Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Impact of COVID-19 on procedure volume at a tertiary pediatric hospital

Alan F. Utria, Patrick J. Javid, Jingyang Chen, Samuel E. Rice-Townsend

Department of Pediatric General & Thoracic Surgery, Seattle Children's Hospital, Seattle, WA, USA

Abstract

Introduction: In March 2020, the COVID-19 pandemic threatened to overwhelm entire healthcare systems. Here we characterize changes in surgical volumes at a regional tertiary pediatric hospital during the early phase of the COVID-19 pandemic.

Methods: Data on all procedures performed during the state-wide ban on elective procedures (March 19th, 2020 to May 18th, 2020) that required anesthesia involvement were collected retrospectively and compared to the same time period in 2019.

Results: A total of 5785 procedures were performed: 4005 (69%) in 2019, and 1780 (31%) in 2020, representing a 55% decrease in total cases. The percentage decrease was disproportionate across surgical services. Add-on cases increased from 23% to 39%, and outpatient procedures decreased from 60% to 27%.

Discussion: The ban on elective procedures during the COVID-19 pandemic resulted in a significant decrease in the volume of procedures performed at a tertiary pediatric hospital that differed among surgical services.

Introduction

In January 2020 a novel coronavirus, SARS-CoV-2, was identified as the causative agent of a pneumonia outbreak that had been spreading the month prior within the city of Wuhan, in the Hubei province of China.1 By the end of January, the disease, termed Coronavirus Disease-2019 (COVID-19), had been identified in over 20 countries across the world, by February the US had declared it a public health emergency, and on March 11th the World Health Organization (WHO) declared it a pandemic.2

The global magnitude of the pandemic led to a spike in demand for personal protective equipment (PPE) that immediately strained a system where production and transport had already been affected by the pandemic.3,4 On March 19th, Governor Inslee announced that the “personal protective equipment supply chain in Washington has been severely disrupted by the significant increased use of such equipment worldwide,” and in order to preserve PPE he was placing a ban on all non-urgent procedures that require the use of PPE.5 This ban would remain in effect for two months until May 18th, 2020.6

The purpose of this study was to characterize the changes in procedure volume at a regional tertiary pediatric hospital during the early phases of the COVID-19 pandemic while there was a ban on non-urgent procedures.

Methods

Study design/population

After obtaining Institutional Review Board approval, a retrospective analysis of patients undergoing a procedure at our tertiary care hospital was performed. Patients met inclusion criteria if 1) their procedure required anesthesia team involvement and 2) was performed either during the statewide ban on non-urgent procedures, March 19th, 2020 to May 18th, 2020, or during the same period during the year prior, March 19th, 2019 to May 18th, 2019.

Data collection/analysis

Data collected from the electronic medical record included demographic information (gender, age, race), procedure information (type, priority, service, date, start time), and COVID-19 testing...
Information (result, time sent, time resulted). Procedure priority was designated as 1) routine, procedures that were non-urgent but could not be delayed without potential harm to the patient, 2) Semi-urgent, procedures that needed to be completed within 24 h, and 3) Urgent, procedures that need to be completed within 8 h. We limited the analysis to services that performed over 50 procedures over the combined time period, 2019 and 2020. Descriptive statistics was used to compare procedures between 2019 and 2020. Data were analyzed using Stata/MP software (v 12, StataCorp).

Results

A total of 1780 procedures requiring anesthesia were performed at a regional tertiary pediatric hospital during the statewide, two-month, COVID-19 ban on non-urgent procedures. This represents a 55% decrease in volume from the same time period in 2019 when 4005 procedures were performed. Outpatient procedures, which comprised 60% (n = 2402) of procedures in 2019, decreased 73%, making up 36% (n = 644) of procedures during the ban. The number of “add-on” procedures in 2019 compared to 2020 decreased 24% (918 vs 700, respectively); however, as a proportion of total procedures “add-on” procedures increased from 23% to 39%, respectively. The number of urgent/emergent procedures did not change significantly between 2019 and 2020, 248 versus 175 (p = 0.305), respectively (Fig. 1).

The COVID-19 ban had a disproportionate effect on procedure volume across hospital departments reflecting each department’s baseline composition of elective versus non-elective procedures (Fig. 2). Within the surgical departments, otolaryngology saw the biggest change in volume with a 76% reduction in procedures, followed by urology 74%, craniofacial surgery 64%, ophthalmology 49%, orthopedic surgery 49%, general and thoracic surgery 37%, cardiac surgery 26%, and neurosurgery 14%. Among non-surgical departments that perform procedures under anesthesia, gastroenterology had the biggest reduction in procedure volume of 67%, followed by diagnostic radiology 55%, dentistry 54%, cardiology 44%, and interventional radiology 34%. After excluding outpatient surgeries, there was no difference in length of stay between patients undergoing procedures in 2019 versus 2020: median length of stay 2 days (IQR: 0–11) versus 2 days (IQR: 1–9), p = 0.369.

For the pandemic cohort, pre-procedure COVID-19 testing results were available for 1577 (89%) patients. An additional 96 (5%) patients had their COVID-19 test result after their procedure. All tests were negative. The majority of tests, 1012 (64%) were performed in the outpatient setting with a median time from test result to procedure start of 39 h (IQR:19–58). For tests performed in the inpatient setting, time from test result to procedure start was 18 h (IQR: 5–59). Median time for all tests to result was 7 h (IQR:6–8). For non-routine procedures, median test result time decreased from 9 h (IQR:6–13) in the first week of the ban to 2 h (IQR:1–7) in the last week of the ban (Fig. 3).

Discussion

The COVID-19 pandemic has had a major impact on healthcare systems across the world. Here we report the impact of COVID-19 on procedure volume at a regional tertiary pediatric hospital in the state of Washington during the early phase of the pandemic. After Governor Inslee instituted a ban on all non-urgent procedures in an attempt to conserve PPE, procedure volume decreased 55% compared to the year prior. The decrease in procedure volume was disproportionately distributed with percentage decreases across hospital specialties ranging from 14% to 76%. As expected, the number of planned outpatient procedures decreased markedly but there were no changes in the number of urgent procedures. COVID-19 testing was routinely performed on patients undergoing procedures and all preoperative tests were negative. Most patients

![Fig. 1. Procedure by urgency classification.](image)

![Fig. 2. Procedure volume by hospital specialty.](image)
received COVID-19 testing as an outpatient within 72 h of their procedure. For urgent procedures, time for tests to result improved over the course of the ban.

In order to assess the impact of the ban on non-urgent procedures at the level of the individual patient, long-term follow-up to include rescheduling of procedures and post-procedure outcomes is necessary. While it is possible that delaying a non-urgent procedure by a couple of months may produce unforeseen complications, there is also the possibility that the delay may have no effect or even prove the procedure was unnecessary. Further long-term specialty and procedure specific studies are warranted.

Understanding these data and the disproportionate effect the ban had by specialty may be important for guiding resource management and allocation. While procedure load decreased 55%, there were still 1785 procedures performed over the two-month ban. Should there be another pandemic in the future, or a second wave of COVID-19 in the winter, it is important for hospitals to be able to continue to perform procedures that are either urgent or cannot be significantly delayed. Additionally, given the fact that the ban had a disproportionate effect according to specialty, resource and personnel allocation should be made with specialty in mind. This is also true for the resumption of “normal” hospital operations, where the backlog of procedures by specialty may be vastly different.

At our tertiary pediatric hospital, the pipeline for pre-procedure COVID-19 testing was quickly established and very effective for routine procedures whereby patients would have their test performed as an outpatient within 72 h of their procedure. In total, 94% of patients underwent a COVID-19 test with the remaining 6% likely having a test performed at an outside institution. Initially COVID-19 testing was resulting in delays for non-routine procedures or if the procedure was truly an emergency, it was being done under full PPE precautions for COVID-19 positivity. However, after the development of a rapid COVID-19 test, time to result decreased to a median of 2 h with the ability to have a result within approximately 1 h. The importance of rapid testing cannot be overstated as it allows procedures to be performed with minimal delay and without expending limited PPE as a precaution.

This study is limited by the lack of data on 1) cancelled procedures secondary to the elective nature of the procedure or a positive COVID-19 result, 2) outcomes for patients undergoing procedures during the ban and patients who had procedures delayed, 3) departmental adaptations to the decrease in procedure volume and management of patient rescheduling after the ban was lifted. Additionally, we make the assumption that in the absence of the COVID-19 pandemic, case numbers in 2020 would be similar to 2019. However, it is possible that natural changes in volume may have occurred between the two years resulting in over- or under-estimation of the impact of the pandemic.

**Conclusion**

We demonstrate the impact on procedure volume of a statewide ban on non-urgent procedures at a tertiary pediatric hospital. We show rapid adaptation of COVID-19 testing allowed for the continuation of necessary procedures while preserving COVID-19 specific PPE. These data should be the basis of future studies on the effect of the ban at the patient level and should be used to guide policy on resource allocation should there be a future pandemic.

**Declaration of competing interest**

The authors have no conflicts of interest to disclose. Approval for this study was obtained from the Seattle Children’s Hospital Institutional Review Board.

**References**

1. Lu H, Stratton CW, Tang YW. Outbreak of pneumonia of unknown etiology in Wuhan, China: the mystery and the miracle. J Med Virol. 2020 Apr;92(4): 401–402. PubMed PMID: 31950516. Pubmed Central PMCID: PMC7166628. Epub 2020/01/18.
2. Sohrabi C, Alsaadi Z, O’Neill N, et al. World Health Organization declares global emergency: a review of the 2019 novel coronavirus (COVID-19). Int J Surg. 2020 Apr;76:71–76. PubMed PMID: 32112977. Pubmed Central PMCID: PMC7105032. Epub 2020/03/01.
3. Ranney ML, Griffeth V, Jha AK. Critical supply shortages - the need for ventilators and personal protective equipment during the covid-19 pandemic. N Engl J Med. 2020 Apr 30;382(18):e41. PubMed PMID: 32212516. Epub 2020/03/27.
4. Cohen J, van der Meulen Rodgers Y. Contributing factors to personal protective equipment shortages during the COVID-19 pandemic. Prev Med. 2020 Oct 2; 106263. PubMed PMID: 33017601. Pubmed Central PMCID: PMC7531934. Epub 2020/10/06.
5. Inslee orders halt elective surgeries and dental services to reserve critical equipment for COVID-19 health care workers. https://www.governor.wa.gov/news-media/inslee-orders-halt-elective-surgeries-and-dental-services-reserve-critical-equipment. Accessed October 18, 2020.
6. COVID-19: restrictions on non-urgent medical procedures. https://www.governor.wa.gov/news-media/inslee-orders-halt-elective-surgeries-and-dental-services-reserve-critical-equipment. Accessed October 18, 2020.