



Covid-19 pandemic and Neonatal Surgical Outcomes: Lessons learned from a resource-challenged setting

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Abstract

Introduction: The management of neonatal surgical diseases is complex, especially in Low- and Middle-Income Countries (LMICs), where limited resources and high rates of sepsis contribute to poorer outcomes. The COVID-19 pandemic further impacted healthcare systems globally, with many elective surgeries postponed and resources reallocated to critically ill patients. This study aimed to assess the impact of COVID-19 on neonatal surgical admissions, mortality, and sepsis rates in a tertiary hospital in Northern India.

Methods: This retrospective, observational study analysed admission data from the Neonatal Surgical Intensive Care Unit (NSICU) over two periods: pre-COVID (March 2019 - February 2020) and during COVID (March 2020 - February 2021). Data included patient demographics, diagnoses, admission-to-surgery intervals, and outcomes. Interrupted time series analysis and statistical comparisons were performed, with $p < 0.05$ considered significant.

Results: There was an 18% decline in annual admissions during the COVID period, with a significant delay in surgery due to mandatory pre-operative COVID testing. Despite fewer admissions, 30-day mortality and sepsis rates significantly decreased (mortality from 29% to 22%, $p = 0.002$), potentially due to enhanced infection control and better nurse-to-patient ratios. However, hospital stays were longer during the COVID phase.

Conclusion: While COVID-19 led to reduced admissions and delayed surgeries, mortality and sepsis rates improved, likely from heightened hygiene protocols and reduced patient volumes. These findings highlight the need for robust infection control and adequate staffing to improve neonatal surgical outcomes in LMICs.

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Cite as: Dogra, S., Peters, N., Bade, R., Solanki, S., Malik, M. A., & Mahajan, J. K. Covid-19 pandemic and neonatal surgical outcomes: Lessons learned from a resource-challenged setting. *Impact Surgery*, 2(1), 40-45. <https://doi.org/10.62463/surgery.113>



Introduction

Managing neonatal surgical diseases is particularly challenging in low-resource settings.¹ Various factors contribute to below-average outcomes in neonatal surgery within Low- and Middle-Income Countries (LMICs).^{2,3} One major cause of morbidity and mortality in this vulnerable population is peripartum and peri-operative sepsis.⁴

Logistical challenges are often intensified during crises, such as the COVID-19 pandemic, which significantly compromised healthcare services worldwide after it was declared a pandemic by the World Health Organisation on 11 March 2020.⁵ Although patient influx for emergency procedures like neonatal surgeries remained constant or slightly decreased in specialised centres,⁶ numbers dropped substantially for routine surgeries.⁷ Changes in the epidemiology and disease profile of paediatric surgical patients were observed during the pandemic, which are now gradually returning to pre-pandemic patterns.⁸ Additionally, several centres reported increased mortality and morbidity rates.⁶ Most elective surgeries were postponed, and resources were reallocated to critically ill patients. While semi-elective and emergency neonatal surgeries continued, hospital and Neonatal Surgical Intensive Care Unit (NSICU) protocols were revised.^{6,10}

Revised admission and emergency protocols included COVID-19 testing (real-time reverse transcription polymerase chain reaction [rRT-PCR]) for all neonates before they were moved to the NSICU. Bed and cot sharing, previously common due to space limitations, was discontinued to limit transmission.

Routine practices also shifted during the pandemic. Resource-limited centres like ours face challenges with overcrowding and inadequate patient-nurse ratios.¹¹ However, the postponement of routine surgeries improved nurse-to-patient ratios. Enhanced hand hygiene practices were implemented, as newborns are particularly susceptible to infections, and effective hand hygiene can significantly reduce pathogen transmission and mortality rates. The increased emphasis on hand hygiene and improved protocols became standard during the pandemic peak.

There is limited literature from LMICs addressing the disease burden and outcomes of neonatal surgeries during the pandemic. This study aimed to assess the impact of the pandemic on admission numbers and disease patterns and to evaluate its effects on mortality and sepsis rates in surgical neonates.

Methods

Study Design and Setting

This study was a single-centre, retrospective, observational analysis conducted in the Neonatal

Surgical Intensive Care Unit (NSICU) of a tertiary care teaching hospital in Northern India. The NSICU is a specialized 25-bed unit dedicated to the management and care of surgical neonates.

Study Period and Data Collection

Data were collected retrospectively over two distinct periods: from March 2020 to February 2021, representing the COVID-19 pandemic phase, and from March 2019 to February 2020, as the pre-COVID phase. All neonates consecutively admitted to the NSICU during these times were included in the analysis, following a waiver of consent from the Institutional Ethics Committee (IEC no IEC/INT/2022/Study-827).

Data Sources and Variables

Baseline data were extracted from Google Sheets, verified through the hospital information system (HIS), and subsequently recorded in Excel. The data collected included patient characteristics such as gestation, gender, day of life at admission and surgery, diagnosis, duration of hospital stay, and surgical outcomes. Sepsis was defined as a positive blood culture in these neonates.

Study Objectives

The primary objective of this study was to investigate changes in the numbers and trends of hospital admissions for emergency neonatal surgeries across the two periods. Additionally, the study aimed to determine the influence of the COVID-19 pandemic on sepsis and mortality rates among surgical neonates.

Statistical Analysis

An interrupted time series analysis was conducted to evaluate trends in monthly admission volumes. For statistical comparisons, quantitative data with normal distribution were analysed using the Student's t-test, while skewed data were assessed using the Mann-Whitney U test. Non-quantitative data were compared using the Chi-square test or Fisher's exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant.

Results

The number of patients admitted decreased from 775 in the pre-COVID phase (March 2019 - February 2020) to 636 during the COVID period (March 2020 - February 2021), marking an 18% decline in yearly admissions (Table 1). Interrupted time analysis (Figure 1) showed a rapid drop in admissions immediately following the lockdown in March 2020, with a gradual recovery thereafter. No significant change was observed in the patient profile; Esophageal Atresia, with or without Tracheoesophageal Fistula, remained the most common condition, accounting for around 25% of cases in both periods, followed by anorectal malformations and



Table 1: Demography of patients and spectrum of conditions

Timing	Pre Covid	Covid
Total patients	775	636
Females	256/775 (33%)	212/636 (33.5%)
Diagnosis		
Tracheoesophageal Fistula	181/775 (24%)	159/636 (25%)
Congenital Diaphragmatic Hernia	47/775 (6%)	28/636 (4.4%)
Anorectal Malformation	98/775 (12%)	84/636 (13%)
Atresia	75/775 (9.6%)	56/636 (8.7%)
Posterior Urethral Valves	37/775 (4.7%)	40/636 (6.2%)
Neural Tube defects/ Hydrocephalous	38/775 (3.9%)	45/636 (7%)
Malrotation	17/775 (2.1%)	18/636 (2.8%)
Intestinal Obstruction	40/775 (5.1%)	35/636 (5.5%)
Necrotizing Enterocolitis	17/775 (2.1%)	11/636 (1.7%)
Abdominal Wall Defect	36/775 (4.6%)	21/636 (3.3%)
Others	189/775 (24%)	167/636 (26%)

intestinal atresia. However, a decrease was noted in neonates presenting with congenital diaphragmatic hernia, likely due to reduced deliveries and transportation challenges for critically ill neonates.

Males continued to outnumber females, with females representing only 35% of admissions across both phases. The interval between admission and surgery increased during the COVID phase due to mandatory pre-surgery RT-PCR testing, extending wait times in triage and the Emergency Room as COVID testing was managed across the hospital. A significant reduction in 30-day mortality was observed during the COVID phase (29% vs. 22%, $p=0.002$), alongside a notable decrease in the sepsis rate. Hospital stays, however, were longer during the COVID period (Table 2).

Discussion

Surgically correctable congenital anomalies represent a significant component of the global health burden.¹² Low-

and middle-income countries (LMICs) face immense challenges in managing these conditions within already strained healthcare systems, which contributes to suboptimal outcomes and elevated morbidity and mortality rates.^{13,14} High neonatal surgical mortality in low-resource settings such as India can be attributed to factors including limited antenatal care, delayed surgical referrals, and inadequate workforce and infrastructure.^{15,16} This fragile healthcare environment further deteriorated during the COVID-19 pandemic, which impacted health services across the board.

Substantial changes in paediatric surgical practices were observed globally during the pandemic.¹⁷ Elective procedures were paused to manage resources effectively, and only

emergency cases were handled. Many centres worldwide reported a decrease in patient admissions,^{18,19} likely due to travel restrictions, especially affecting referral-based centres like ours. In this study, interrupted time series analysis indicated an 18% decline in admissions following the Indian government's lockdown in March 2020. This influx of neonates gradually improved over the following months. We also noted a shift in disease patterns during the pandemic, with a decrease in cases of Congenital Diaphragmatic Hernia (CDH), likely due to logistical challenges in transporting critically ill neonates and a decline in antenatal diagnoses linked to suboptimal antenatal care during the pandemic. Delay in early management of Pulmonary Hypertension (PPHN) significantly contributes to high CDH mortality rates.²⁰

Analysis also indicated a notable delay in surgical timing, as COVID testing before ICU transfer delayed procedures by 24-48 hours. Further delays could be attributed to

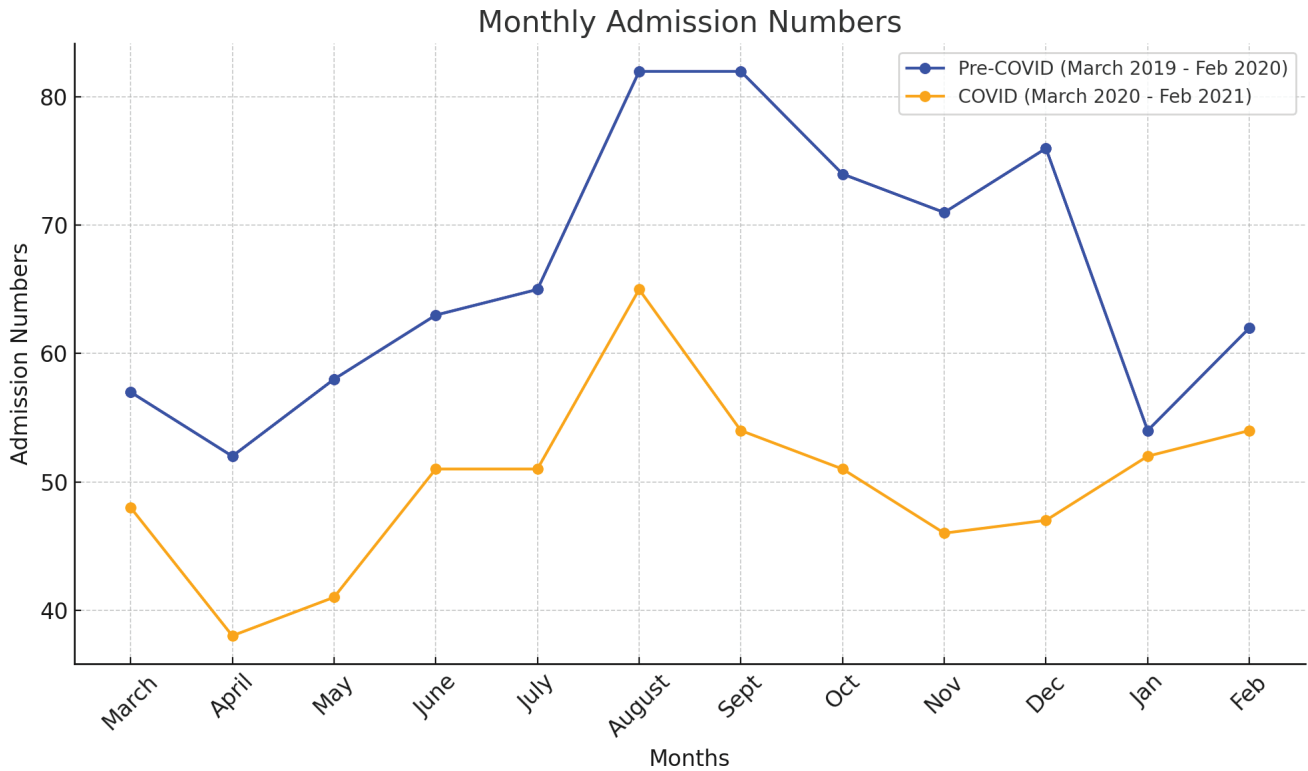
Table 2: Admission to surgery interval, admission days and 30-day mortality

Timing	Pre Covid	Covid	p-value
Median Admission to Surgery interval (Inter-quartile Range)	775	3(2-4)	-
Median Hospital Stay (Inter-quartile Range)	7(4-13)	10(6-18)	-
Tracheoesophageal Fistula*	2.19 ± 1.02	3.2 ± 1.07	0.001
Anorectal Malformation*	1.9 ± 0.8	2.8 ± 1.5	0.001
Atresia*	3.35 ± 1.6	3.46 ± 1.8	0.220
Sepsis	239/775 (31%)	159/636 (25%)	0.012
30-day Mortality	223/775 (29%)	145/636 (22%)	0.002

Mean Admission to Surgery time (days)



Figure 1: monthly admission numbers for both pre-COVID (March 2019 - Feb 2020) and COVID (March 2020 - Feb 2021) periods.



transport restrictions and parental concerns. Gender bias was evident in both periods, with males comprising around two-thirds of admissions. This disparity aligns with prior studies indicating a higher care-seeking rate for male neonates.^{21,22} Gender-based discrimination is documented across paediatric healthcare but may be more pronounced in surgical cases due to concerns over long-term outcomes.

LMICs report very high mortality rates (15-30%) among surgical neonates, contrasting with rates below 5% in developed countries.^{23,24} While mortality remained high during the pandemic at our centre, there was a statistically significant reduction compared to the pre-COVID period. This differs from other studies reporting higher neonatal mortality during the pandemic.²⁶ Decreased sepsis rates may partially explain this trend, and a lower admission rate may also imply that more critically ill neonates succumbed before reaching tertiary care.

Sepsis is a leading cause of mortality in surgical neonates, with studies reporting high sepsis rates (20-70%).^{27,28} Postoperative sepsis rates in neonates are substantially higher in LMICs than in developed countries.²⁹ Improvements in antenatal care, asepsis during transfers, and neonatal handling are essential to improve outcomes for surgical neonates.³⁰ In our study, the sepsis rate was significantly lower during the COVID phase. Factors such as the restriction of cot-sharing, stringent infection control protocols, and rigorous hand

hygiene practices likely contributed to this outcome. Hand hygiene, recognised as a critical measure against healthcare-associated infections (HAIs), was strictly adhered to during the pandemic, which may have significantly reduced sepsis rates.

Optimal nurse-to-patient ratios are critical in neonatal care, especially in surgical units where neonates require intensive management. The pandemic-related decrease in overcrowding improved nurse-to-patient ratios and care quality. Stable neonates were moved to a step-down area, enhancing care for more critical cases. Additionally, changes in hospital and NSICU entry policies due to COVID-19 facilitated stricter hand hygiene measures. Lower postoperative sepsis and surgical site infection rates, along with reduced mortality, have been reported in other centres as well.³¹

Hospital stays were longer during the pandemic, likely due to the suspension of routine surgeries, which allowed greater bed availability. This permitted more flexible discharge policies, and similar observations have been made in other centres.³²

This study has several limitations. As a retrospective single-centre study, it may lack generalisability. Additionally, records for neonates testing COVID-positive were unavailable, as they were managed in a separate facility.

The COVID-19 pandemic has severely disrupted



healthcare systems globally, contributing to a backlog of elective surgeries.³³ The unmet surgical needs in LMICs, already alarmingly high, have been further exacerbated by this crisis. Recovery plans are essential to safely restore surgical activity. During the pandemic, limited availability of operating rooms and personnel highlighted the need for clear resource optimisation guidelines. Expanding telemedicine for pre-surgical consultations, routine check-ups, and postoperative care can help reduce hospital visits and exposure risk. The pandemic underscored the importance of strengthening hygiene protocols, infrastructure, and workforce—especially nursing—to optimise neonatal surgical care in LMICs. Enhanced infection prevention, including strict hand hygiene and surgical environment protocols, is vital to minimising infection risks, particularly in neonates.

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