Understanding the Effect of COVID-19 Pandemic on Emergency Surgical Care Delivery in India: A Multicenter Cross-sectional Study

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Research Article

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Abstract

Background

The COVID-19 pandemic and subsequent lockdowns adversely affected global health care services to varying extent. Emergency Services were affected along-with elective surgeries, to accommodate the added burden of COVID19 affected patients. We aimed to reflect, quantify and analyse the trends of essential surgeries and bellwether procedures during the waxing and waning of the pandemic, across various hospitals in India.

Methodology

A research consortium led by WHO Collaboration Centre (WHOCC) for Research in Surgical Care Delivery in Low-and Middle-Income countries, India, conducted this study with 5 centres. All surgeries performed during the months of April 2020 (wave 1), November 2020 (recovery 1) and April 2021 (wave 2) were compared with those performed in April 2019 (pre-pandemic period).

Results

The total number of surgeries reduced by 77% during wave 1, which improved to 52% reduction in recovery 1, as compared to pre-pandemic period. However, surgeries reduced again during wave 2 to 68%, but reduction was less as compared to wave 1. Emergency and essential surgeries were affected along-with the elective ones, but to a lesser extent.

Conclusion

Our study quantified the effects of the pandemic on surgical-care delivery across a timeline and documented reduction in overall surgical volumes during the peaks of the pandemic (wave 1 and 2) with minimal improvement as the surge of COVID19 cases declined (recovery 1). The second wave showed improved surgical volumes as compared to the first one which may be attributable to improved preparedness. Caesarean sections were affected the least.

Introduction

The COVID-19 pandemic and the resultant world-wide lockdown led to a drop in surgical volumes globally[1] .With successive waves of surge in COVID-19 cases, the hospitals and healthcare staff found themselves overburdened with patient-care, tackling severe shortage of resources (manpower/essential supplies/equipment). There was a global call for deferment of all elective surgeries to reorganize the healthcare facilities, infrastructure and workforce for providing care to the COVID-19 affected patients[2] .However, with this shift of human and material resources, despite all previous priority-settings and protocols, a natural selection of surgeries was observed. Alongside cancellation and postponements of non-essential or elective surgical services, it was seen that rates of emergency and essential surgical care delivery also took a major hit.[3–6]

Studies from Italy and Spain reported 85% and 65.5% decrease in emergency surgical activity during lockdowns following the first major wave of COVID-19 cases in March 2020[5,7] .Many of these surgeries are categorised as ‘essential surgeries’ by the World Bank in ‘Disease Control Priorities-3’(DCP3) and are needed to be performed in order to avert l.5 million preventable deaths, globally per year[8] .Among these essential surgeries, caesarean births, exploratory laparotomy and fracture fixation surgeries are considered ‘bellwether procedures’ which indicate the capacity of healthcare system to perform essential and emergency surgeries[9]. Failure and delay to meet these

surgical demands comes at a huge societal cost and contributes significantly to the burden of avoidable mortality and morbidity.[9]

Low- and middle-income countries (LMICs) harbour the poorest 1/3rd of the total population, but receive only 6% of global surgical volume, despite contributing towards a considerable burden of surgical diseases[10,11] .Thus, consequences of COVID-19 on the emergency and essential surgeries in LMICs will inevitably be much worse. While an extensive body of literature has dealt with practice guidelines, prioritisation and resource managements in pandemic in subspecialties like surgical oncology, urology, minimal access surgery, otolaryngology, neurosurgery amongst others,[6,12–15] very few studies have quantified and analysed the effect and trends during the COVID-19 pandemic with its successive waves of rise and fall of cases on the essential surgical load. Adequate quantification of the essential surgical-care delivery and disruption, may help highlight the gaps/deficiencies in the healthcare systems. At the same time, it may serve to inform measures towards improvement during this pandemic and beyond. Hence, we aimed to reflect, quantify and analyse the trends of essential surgeries and bellwether procedures during the waxing and waning of the COVID-19 pandemic, across various hospitals in India.

Methodology

Research Collaboration[16]

A research consortium 'IndSurg', led by World Health Organisation Collaboration Centre (WHOCC) for Research in Surgical Care Delivery in LMICs, India, conducted this retrospective study. The healthcare centres with the capacity to provide all the 'essential surgeries', including the bellwether procedures of caesarean sections, surgery for fractures and exploratory laparotomies, were included. We recruited public and private hospitals which provided emergency and planned/elective surgical services in the departments of General Surgery, Orthopaedics and Obstetrics-Gynaecology. The total and emergency surgical volumes in the month of April 2020, November 2020 & April 2021 were collated and analysed. Data from the month of April 2019 was also analysed as a pre-pandemic comparator. The month of April 2020 (wave 1)[17] was selected to capture the initial impact of pandemic and lockdown on surgical services, as the nation-wide lockdown in India started on March 24th, 2020. The essential surgical services in India after the first lockdown started to escalate from October 2020 onwards. Therefore, November 2020 (Recovery 1) was selected to analyse the rising trend in the recovery period. April 2021 (Wave 2)[17] was the time when the second wave of Covid 19 hit India, which again affected the essential surgical services and hence, this was the third point in our dataset. During this period between April 2020 to May 2021 many healthcare facilities were converted to dedicated COVID-19 facilities[18]. Wave 1 is defined as the period when wave 1 of COVID-19 pandemic started and Wave 2 is defined as the period when Wave 2 COVID-19 Pandemic started. Recovery 1 is defined as the period between Wave 1 and Wave 2. This nomenclature was added for ease of understanding for this particular study

We invited several hospitals across the country, based on convenience. Initially, 12 hospitals agreed to participate, but only 7 shared data for April 2019 and April 2020. Of these 7, only 5 hospitals could manage collating data for all the data-points in this study, which were then included in the study (Figure 1). There were three government teaching hospitals namely Maulana Azad Medical College (MAMC) and Lok Nayak Hospital, New Delhi; Seth G.S. Medical College & King Edward Memorial Hospital Mumbai (SGSMC & KEMH), Mumbai; and Bhabha Atomic Research Centre Hospital (BARC), Mumbai; one private teaching hospital namely Terna Medical College and Hospital (TMC), one private hospital namely Manipal Hospital, Delhi. The centres shared data of all the selected departments performing essential as well as non-essential surgeries.

Data collection

The investigator team at each institute collected the data either from the electronic medical records of the hospitals or captured the snapshots of the operation theatre registers where details of the surgeries were entered manually. Data variables collected from the centres were department names, patient unique identification number, age, sex, name and date of the surgery, type of anaesthesia administered, and whether surgery was elective or emergency.

Data categorisation

The patient identification was masked and the hospital names were coded. Data analysis team collated and standardised the names of the surgeries. The names of the surgeries were finalised by discussion between the members in the team for uniformity. Any differences or discrepancies were resolved with mutual discussion between the team members over periodic telephonic meetings. The standardised names were then grouped as emergency and elective surgeries and essential and non-essential ones as per DCP3[3]. Ambiguous/ illegible surgery names were excluded from the analysis (Figure 1). The surgeries were further classified as per the 'National Health Service (NHS) list for prioritisation of surgeries in COVID-19 pandemic document'. For this categorisation, we used two separate lists, one published for Obstetrics-Gynaecology and another one for subspecialties of surgery[14,19] .NHS surgery prioritisation lists describe various surgical procedures as per the urgency of carrying them out without risk to life. Category 1a includes high priority surgeries that cannot be postponed beyond 24 hours, like laparotomy for perforated hollow viscus or caesarean sections. Category 1b includes procedures that cannot be postponed beyond 72 hours. Similarly, category 2, 3 and 4 include procedures that cannot be postponed beyond one month, can be postponed only up to three months and beyond three months, respectively. We combined categories 1a and 1b for ease of analysis.

Data analysis

We used Microsoft Excel 2019 and SPSS Version 20 (SPSS Inc., IBM Corporation, Chicago) for the analysis. Frequency of surgeries performed during the following months (pre-pandemic period April 2019, wave 1 April 2020, Recovery 1 November 2020, Wave 2 April 2021) was estimated, number of surgeries were calculated across age group, sex, specialty and participating centres. We calculated the difference in emergency and elective surgeries and differences across NHS categories one to four. For ethical reasons we did not compare the surgeries and reductions in numbers between various hospitals. Our primary outcome measure was to calculate the change and trend in the total number of essential surgeries performed in April 2020, November 2020 and April 2021 as compared to April 2019. This change and trends in surgery numbers were plotted against the case-positivity rate of COVID-19 during the middle of each month. The secondary outcomes were to document the change in essential surgeries and bellwether procedures of caesarean section, fracture fixation and exploratory laparotomies.

Results

Figure 1 shows the recruitment algorithm and exclusion criteria for surgeries. 15 surgical departments from 5 hospitals across Indian cities participated in the study. We analysed records of 5063 surgeries from these centres.

Table 1 describes the characteristics of the participants and the reduction in surgical volumes across various parameters considered, during the evolution of the pandemic. 59.5% (n=3013) were females and 38.4% (n=1943) were males. The overall trend demonstrated that the percentage reduction of surgeries amongst females was less compared to males across the pandemic period. A total of 2496 surgeries were performed at these centres in April 2019. 574 surgeries were performed in April 2020, 1197 during November 2020 and 796 during April 2021. The total

number of surgeries reduced by 77% in April 2020, compared to April 2019. During the Recovery 1, the surgical volumes improved with a 52% reduction as compared to the pre-pandemic period. However, during the pandemic period II in April 2021, the surgical volumes reduced again to around 68% of the pre-pandemic period.

The most reduction was observed in general surgical procedures during both the waves I (April 2020) and II (April 2021), 90% and 83% reduction respectively. The volumes of obstetrics-gynaecology procedures demonstrated the least reduction, 47% and 28% respectively, during the two waves. More reduction was observed in surgeries performed under general anaesthesia as compared to regional anaesthesia.

The total number of emergency surgeries reduced by 61% and the elective surgeries reduced by 92% during wave 1. The surgical care delivery improved with the waning of the first wave 1n the Recovery 1, but a re-reduction was observed during Wave 2 with a 57% decline for emergency surgeries and 79% for elective surgeries. However, the proportion of emergency surgeries to the total number of surgeries increased from 48.7% in April 2019 to 82.2% in April 2020, 57.8% in November 2020 and 65.4% during April 2021.

Table 1
Comparison of Surgical Volume Change as compared to pre-pandemic period

	Base Year	Surgery Vol (%Change) *		
	Apr-19 (Pre-pandemic)	Apr20 (Wave 1)	Nov-20 (Recovery 1)	Apr-21 (Wave 2)
Overall (% reduction)	2496	574 (77)	1197 (52)	796 (68)
Gender				
Male	1073	147 (-86)	511 (-52)	212 (-80)
Female	1317	427 (-68)	685 (-48)	584 (-56)
Surgery Speciality				
General Surgery	1106	115 (-90)	468 (-58)	190 (-83)
Obstetrics-Gynaecology	643	343 (-47)	458 (-29)	461 (-28)
Orthopaedics	747	116 (-84)	271 (-64)	145 (-81)
Anaesthesia Type				
Regional Anaesthesia: Spinal, Epidural and Regional Blocks	1036	407 (-61)	663 (-36)	528 (-49)
General Anaesthesia	980	113 (-88)	398 (-59)	203 (-79)
Local anaesthesia not supplemented by sedation or GA	290	20 (-93)	95 (-67)	32 (-89)
sedation	128	23 (-82)	17 (-87)	10 (-92)
DCP Category				
Essential	1219	431 (-65)	688 (-44)	522 (-57)
Non-Essential	1277	143 (-89)	509 (-60)	274 (-79)
NHS Prioritisation				
1 (within 72 hours)	1254	489 (-61)	809 (-35)	524 (-58)
2 (within 1 month)	182	15 (-92)	78 (-57)	68 (-63)

(Note*: Surgical Volume (% changes over base period (pre-pandemic) i.e., April 2019), DCP 3- Disease Control Priority 3, NHS Prioritisation- period beyond which the surgery cannot be postponed

Missing data for sex of the participants*= 107, Missing data for age of the patient*= 267)

	Base Year	Surgery Vol (%Change) *		
	Apr-19 (Pre-pandemic)	Apr20 (Wave 1)	Nov-20 (Recovery 1)	Apr-21 (Wave 2)
3 (within 3 months)	25	4 (-84)	38 (52)	7 (-72)
4 (beyond 3 months)	1000	59 (-94)	249 (-75)	193 (-81)
Emergency / Elective				
Emergency	1215	472 (-61)	692 (-43)	521 (-57)
Elective	1281	102 (-92)	505 (-61)	275 (-79)
(Note*: Surgical Volume (% changes over base period (pre-pandemic) i.e., April 2019), DCP 3- Disease Control Priority 3, NHS Prioritisation- period beyond which the surgery cannot be postponed				
Missing data for sex of the participants*= 107, Missing data for age of the patient*= 267)				

Table 1 and Fig. 2 depict the overall reduction in surgical volumes based on the DCP 3 Categorisation for essential and non-essential surgical categorisation. There was reduction in both essential and non-essential surgical volumes during the evolution of the pandemic, higher reduction in non-essential surgeries. The volumes of essential surgeries showed a 65% reduction during April 2020 with the surgeries picking up (only 44% reduction) during November 2020. The surgical volumes again reduced in April 2021 (Wave 2); however, the reduction was lower (57%) as compared to April 2020 (wave 1).

Table 2 demonstrates speciality-wise changes in the surgical volumes during the pandemic period. During wave 1, essential surgical care was most-affected in the speciality of general surgery with around 85% reduction while it was least affected in obstetrics-gynaecology with a 36% reduction. As the pandemic evolved, in Recovery 1, there was an improvement in delivery of obstetrics-gynaecology care which remained unchanged even during Wave 2. The general surgical care delivery again showed a-reduction during Wave 2 after just a minimal improvement during recovery I. However, the orthopaedic surgical volumes continued to dip consistently in both recovery I and Wave 2.

Table 2
Impact on Essential Surgical Care (Speciality-wise) during the Pandemic Period

	Base Year	Surgery Vol (%Change) *		
	April-19 (Pre-pandemic)	April-20 (wave 1)	November-20 (Recovery I)	April-21 (Wave 2)
General Surgery				
Essential	670	98 (-85)	260 (-61)	105 (-84)
Non-Essential	436	17 (-96)	208 (-52)	85 (-81)
Obstetrics-Gynaecology				
Essential	500	321 (-36)	417 (-17)	414 (-17)
Non-Essential	143	22 (-85)	41 (-71)	47 (-67)
Orthopaedics				
Essential	49	12 (-76)	11 (-78)	3 (-94)
Non-Essential	698	104 (-85)	260 (-63)	142 (-80)

Figure 3 shows the trends in the 'Bellwether procedures' during the various time periods in the pandemic. All emergency procedures were reduced with maximum reduction in the management of fractures and minimum reduction in caesarean sections, especially during both waves I and II. Also, a relative increase in the caesarean sections was observed during recovery I and Wave 2 as compared to the pre-pandemic period (April 2019).

Discussion

Our study documented a 77% reduction in the overall surgical volumes across various levels of healthcare facilities due to the impact of the first lockdown in April 2020 (wave 1) and a 68% reduction due to the partial lockdown during the second wave of COVID 19 in the month of April 2021 (Wave 2). The COVID-19 pandemic affected the pre-existing frail surgical care delivery system in LMIC like India where workforce as well as infrastructure resources are limited.[10] The reduced access to hospitals due to national lockdown and subsequently reduced admissions and footfalls further affected the number of surgeries being performed[5,20] .The 'COVID Surg Collaborative' in its prediction of the effect of pandemic on cancellations of surgeries had estimated that 72% of the total surgeries would be canceled due to pandemic[4]. A study from Italy documented a reduction in emergency surgery by 86% in the first month after nation-wide lockdown which was in spite of reserving a centre specially for emergency medical and surgical care in patients, other than COVID-19 infected patients[5]. Similar 70% reduction in surgical admissions and 50% reduction in major surgeries was documented in the Ebola pandemic in Sierra Leone[21]. However, only a handful of studies documented the trend in the surgical volumes during the various periods of waxing and waning of the pandemic. A noteworthy study from the United States documented an initial fall during the lockdown period of more than half the surgical capacity as compared to the pre-pandemic period. But, after reopening, the rate of surgical procedures rebounded to 2019 levels and this trend was maintained throughout the pandemic period despite multiple episodes of the resurgence of COVID 19 infected patients[22]. Contrary to this, we found only a partial recovery in the surgical volumes with still a 52% reduction during November 2020 (Recovery 1) when the surgical services had started escalating with

waning of the first wave. However, this partial improvement could not be sustained and the surgical volumes dropped again in April 2021 (Wave 2) to 68% of the pre-pandemic period. On the positive side, the surgical volumes were relatively better than in wave 1. This relative improvement in surgical volumes during Wave 2 which was more devastating in India than the first wave may be attributed to relatively better preparedness of the healthcare system to handle the surge and surgical services not being completely shut down. It may also reflect upon the ability of our healthcare infrastructure to readjust certain facilities to better cope with the surgical volumes. But at the same time, certain factors like lack of availability of oxygen supplies throughout India could be incriminated as the reason for the inability to sustain the improvement in surgical volumes noted in the first recovery period.

With the reduction in the surgical volumes, we observed a 61% reduction even in emergency surgeries in the first wave, with a relatively improved picture in the first recovery period (43% reduction). However, this improvement could not be sustained for emergency surgeries too and a second drop (57% reduction) was observed in emergency surgical volumes in the second wave of the pandemic. This trend corroborates with the trends in NHS I surgeries category. The reduction in the emergency surgeries may be attributed to resource diversion to the care of COVID-19 patients, as well as lockdowns leading to poor access to healthcare. Omission of these emergency surgeries, which include essential surgeries, may have led to a huge disease burden and consequently a larger number of Disease Adjusted Life Years (DALYs)[8] But at the same time, as the number of total surgeries reduced, the proportion of emergency surgeries in the three surgical departments considered, increased throughout the pandemic. The pandemic situation brought down the surgical systems all over the world to 'limited resource environments', where predominantly emergency surgeries were being performed and there were limited or no resources allotted for advanced and elective surgeries[23]

Caesarean sections were affected the least of all emergency surgeries with the least reduction during wave 1, documenting that redistribution of priorities happened even within the emergency surgery category And, surprisingly, the volumes of caesareans improved in the first recovery period and Wave 2 in comparison to the pre pandemic period. A study from Italy showed reduction in emergency obstetric admissions during the COVID 19 pandemic[24] .However, there are no studies documenting the trends specific to caesarean sections during this pandemic. A study from Sierra Leone documented a 20–40% reduction in Caesarean surgeries during initial period of Ebola epidemic within first 21 weeks from the onset of pandemic[25] .Another study documenting the narratives by healthcare workers during the Ebola pandemic demonstrated that the caesarean sections picked up and even increased within six months of the pandemic[26] .This improved trend in caesarean sections in our study could be due to the prioritisation by the Indian government as also a better risk-taking ability of healthcare workers for caesarean sections. Also, as caesareans are done under spinal/epidural anaesthesia, it wasn't a deterrent factor during the pandemic.

The higher number of reductions in surgeries for fractures and trauma during the first wave could be due to reduced numbers of vehicular accidents and road traffic restrictions enforced due to lockdown. However, this reduction continued throughout the pandemic in spite of the curtailment of the lockdowns. A similar trend was also observed in abdominal laparotomies with just a minimal improvement noticed in the first recovery period. An orthopaedic study considering femur fractures documented reduced femur fracture rates by 25%[27]. A definite change of indications for operations was documented in the global neurosurgery survey and also in a study from Spain, where threshold for surgery was higher than pre-pandemic period[6,7]. A study from Spain documenting abdominal emergency surgeries, attributed the reduction partly to changed indications for surgeries. Appendicitis, cholecystitis, and some of abdominal conditions may have been treated conservatively with a higher threshold for surgery[7]. This may explain a similar decline in laparotomies and surgeries for fractures in our study. However, in our opinion, reduced access to hospitals and subsequent reduced footfalls and admissions due to fear of COVID 19 among the masses, still remain the most likely reason for the reduction in all surgeries.

The strength of our study is that it is the first Indian study looking at the immediate impact and trends across various periods during the ongoing pandemic and lockdowns on delivery of surgical services. Documenting trends across a timeline may help provide a snapshot in one single frame to evaluate the gaps in healthcare delivery. This may be used as a benchmark for identifying areas of potential strengthening of emergency surgical care delivery in India. Assessing workload and patient population has been recommended as a strategy while considering reopening and reorganisation of services by the guidelines published by Royal College of Surgeons[28]. Reserving dedicated healthcare facilities or dedicated teams within the existing facilities for emergency surgical and medical care was also documented in various studies[29,30].In a limited resource country like India, health care facilities need to provide essential surgical care along with managing the COVID 19 patients which may be a sustainable solution over a prolonged duration. Strengthening government healthcare facilities to take the additional disease burden of COVID affected patients, reserving different teams for continuing the emergency surgical services in patients affected with COVID as well as those needing emergency care not affected with the virus, could be explored.

The limitations of our study are the relatively lesser number of representative health care institutions, compared to the size of our country. There is also a possibility of selection bias, due to the unequal distribution of public and private institutions in our study population. This being said, our study included hospitals from different cities, and may partly overcome the said limitations.

Conclusion

To conclude, our study quantified the effects of the COVID-19 pandemic on surgical care delivery across a timeline and documented that the overall surgical volumes reduced during the peaks of the pandemic with improvement as the surge of COVID 19 cases declined. The second wave of the pandemic showed improved surgical volumes as compared to the first one in spite of the effects of the COVID 19 mutation being more devastating. It may be attributable to the improved preparedness and the surgical services not being shut down. The proportion of reduction in emergency surgeries was less as compared to the elective ones, a picture simulating a ‘limited resource’ environment. Caesarean sections were affected the least with better delivery rates as the pandemic progressed in comparison to the pre-pandemic period.

Declarations

Ethics Approval: Institutional review board concurrence was obtained by the respective participating center (TMCHRC/SURG/2020/IEC/28/58; CT/HCMCT/IEC/Gen Surg/2020-21). A waiver on informed consent from the patient was obtained from the institutional review board of all the participating centre in view of anonymized data and deidentification of participants.

All the methods were performed in accordance with the **STROBE (Strengthening the Reporting of Observational Studies in Epidemiology guidelines and regulations)** guidelines and regulations.

Consent: Not applicable as this is an audit of surgical procedures during the COVID 19 pandemic in India.

Consent for Publication: All the authors of the manuscript have provided their consent for publication

Consent for Images/ Online information: Not Applicable

Availability of Data & Materials: The anonymized and deidentified data and material used in this research have been shared as a supplementary file.

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SJ, AM: Contributed equally to the Manuscript.

LB, AR: Refined the methodology, helped in the data collection, contributed in revising and improving the manuscript

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As per the requirement, we have submitted the data and it is available free on line on the following link. http://dx.doi.org/10.6084/m9.figshare.13042664

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Figures

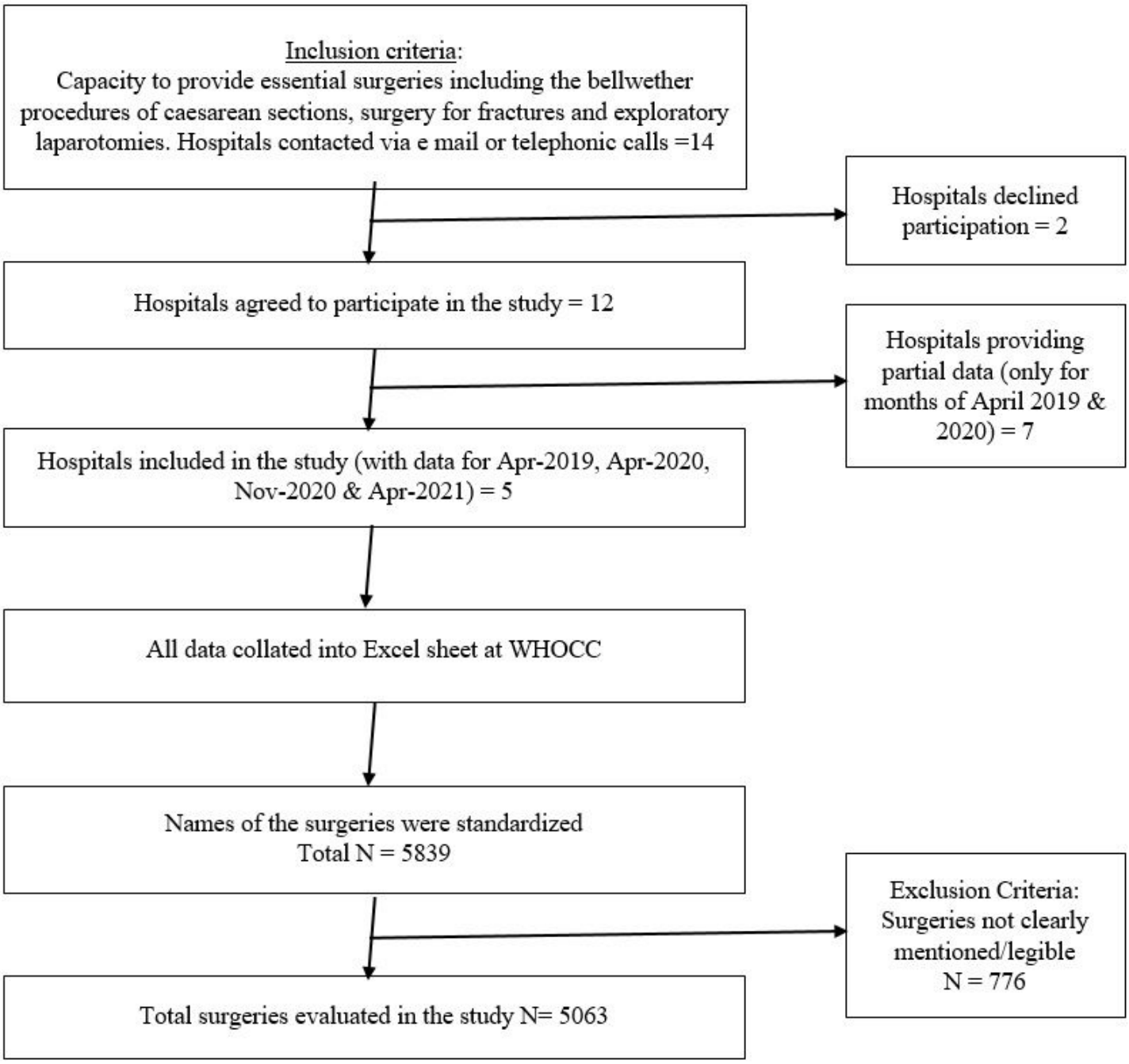

Figure 1

Recruitment Algorithm

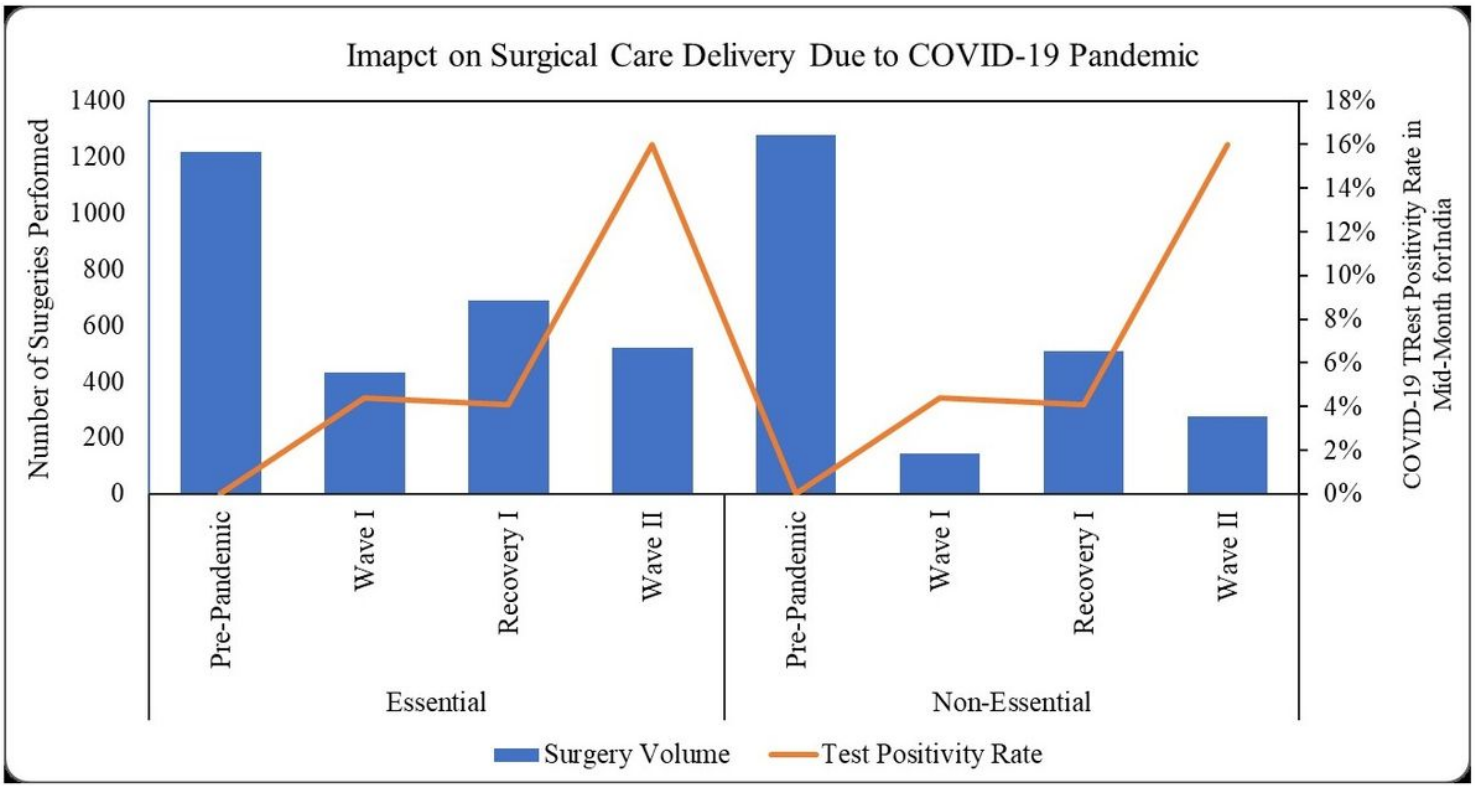

Figure 2

Overall Change in Surgical Care Delivery (Surgical volumes) during the Pandemic Period

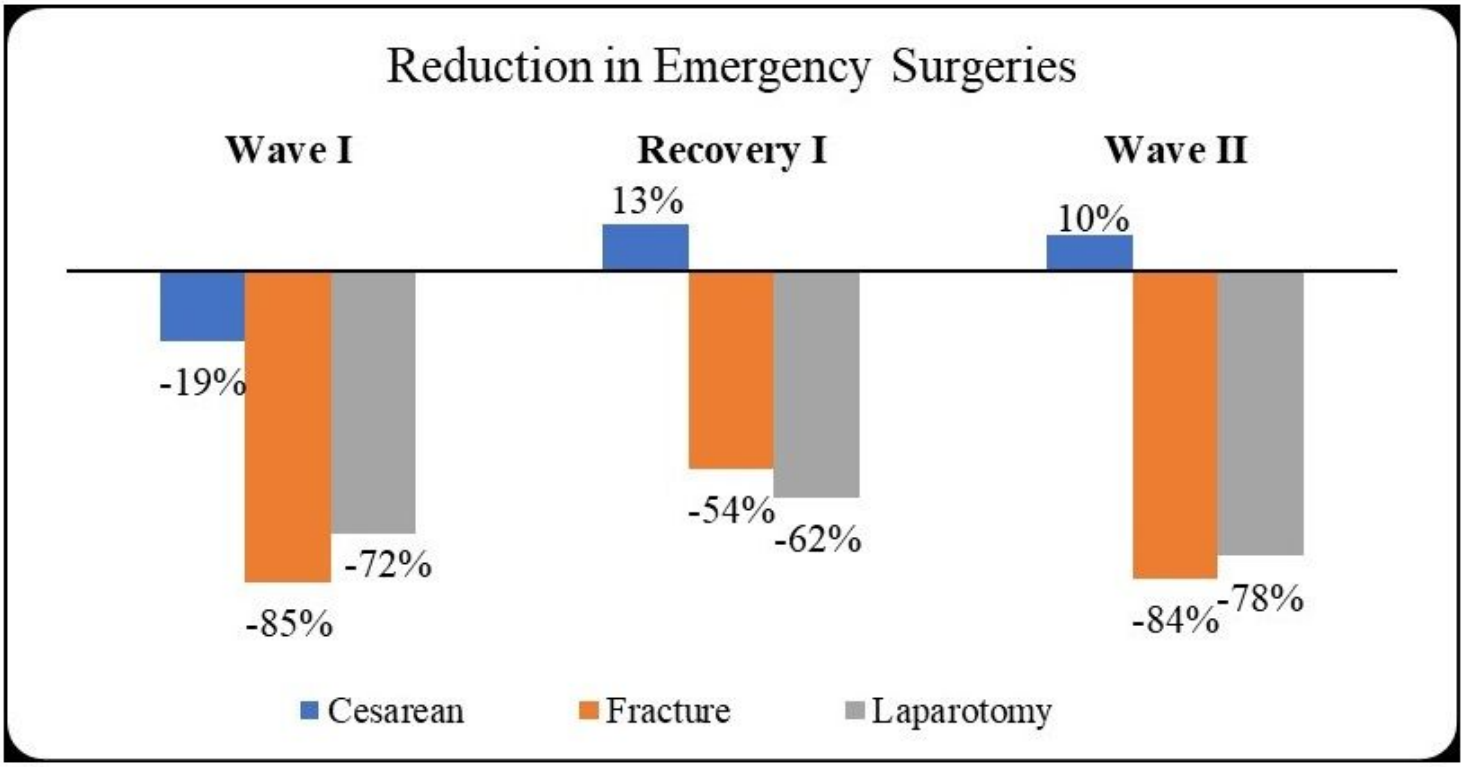

Figure 3

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- IndSurg1Part2FinalData.xlsx