, confirming that even among highly qualified specialists such as otorhinolaryngologists, the infodemic had a tangible impact on risk perception and the sense of being adequately informed. This underscores the importance of institutionally guaranteed, reliable, and regularly updated information sources for the medical community.

### 5.2.3. Organisation of Work

The analysis of the impact of the COVID-19 pandemic on the organisation of work among otorhinolaryngologists in Bulgaria reveals marked changes. The high proportion of specialists reporting significant changes reflects adaptation of clinical practice to the new conditions through a combination of measures (limiting patient flow, introducing scheduling systems, remote consultations) and clinical strategies (targeted triage, restriction of invasive procedures, use of protective barriers). In this context, the results of the Bulgarian study are consistent with international observations and confirm that otorhinolaryngologists were among the most adaptive medical specialists, implementing new organisational and clinical models in response to the pandemic situation.

Approximately one-fifth of respondents reported only minimal changes, suggesting a certain degree of resilience within some structures or the presence of more flexible organisational models that allowed easier adaptation. Only 7 respondents (5,7%) stated that no change occurred in the organisation of their work, emphasising the exceptional rarity of maintaining a normal working rhythm during the pandemic.

The state of emergency led to a substantial transformation of daily practice, necessitating the introduction of new safety standards that are likely to have a lasting impact on future clinical protocols. This multi-component personal protection strategy fully corresponds to the recommendations of an international research team (Kowalski et al.),

according to which, during all interventions involving the upper respiratory tract, such as rhinoscopy, flexible laryngoscopy, and tracheostomy, medical personnel should be equipped with personal protective equipment, including an N95 mask, gown, cap, eye protection, and gloves. Kowalski et al. emphasise that otorhinolaryngologists are among the highest-risk specialists in the context of the pandemic, underscoring the need to prioritise their protection.

#### 5.2.4. Changes in the Structure of Morbidity During the Pandemic

Our data show that 54,2% of surveyed otorhinolaryngologists reported a decrease in the number of patients with acute respiratory infections (ARI) of non-COVID-19 origin during the pandemic, while 23,3% reported an increase. The remaining 22,5% observed no change. These findings correspond to international studies demonstrating a substantial decline in the incidence of influenza and other respiratory infections following the implementation of anti-epidemic measures. For example, Avadhanula and Piedra document an “unexpected” benefit of public health measures, leading to the prevention of epidemics of common respiratory viruses during 2020-2021. The following measures, such as mask use, social distancing, and restrictions on gatherings, significantly influenced the epidemiology of multiple viral infections. Similar conclusions were presented by Chow et al., who noted that the reduction in respiratory viral infections, including influenza and RSV, was most pronounced in the early phases of the pandemic and resulted in a significant decrease in hospitalisations and mortality rates. In this context, data from the Bulgarian study support the notion that implemented measures not only limited the spread of SARS-CoV-2 but also had a secondary effect in reducing other respiratory pathogens. This confirms that such interventions could serve as a sustainable long-term strategy for controlling seasonal ARIs in the future.

#### 5.2.5. Dynamics of Emergency Care

Our data indicates that approximately one quarter of otorhinolaryngologists in Bulgaria observed an increase in emergency conditions. This trend may be attributed to several factors. First, postponement of procedures and visits-some patients likely sought medical care only after deterioration of their condition due to delayed elective visits and fear of hospital environments. Diagnostic shift is also observed, whereby mild clinical symptoms may have remained unrecognised due to the focus on COVID-19, contributing to later disease presentation. The reorganisation of healthcare services, namely prioritising emergency cases and restricting elective activity, may have influenced the relative proportion of emergency conditions. Munhall et al. explain the observed increase in the relative share of non-infectious emergency conditions (such as epistaxis, foreign bodies, and airway obstruction) after lockdown by the proportional reduction in infectious diseases associated with reduced social contacts aimed at preventing SARS-CoV-2 transmission (Munhall et al. 2023).

According to the majority (60%) of surveyed Bulgarian physicians, no change in the number or characteristics of emergency cases was observed. Foreign studies report the opposite trend-a reduction in visits to ENT emergency units, particularly for low-acuity cases, while maintaining the number of life-threatening emergencies (Wolpert et al. 2024; Deekonda et al. 2022; Benhoummad et al. 2022).

Special emphasis on a particular patient group-the pediatric population- reveals highly polarised data. Our results correspond with numerous international publications that also report

a drastic reduction in pediatric cases, including acute otitis media and OSAS (Carré et al. 2021; Cheng et al. 2022; Marom et al. 2022; Favoretto et al. 2022; Noda et al. 2024).

Another critical aspect of healthcare practice during COVID-19 is the perceived delay in the diagnosis and treatment of oncological diseases. In our national survey, 68,6% of otorhinolaryngologists confirmed this perception. International literature outlines a clear trend: the COVID-19 pandemic caused serious disruptions in oncological care pathways, including within ENT practice, both in terms of delayed diagnosis and limited access to treatment. Moreover, cases that did present were often characterised by increased disease severity and a greater need for complex reconstructive interventions (Tevetoğlu et al. 2021). A study from South Tyrol (Italy) demonstrates a significant reduction in newly diagnosed head and neck cancers after lockdown, as well as a decline in early-stage cancers, indicating delayed diagnosis and presentation at more advanced disease stages (Gazzini et al. 2022).

#### 5.2.6. Financial Impact of the Pandemic on Physicians' Income

The trend toward reduced physician income during the pandemic is well-documented in the international literature. The American Medical Association (AMA) reported that medical practices in the United States experienced an average 32% decline in revenue in 2020, while specialities such as otorhinolaryngology recorded up to a 24% reduction in Medicare payments. According to The Physicians Foundation, approximately 49% of physicians reported decreased income, and 32% experienced staff reductions in their practices. Conversely, a study from Brazil found that physicians working exclusively in the public sector reported increased workload and associated income during the second peak of the pandemic (de Oliveira et al. 2022).

Our data confirms that physicians' financial outcomes differed according to professional experience, role, and degree of involvement in COVID-19-related activities. Mid-career specialists were exposed to greater financial pressure during the pandemic and were less involved in COVID-19 activities. Income increases were more commonly reported among younger physicians and residents, who played a more active role in COVID-19 care. Our results indicate that not only professional experience but also the work environment are key determinants of the pandemic's financial impact on physicians. Younger specialists and residents, as well as those working in COVID-19 units, had greater opportunities for financial compensation, whereas experienced hospital-based physicians sustained more substantial losses (Milcheva and Sapundzhiev 2025).

#### 5.2.7. Stress Levels Among Otorhinolaryngologists

The results of the study demonstrate a significant psychological burden among otorhinolaryngologists during the COVID-19 pandemic. A substantial proportion of respondents - 78 (65%)-reported high or very high stress levels, while only a small fraction underwent formal psychological assessments, and even fewer followed recommended coping strategies. This is consistent with international studies reporting high levels of burnout, anxiety, and depression among frontline healthcare workers (Crotty et al. 2021).

In the present study, a statistically significant association was found between stress level and professional experience, with mid-career specialists and older physicians experiencing higher levels of psychological distress. This trend is probably linked to increased

professional responsibilities - both clinical and administrative - combined with the necessity to adjust to rapidly changing protocols.

The work environment also proved to be particularly important. Hospital-based physicians reported significantly higher stress levels compared with their colleagues in outpatient care. This finding may be explained by the higher volume of emergency cases, direct contact with infected patients, increased procedural risk, and sustained occupational stress inherent to hospital practice.

International data corroborate this trend. Phonmanee et al. reported high levels of stress, anxiety, and depression among frontline otorhinolaryngologists in a university hospital in Thailand. Linzer et al. noted significantly higher stress levels among hospital physicians in the United States compared with outpatient practitioners, while Šiupšinskienė et al. documented a high prevalence of burnout syndrome among otorhinolaryngologists in Lithuania, particularly among older specialists and those working in hospital settings.

Historical data from previous epidemics confirm that crisis periods increase the psycho-emotional burden on healthcare workers. During the Ebola epidemic (2014-2015) in Sierra Leone, medical staff directly involved in patient care reported depression, paranoia, and obsessive-compulsive symptoms (Ji et al. 2017). Similar findings were reported during the SARS epidemic (2003), when up to 57% of healthcare workers experienced emotional distress (Tam et al. 2004).

Interestingly, a 2021 study by Walvik et al. in Denmark did not identify severe anxiety or depression symptoms among otorhinolaryngologists during the pandemic. This is likely attributable to better epidemiological control, extensive coronavirus testing, and widespread use of personal protective equipment in the country.

### 5.3. Mucormycosis

The three cases presented during the COVID-19 pandemic represent the first observed cases of rhino-cerebral mucormycosis in our clinic. All three patients had a history of COVID-19 infection and type II diabetes mellitus. The COVID-19 pandemic led to a marked increase in the incidence of mucormycosis, particularly in countries such as India, where thousands of cases were reported among patients with COVID-19 and diabetes (Patel et al. 2021). The association between coronavirus infection and the development of mucormycosis appears multifactorial, involving a combination of SARS-CoV-2-induced immunosuppression, uncontrolled diabetes, hyperglycemia, prolonged corticosteroid and broad-spectrum antibiotic therapy, hypoxia, and prolonged hospitalisation.

Beyond well-known risk factors, the possibility of a nosocomial aetiology in some cases warrants attention. The medical literature documents outbreaks associated with contaminated hospital linens. Cultures from “freshly laundered” linens in transplant centres frequently show contamination with Mucorales, and several mucormycosis outbreaks have been traced to inadequate laundering and storage processes (Sundermann et al. 2019). Environmental contamination (air, surfaces, oxygen outlets) with *Mucor* spp. has also been documented in intensive care units, underscoring the importance of strict environmental control (Abd El-Baky et al. 2023).

In the context of COVID-19, the potential role of oxygen humidifiers and non-sterile water has been widely discussed. Analyses suggest that poorly maintained humidifiers may

serve as reservoirs for fungi and bacteria; some authors consider this a possible cofactor for COVID-19-associated mucormycosis (CAM), particularly in overburdened healthcare systems. Importantly, not all studies detect Mucorales in humidifiers, and targeted microbiological inspections have yielded negative results in some settings. Thus, the “humidifier → CAM” link is plausible but not universally proven and is likely context-dependent (Ravindra and Ahlawat 2021).

During the pandemic, nasopharyngeal testing for COVID-19 diagnosis was used extensively. According to the National Health Information System (NHIS) in Bulgaria, 11650230 tests were performed as of 16 March 2024. With a population of 6,4 million, it can be roughly estimated that individuals subject to testing underwent an average of three tests. Collection of nasopharyngeal swabs likely represents the most frequently performed ENT procedure in the country during the COVID-19 pandemic. These tests were often supplied by non-traceable vendors of unclear origin (including regions endemic for mucormycosis), raising concerns about potential microbiological contamination of swabs. In the context of an overburdened healthcare system, accelerated procurement, and insufficient quality control, the possibility of iatrogenic inoculation of pathogenic fungal spores directly into the nasal cavity or nasopharynx during diagnostic sampling cannot be excluded. Such a mechanism could explain cases with rapid disease progression in patients without severe immunosuppression but with a history of frequent nasopharyngeal testing. This hypothesis aligns with the broader framework of preventing healthcare-associated outbreaks reported as early as 2015 (Cheng et al. 2016).

The international literature to date has focused primarily on COVID-19-associated immunosuppression and diabetes as the main risk factors for mucormycosis. Nevertheless, several recent reports have highlighted the possibility of contamination of medical consumables and their association with the development of invasive fungal infections in the hospital setting (Boodman and Cheng 2021; Bruno et al. 2020). The presence of uncontrolled procurement and supply of tests and materials during the pandemic raises the question of novel, previously unrecognised etiological pathways for infections such as mucormycosis.

Our three cases, all with a history of frequent nasopharyngeal testing during or after COVID-19 infection, further draw attention to the need for more in-depth investigations into possible nosocomial transmission. Although a causal relationship cannot be definitively established at this stage, the temporal association, the detection of various microbial contaminants in some samples, and the absence of antifungal prophylaxis underscore the necessity for future research in this direction.

The review by Hoenigl et al. outlines the global landscape of mucormycosis, emphasising its high lethality, diagnostic challenges, and the need for early, aggressive surgical management combined with systemic antifungal therapy. In our series, all three patients demonstrated extensive destruction of bony structures, and in two cases, there was intracranial extension, highlighting the aggressive nature of the infection. Diagnosis was challenging; in the first case, mucormycosis was confirmed retrospectively by histopathology, and systemic antifungal therapy was not administered in any of the three cases due to logistical constraints. The lack of antifungal treatment in our patients represents a significant limitation; nevertheless, local disease control was achieved, albeit with residual defects and functional impairment in one case (Case 2).

Concerning treatment, the ECMM/MSGERC guidelines recommend early, aggressive surgical debridement in combination with systemic antifungal therapy as the standard of care for mucormycosis; timely surgery is critical for limiting invasion and improving survival (Cornely et al. 2019). In rhino-orbital-cerebral mucormycosis, endoscopic endonasal debridement is preferred because of superior visualisation, lower invasiveness, and the possibility of staged, “on-demand” extension; multiple series have linked early endoscopic debridement with reduced fungal burden and containment of disease spread, including a lower need for orbital exenteration (Keshri et al. 2023; Arora et al. 2022). In cases with severe orbital involvement, management is individualised, ranging from endoscopic orbital debridement and decompression to exenteration in uncontrolled disease; some treatment algorithms also include transcutaneous retrobulbar amphotericin B injections to preserve the globe. Evidence from the COVID-19 period further emphasises that the combination of early surgery and systemic antifungal therapy is associated with better clinical and radiological outcomes, whereas delays increase mortality (Shah et al. 2022).

Our clinical experience suggests that early intervention with extensive debridement alone was sufficient to control infection in patients with purely intracavitary and intracranial involvement (Cases 1 and 3). The second case raises the hypothesis that the chronic, relatively stable course of the disease may have resulted from initially insufficient debridement, as radical surgery would have required resection of the external nose, an intervention associated with high morbidity and profound functional and aesthetic consequences. However, evaluation of this hypothesis is limited by the lack of long-term follow-up and the absence of systemic antifungal therapy, which precludes definitive conclusions. Nevertheless, the endoscopic surgical approach demonstrates substantial advantages over traditional open surgery, offering superior visualisation, reduced invasiveness, and the potential for favourable therapeutic outcomes-even in the absence of systemic antifungal treatment.

## 6. CONCLUSIONS

1. The COVID-19 pandemic leads to a lasting systemic effect on hospital activity, manifested by a reduction in hospitalisations, disrupted seasonality, and a diagnostic shift toward more severe pathology.
2. Oncological care has been preserved in terms of volume, but with a significant change in the mode of admission. The proportion of emergency oncological hospitalisations has increased, suggesting delayed diagnosis and later clinical presentation. These findings draw attention to hidden dysfunctions in the oncological care system, likely exacerbated by the pandemic, and highlight the need for adapted screening and diagnostic strategies in crisis conditions in order to maintain uninterrupted access to oncological care even during a pandemic.
3. The obtained results do not demonstrate an increase in the number of tracheostomies performed during the studied period, which contrasts with published international data. This suggests specific organisational and clinical characteristics of local hospital practice and underscores the importance of regional factors and differences in therapeutic strategies when interpreting global trends.
4. The analysis of the results from the national survey outlines a picture of exceptional organisational and psychosocial pressure on otorhinolaryngological practice during the COVID-19 pandemic.
5. The COVID-19 pandemic is associated with the emergence of invasive fungal infections that are atypical for Bulgaria. Early and radical endoscopic surgical intervention is crucial for infection control in rhino-orbital-cerebral mucormycosis, even in the absence of systemic antifungal therapy. Endoscopic surgery emerges as the primary method of treatment for ROCM.
6. The results from the analysis of hospital activity and the national survey confirm the presence of an “organisational shift” typical of global practice - prioritisation of oncology and emergency care, restriction of elective activity, accelerated implementation of safety measures, and the need for long-term support for the mental health and professional resilience of medical staff.

## 7. CONTRIBUTIONS

1. A systematic historical review of major pandemics - from Antiquity to the present-has been conducted, with a focus on their impact on upper respiratory tract diseases and the organisation of otorhinolaryngological care.
2. The study proposes an original scientific model for assessing the pandemic effect on a medical speciality highly exposed to airborne infections, through a combination of epidemiological, socio-professional, and organisational analyses.
3. The present study systematically documents and analyses, for the first time, the effect of the COVID-19 pandemic on the activity of an ENT clinic in Bulgaria, revealing specific changes in the volume, structure, and organisation of hospital care and providing an objective basis for optimising clinical protocols and resource management during future epidemic crises.
4. For the first time, a series of clinical cases of COVID-19 - associated rhino-orbital-cerebral mucormycosis is described.
5. An original questionnaire in the Bulgarian language was developed to investigate the attitudes of practising specialists. Empirical data from Bulgarian ENT practice during the pandemic were documented and analysed, and a database was established for comparison with international studies. This questionnaire could also serve as a basis for research in other medical specialities in Bulgaria.
6. The study provides a quantitative and qualitative assessment of the organisational, professional, and psycho-emotional effects of the pandemic on the speciality of otorhinolaryngology at the national level. The conclusions and recommendations may serve as a foundation for the development of national protocols for safe ENT practice during future pandemics.

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## PUBLICATIONS

1. **Milcheva K**, Sapundzhiev NR, Georgiev R, Stoyanov GS, Niyazi D. Post-COVID-19 Related Rhinocerebral Mucormycosis in Bulgaria: A Report of Three Cases . Published: October 26, 2024 CUREUS; DOI: 10.7759/cureus.72434

2. **Milcheva K**, Sapundzhiev NR. Impact of COVID-19 on Otorhinolaryngologists in Bulgaria: A Survey of Healthcare Professionals. Published: February 18, 2025 CUREUS; DOI: 10.7759/cureus.79229

6. **Milcheva K**, Sapundzhiev NR. „The most common manipulation in otorhinolaryngology – from A to X“ - MEDINFO n.10,2022, p. 76-79

## REPORTS

1. **Милчева К**, Сапунджиев НР, Георгиев Р, Ниязи Д, Стоянов ГС, Косев И. Пост-COVID-19 мукормикоза - екзотика или ново ежедневие. XVI Национален конгрес по оториноларингология, 07-09 октомври 2022 г., Бургас

2. **Милчева К**, Сапунджиев Н, Димова А, Хаджиева Ст, Михайлов Н, Методиева В. Влияние на COVID-19 върху оториноларингологичната практика - национално анкетно проучване. XVII Национален конгрес по оториноларингология 6-8.10.2023 г., Поморие

3. **Milcheva K**, Sapundzhiev N, Metodieva V. Retrospective attitude of otorhinolaryngologists to the COVID-19 pandemic. CEORL-HNS 06.2024 Dublin, Ireland (e-Poster)