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COVID-19 Pandemic Specificity in Emergency ENT Department: Urgent Admissions for Dyspnea in Order to Restore the Airway

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Abstract

Importance: The COVID-19 pandemic changed the profile of patients admitted to the ENT emergency department due to the acute dyspnea.

Objective: To determine if the organizational changes (telemedicine appointments, limitation of inpatient services) and an increase in the number of patients treated with mechanical ventilation during the COVID-19 pandemic influenced the scope of patients admitted as an emergency and treated in the tertiary-referral otolaryngology department.

Design: The aim of the study is to compare the clinical features of two cohorts of patients: "pre-COVID-19" (2019/2020) and "COVID-19" (2020/2021), admitted as an emergency for dyspnea in order to restore the airway.

Setting: The therapeutic activity of the ENT Emergency Department of a University Clinic in two time periods: September-February 2019/2020 and 2020/2021 were analyzed.

Participants: In the "pre-COVID-19" period, 5,102 planned outpatient visits, 1,260 emergency visits, and 1,520 operations were performed, and in the "COVID-19"period, 5,270, 1,371, and 1,232, respectively. 27 and 31 patients were admitted and treated, respectively, for laryngeal dyspnea in the first and the second period. Patients who developed dyspnea due to HNC (19 and 17 patients) and LTS (8 and 14 patients) were included in these two "pre-COVID-19" and "COVID-19" cohorts. Urgent dyspnea was defined as a significant deterioration of respiratory comfort, with inspiratory-expiratory dyspnea and a decrease in oxygen saturation below 90%. Laryngoscopy or transnasal videolaryngoscopy using flexible scopes was performed; the necessary information was taken from patients' documentation, family, or post the surgery. Tumor location and extent in oncology group and dynamic information on laryngeal mobility, grade and level of the stenosis, swallowing function, tracheal malacia and distal airway in LTS was assessed. Each patient admitted due the urgent dyspnea was included in the study.

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Introduction

The COVID-19 pandemic has changed all aspects of social life; however, its greatest long-term impact is visible in the organization of the healthcare system. The use of healthcare services for elective specialists and emergency conditions was altered during this period [1]. Due to the overcrowding of the emergency departments and fear of infection, patients with serious or life-threatening conditions unrelated to COVID-19 failed to seek medical attention. A displacement of the specialist care to other venues such as telemedicine visits was observed [2].

An analysis of changes in the ENT services, regarding both acute hospitalizations and planned procedures, has not been published so far. One of the most important trends observed in this period seemed to be a spike in admissions for immediate life-threatening reasons such as laryngeal dyspnea.

Infectious and internal medicine departments, as well as intensive care units, were enlarged and the number of mechanically ventilated patients increased sharply with successive waves of the pandemic, which may result in an increased number of post-treatment complications. These include narrowing of the upper airways, i.e. Laryngotracheal Stenosis (LTS), following prolonged intubation or bedside transcutaneous tracheotomies. LTS caused the dyspnea or an inability to decannulate

upon discontinuation of intensive therapy. Some authors report the delayed onset of dyspnea resulting from prolonged intubation in COVID-19 convalescents, which can manifest itself after the successful removal of the tracheal tube as early as 10 days [3] and up to a month after discharge from ICU [4]. These are patients who, as COVID-19 convalescents, urgently seek the help of laryngologists and phonosurgeons.

In contrast, there has been a huge reduction in medical services in certain areas of healthcare, especially in primary and outpatient specialist care [5,6]. These changes also affected Head and Neck Cancer Patients (HNC). Due to telemedical visits, a limitation of inpatient services, or, finally, individual fear of contact with the health service, the diagnosis, and implementation of cancer treatment was delayed. The consequence of this was (and still remains) the admission of patients with extremely high-stage HNC, with severe dyspnea, urgently requiring tracheotomy [7-9].

The above phenomena have been observed in clinical practice since autumn, 2020, whereas now, i.e. in the spring of 2021 and at the verge of another wave of the pandemic, they require detailed analysis and reorganizing treatment procedures, and taking remedial measures. Therefore, changes in the profile of activities of ENT emergency and departments dealing with the HNC and LTS should be expected.

The research hypothesis assumes that organizational changes (telemedicine appointments, limitation of inpatient services) and an increase in the number of patients treated with mechanical ventilation during the COVID-19 pandemic influenced the scope of patients admitted as an emergency and treated in the tertiary-referral otolaryngology department.

The aim of the study is to compare the clinical features of two cohorts of patients: "pre-COVID-19" (2019/2020) and "COVID-19" (2020/2021), admitted as an emergency for dyspnea in order to restore the airway.

Methods

The therapeutic activity of the Department of Otolaryngology Poznań Medical University of two time periods: September-February 2019/2020 and 2020/2021 was compared. In the first period, 5,102 planned outpatient visits, 1,260 emergency visits, and 1,520 operations were performed, and in the second period, 5,270, 1,371, and 1,232, respectively. 27 and 31 patients were admitted and treated, respectively, for laryngeal dyspnea in the first and the second period. Patients who developed dyspnea due to HNC (19 and 17 patients) and LTS (8 and 14 patients) were included in these two "pre-COVID-19" and "COVID-19" cohorts.

Urgent dyspnea was defined as a significant deterioration of respiratory comfort, with inspiratory-expiratory dyspnea and a decrease in oxygen saturation below 90%. The time from registration in the emergency room to performing the procedure (tracheotomy or dilatation) ranged from 15 min to 180 min; average 95 min, median 60 min.

Diagnostic workup: Laryngoscopy or transnasal videolaryngoscopy using flexible scopes was performed; the necessary information was taken from patients' documentation, family, or post the surgery. Tumor location and extent in oncology group and dynamic information on laryngeal mobility, grade and level of the stenosis, swallowing function, tracheal malacia and distal airway in LTS was assessed. CT of the larynx and trachea in none of the patients was performed before the procedure. All LTS patients have had chest imaging performed in the last 3 weeks before admitting and in all of them the absence of radiological changes in the lungs were stated, no other alterations like tracheal or laryngotracheal stenosis had been reported by the radiologist as well.

Treatment in oncology group: Tracheostomy, as a treatment of choice, was performed in all patients. Treatment in the LTS group varied. The final goal in the management of early post-intubation LTS was to avoid a tracheostomy. The goal in the management of unsuccessfully decannulated LTS patients was to avoid re-tracheostomy. Dilatations by bougies or rigid bronchoscopic instrumentation plus steroid injection were applied in 17 patients. Systemic use of antibiotics and anti-inflammatory drugs, as prevention of excessive scar tissue formation, was a routine. Endoscopic removal of granulation tissue plus injection of corticosteroids was necessary in 1 post-tracheotomy LTS case, but the CO_2 was not used, according to our routine experience. These maneuvers were well tolerated even by comorbid patients and had been repeated in a 4 to 8 week sequence. In 4 LTS cases, tracheostomy was absolutely necessary. In 2 cases, it was performed as low as possible, not to cause further damage to the stenosed cricoid cartilage, and not to compromise further the adjacent healthy tracheal rings. In 2 cases of low-grade cotton 3 tracheal stenosis, the tracheotomy was performed by stenosis to secure the airway while waiting for the definitive open surgery.

The "pre-COVID-19" and "COVID-19" patients were compared. The following variables were analyzed for both cohorts: Age, gender, cause of dyspnea, duration, history of documented cardiovascular events, BMI (categorized as low, normal, high), blood count (categorized as normal/abnormal), lung tissue involvement in chest imaging (categorized as correct/incorrect) and the treatment used. The differences in the presented variables for both "pre-COVID-19" and "COVID-19" cohorts were analyzed.

The first outcome measure was the incidence ratio of the urgent dyspnea patients, in relation to the total number of emergency visits and the total number of surgical procedures in both time periods. The second outcome measure was the incidence ratio of the urgent dyspnea patients divided into HNC and LTS subgroups and the differences between time periods within the HNC and LTS groups. The third analysis included a detailed description of "post-COVID-19" LTS specificity.

The Shapiro-Wilk test was used to assess the normal distribution of continuous variables, which were summarized using mean and Standard Deviation (SD) for normally distributed variables and median and interquartile range for non-normally distributed variables. Statistical analysis was conducted in independent groups, according to treatment methods (tracheostomy or dilatation). Comparisons between "pre-COVID-19" and "COVID-19" cohorts for continuous and normally distributed variables within the groups were performed by firstly performing the Levene's test to check for equality of variance between the groups, upon rejecting the null hypothesis in all instances, the Student's t-test for independent samples was performed. For non-normally-distributed continuous variables, the U-Mann-Whitney test was conducted. To analyze the effect of nominal variables between the cohorts, the Pearson's Chi-squared test was utilized. In populations smaller than 5 subjects, Fischer's exact test was used. The level of significance used for all analyses was 2-tailed and set at $P<0.05$. Statistical analysis was

Table 1: The number of procedures for laryngotracheal dyspnea in both cohorts and different measures of incidence were summarized.

Parameter	Pre-COVID-19 Cohort	COVID-19 Cohort	Change (in %)
Number of tracheotomy procedures for acute dyspnea (TRA)	15	17	113%
Number of dilatation procedures for acute dyspnea (LTS)	8	14	175%
Total number of procedures for acute dyspnea (DYS)	23	31	135%
Total number of ENT surgeries (SUR)	1520	1371	90%
Total number of ENT related emergency department visits (ED)	1260	1232	98%
Incidence rate (DYS/SUR)	0.015	0.023	149%
Incidence rate (DYS/ED)	0.018	0.025	138%
Incidence rate (TRA/SUR)	0.01	0.0124	124%
Incidence rate (TRA/ED)	0.012	0.014	116%
Incidence rate (LTS/SUR)	0.005	0.01	194%
Incidence rate (LTS/ED)	0.006	0.011	179%

TRA: Open Tracheostomy; LTS: Laryngotracheal Stenosis; DYS: Dyspnea; ED: Number of Emergency Department visits consulted by an ENT specialist; SUR: Total number of ENT surgical procedures

performed using STATISTICA software (Version 13.1, Dell). The incidence rate for laryngeal dyspnea was calculated by dividing the total number of surgical procedures related to emergency dyspnea admissions and the total number of surgical procedures in a given time.

Results

The incidence rate calculated for laryngotracheal dyspnea the "pre-COVID-19" period of 2019/2020 was 0.015 for "pre-COVID-19" period and 0.023 for "COVID-19" period respectively. There were 23 emergency procedures for dyspnea in 2019/2020 and 31 procedures in 2020/21, and a 135% increase in emergency procedures for dyspnea was observed. The number of procedures for laryngotracheal dyspnea in both cohorts and different measures of incidence were summarized in Table 1.

Comparing the incidence rate for emergency dyspnea procedures, a 149% increase was observed in relation to all surgeries, and 128% increase in relation to all ENT related emergency department consultations. The amount of LTS procedures increased by 175% which accounts for an almost 2-fold (194%) increase in relation to all surgical procedures (LTS/SUR) and a high increase when compared to all emergency department ENT consultations (179%).

Epidemiological data for patients in both "pre-COVID-19" and "COVID-19" cohorts are presented and compared in Table 2 (patients treated by open tracheostomy) and Table 3 (patients who underwent dilatation procedures). The duration of symptoms was categorized according to the length: <1 month 1; 2; 3> 3 months and finally <1 month and >1 month, but there were still no differences between the "pre-COVID-19" and "COVID-19" cohorts regardless of the treatment method used. In both treatment modalities and respective time cohorts, there were no abnormalities reported on radiological imaging.

The mean age in the oncological "pre-COVID-19" cohort was 64.4 years (SD 8.5 [95% CI 59.7; 69.1]), while in the oncological "COVID-19" cohort – 70.9 years (SD 9.8 [95% CI 65.9; 75.9]). There were no statistically significant differences between the groups, although a trend towards the "COVID-19" group (being older) can be observed (p=0.056). The mean value for BMI in the "pre-COVID-19" and "COVID-19" cohort was 20.08 (SD 4.71 [95% CI 17.24; 22.93]) and 24.13 (SD 5.62 [95% CI 21.14; 27.13]) respectively and the differences were statistically significant with the "COVID-19" cohort exhibiting higher BMI values (p=0.048). When the BMI values were classified as low, normal or overweight, according to generally accepted criteria, there were more overweight patients in the "COVID-19" cohort (p=0.046). Gender distribution between the groups was equal between the cohorts (2 tailed Fischer's exact test p=1.0) with 3 females and 12 males in the "pre-COVID-19" and 4 females and 13 males in the "COVID-19" cohort. Comorbidities: in terms of cardiovascular events (restoration of the artery, strokes and infarctions), the "pre-COVID-19" tracheotomy oncology group was more loaded: 6 patients with incidents *vs.* 2 in the "COVID-19" cohort (P=0.1).

The median age in the LTS "pre-COVID-19" cohort was 42 years (IQR 12), while in the LTS "COVID-19" cohort – 49 years (IQR 36), there were no statistically significant differences between the groups (U-Mann-Whitney p=0.94). The mean value for BMI in the "pre-COVID-19" and "COVID-19" cohort was 26.03 (SD 5.19 [95% CI 21.7; 30.4]) and 24.13 (SD 4.07 [95% CI 21.78; 26.48]), and there were no statistically significant differences between the groups. When the BMI values were classified as low, normal or overweight, according to generally accepted criteria, there were no differences between the cohorts (p=0.337). Gender distribution between the groups was equal between the cohorts (2 tailed Fischer's exact test p=0.675) with 5 females and 3 males in the "pre-COVID-19" and 7 females and 7 males in the "COVID-19" cohort.

The leading cause for LTS procedures in the "COVID-19" cohort was prolonged intubation, which accounts for 50% of procedures. It was related to prolonged mechanical ventilation of COVID-19 patients in 3 cases. Additionally, 3 patients developed LTS after percutaneous tracheostomy in the Intensive Care Unit–COVID-19 wards. They were discharged after successful decannulation, but exhibited symptoms of dyspnea up to a month from discharge from ICU. In the "pre-COVID-19" cohort, there were only 2 cases of prolonged intubation being the cause for LTS (p=0.089), and in those cases prolonged intubation was due to a stroke (1 case) and trauma (1 case). Comorbidities in terms of cardiovascular events were not reported in the LTS group.

Additional cases of LTS in the "COVID-19" cohort were attributed to the pandemic, as the 3 cases of transcutaneous tracheostomy complications and 3 cases of prolonged intubation were related to

Table 2: Patients who developed dyspnea due to advanced neoplasms (oncology group) and were treated by an open surgical tracheostomy.

Variable	Pre-COVID-19 Cohort	COVID-19 Cohort	P*
Tumor primary site	Total N=15	Total N=17	P=0.176*
Oropharynx (incl. tonsil)	3 (20%)	0	
Larynx	5 (33.3%)	**11 (64.71%)**	
Tongue	1 (6.67%)	1 (5.88%)	
Oral cavity	4 (26.67%)	1 (5.88%)	
Thyroid	2 (13.33%)	2 (11.76%)	
Mediastinum	0	1 (5.88%)	
Esophagus	0	1 (5.88%)	
BMI			P=0.046*
Low	4 (30.77%)	2 (12.5%)	
Normal	8 (61.54%)	6 (37.5%)	
Overweight	1 (7.69%)	**8 (50%)**	
RBC			P=0.068**
Normal	2 (14.29%)	8 (47.06%)	
Low	**12 (85.71%)**	9 (52.94%)	
HB			P=0.067**
Normal	3 (21.43%)	10 (58.82%)	
Low	11 (78.57%)	7 (41.18%)	
Documented vascular incidents			P=0.1**
Yes	6 (40%)	2 (11.76%)	
None	9 (60%)	**15 (88.24%)**	
Lung tissue involvement in radiological imaging			
None	15 (100%)	17 (100%)	

*Chi squared Pearsons; **Fischer's exact test

BMI: Body mass Index; RBC: Red Blood Cells (10^6/mm^3); WBC: White Blood Cells (10^6/mm^3); PLT: Platelet Count (10^9/l^3); HB: Hemoglobin g/dl

COVID-19 convalescents. The 3 cases of iatrogenic LTS in the "pre-COVID-19" and lack of iatrogenic LTS in the "COVID-19" cohort is most likely due to a decrease in number of planned surgeries, thus reducing the number of late post-surgical complications requiring dilatation procedures.

Discussion

We presented the first to our knowledge cohort analysis of the therapeutic activity of the emergency ENT unit in pandemic time in terms of urgent dyspnea. We based our observations and conclusions on a comparison of the patients admitted in time periods September-February 2019/2020 and 2020/2021. To take a look at all the medical activities of the ENT department, we have summarized the number of services provided. The numbers of planned outpatient visits were comparable and oscillated slightly above 5 thousand, increased emergency visits (1260 *vs.* 1371) and decreased overall operation capacity (1520 *vs.* 1232) were stated.

Our findings have been partially reflected in the up-to-date literature. Coronavirus pandemic and subsequent need for disease transmission mitigation efforts have significantly altered the delivery of cancer care [5,6]. The utilization of inpatient care and subsequent hospitalization deficit was estimated around the developed countries for - 7% to 35% in oncology [7,11,13,14]. All oncological subspecialties in the US experienced significant decreases in new patient visits during COVID-19 and surgery capacity with a 25% reduction in newly diagnosed head and neck malignancies [15]. In our experience, this was not reflected in the number and proportion of urgent tracheostomies between the two cohorts. However, there was some alteration in oncological patients' characteristics. Regardless of the place of residence, oncological patients with extreme dyspnea are mainly neglected health cases. Here one can put forward the thesis that the "pre-COVID-19" group was younger, significantly more burdened with comorbidities, which is typical for these types of patients. The "COVID-19" group is made up of older and healthier people; this may be explained by delays in accessing services in the pandemic era for the elderly, less resourceful, but so far taking care of their health.

Another observation is the change in the proportion of primary lesions and the overrepresentation of laryngeal cancer. This is probably related to the fact that during the pandemic, primaries with a rapid progression could not wait anyway, while those with slowly developed cancers, adapted to dyspnea, more often reported in an extreme state.

On the other hand, as the COVID-19 pandemic intensified, associations were observed with a decrease in emergency department visits and an increase in hospital admission rates irrespectively of the healthcare system [2]. These findings suggest visiting the emergency department during the COVID-19 pandemic for serious symptoms, illnesses, and injuries that cannot be managed in other settings [1]. Our observations did not confirm the decrease in the number of emergency visits but definitely confirmed their greater urgency. The number of patients brought by ambulance service for urgent dyspnea was statistically higher. While the number of emergency

Table 3: Patients who developed dyspnea due to laryngotracheal stenosis in both time cohorts and were treated with dilatation procedures.

Variable	Pre-COVID-19 Cohort	COVID-19 Cohort	P*
Stenosis location	Total N=8	Total N=14	P=0.213*
Tracheal	1 (12.5%)	7 (50%)	
Glottic	1 (12.5%)	1 (7.14%)	
Subglottic	6 (75%)	6 (4.86%)	
Stenosis cause			P=0.089**
Granulomatosis with polyangitis	1 (12.5%)	2 (14.29%)	
Prolonged intubation	2 (25%)	**7 (50%)**	
Iatrogenic	3 (37.5%)	0	
Idiopathic	2 (25%)	2 (14.29%)	
After transcutaneous tracheostomy	0	3 (21.43%)	
BMI			P=0.337*
Low	1 (12.5%)	1 (7.14%)	
Normal	1 (12.5%)	6 (42.86%)	
Overweight	6 (75%)	**7 (50%)**	
Duration of symptoms			P=0.002*
<=1 month	2 (25%)	**13 (92.86%)**	
>1 month	6 (75%)	1 (7.14%)	
Documented vascular incidents			
None	8 (100%)	14 (100%)	
Lung tissue involvement in radiological imaging			
None	8 (100%)	14 (100%)	
BMI – Body mass Index			
RBC – Red blood cells ($10^6/mm^3$)			
WBC – White Blood cells ($10^6/mm^3$)			
PLT – Platelet count ($10^9/l^3$)			
HB – Hemoglobin g/dl			

tracheotomies performed for oncological reasons did not differ between the two cohorts, the number of LTS increased significantly in "COVID-19" time (8 *vs.* 14).

Airway trauma during tracheal intubation in COVID-19 patients [16] and airway management lessons from case reports of negative outcomes [17] was presented. As well, laryngeal and tracheal pressure injuries [18] and comments [19] are available in current literature. Few cases of post-intubation LTS in patients required mechanical ventilation, and have been described [20].

Our cohort analysis of the emergency ENT dyspnea clearly showed that dilatation performed due to prolonged intubation was significantly more often in the COVID-19 period. Six post-COVID-19 patients were treated in "COVID-19 wards" with an internal medicine or rehabilitation profile. What is more, all of them developed symptoms of cough and dyspnea after being discharged. Only after 3 to 6 weeks of symptoms and in the absence of radiological changes in the lungs, the patients with increasing dyspnea were referred to the ENT emergency. Additionally, no stenosis had been reported by the radiologist in previous chest imaging in any of these patients. The important observation is that in the "COVID-19" cohort, the stenosis was more often located in the trachea (7 *vs.* 1). There were no differences in age, sex, or BMI in LTS patients during the "COVID-19" cohort, compared to the reference cohort. In contrast, the median of RBC, HB was lower than in the "pre-COVID-19" cohort, which may reflect the worse general condition of LTS patients.

To our knowledge, this study constitutes the largest clinical group analyzed in regard to emergency department services related to severe laryngotracheal dyspnea. As the first clinicians, we have proved that the surplus of patients with LTS in the second wave of the pandemic was related to COVID-19 complications.

One of the strongest limitations for this study was a still relatively small study group, which was then divided into cohorts. Sample sizes below 5 individuals for some variables enforce utilization of a conservative Fisher's exact test. An inclusion of other centers might improve outcomes towards observed tendencies by expanding on the population size. Moreover, as further patients with COVID-19 complications are reported, the results of LTS treatment will require careful analysis.

To summarize, the health system should be prepared for post-COVID-19 sequels and complications treatment. We confirm the thesis that practitioners and public health officials should emphasize the importance of continuing to visit the emergency for serious symptoms that cannot be managed in other settings, such as telemedicine visits. [Reeves JJ]. The most important conclusion from this study is that in post-COVID-19 rehabilitation process, the persistent dyspnea can be caused by non-pulmonary reasons. LTS should be considered in the post-COVID-19 differential

diagnosis, for persistent cough and dyspnea are common symptoms in both LTS and the recovery phase of severe COVID-19 [21,22]. In addition, radiologists should be vigilant in assessing the chest for possible narrowing of the tracheal lumen. Thus, ENT consultation videolaryngoscopy is mandatory in post-COVID-19 patients.

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