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Early postoperative morbidity, recovery milestones, and critical-care utilization after pediatric abdominal surgery in a general surgery-led tertiary hospital: A prospective observational cohort

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Abstract
Background: Published pediatric surgical outcome studies frequently focus on a single diagnosis or procedure. General surgery-led government hospitals, however, often manage a heterogeneous, neonatal-dominant abdominal surgical workload. The clinically relevant question in such settings is not whether one procedure outperforms another, but the magnitude and pattern of early morbidity, recovery delay, and critical-care use across the service.
Methods: This prospective observational cohort included 60 consecutive patients aged <18 years who underwent an abdominal operation at a government tertiary hospital between March 2024 and October 2025. The primary outcome was any recorded postoperative complication during the index admission and follow-up period. Secondary outcomes were complication-event profile, NICU/ICU utilization, duration of critical-care and hospital stay, return of bowel sounds, initiation of enteral feeding, discharge, referral, and mortality. Analyses were descriptive; exploratory comparisons were unadjusted because only 19 patients experienced the primary outcome, precluding a reliable multivariable prediction model.
Results: Neonates comprised 28/60 (46.7%) and infants 14/60 (23.3%) of the cohort. Forty patients (66.7%; 95% CI 54.1-77.3) required NICU/ICU care. Any postoperative complication occurred in 19/60 patients (31.7%; 95% CI 21.3-44.2). A total of 37 complication events were recorded among affected patients (mean 1.95 events per affected patient): wound infection in 15 (25.0%), fever in 13 (21.7%), paralytic ileus in 7 (11.7%), and sepsis in 2 (3.3%). Mean critical-care stay was 7.93 ± 3.77 days and mean hospital stay was 18.10 ± 5.20 days. Bowel sounds returned at 4.38 ± 1.42 postoperative days and enteral feeding began at 6.33 ± 1.48 days. Fifty-five patients were discharged (91.7%; 95% CI 81.9-96.4), four were referred, and one died (1.7%; 95% CI 0.3-8.9). Exploratory age- and procedure-based comparisons were not statistically significant.
Conclusion: This neonatal-dominant cohort demonstrated substantial early morbidity, delayed gastrointestinal recovery, and high critical-care utilization despite low observed mortality. The study should be interpreted as a service-level benchmark rather than a predictor study. Its principal actionable signal is the combination of frequent wound-related morbidity and late enteral feeding, supporting prospective implementation and evaluation of standardized infection-surveillance and pediatric enhanced-recovery pathways.

Keywords: Pediatric abdominal surgery, postoperative morbidity, surgical site infection, neonatal surgery, critical care utilization, recovery milestones, prospective cohort

Introduction

Pediatric abdominal surgery encompasses congenital anomalies, obstructive disorders, inflammatory conditions, and emergencies that differ markedly in physiology, operative complexity, and expected recovery. These differences make unrestricted pooling clinically difficult when the purpose is causal inference or procedure comparison. Nevertheless, mixed surgical cohorts remain relevant for health-service evaluation in hospitals where a single general surgery unit manages the full pediatric abdominal workload and where intensive-care capacity, infection prevention, referral pathways, and postoperative feeding practices are shared across diagnoses.

Large prospective perioperative studies have shown that postoperative complications in children are strongly related to urgency, severity of surgery, physiological status, and infective indications. In the South African Paediatric Surgical Outcomes Study, infective complications predominated and postoperative morbidity varied substantially according to perioperative risk. More recent multicountry work similarly emphasizes that pediatric surgical outcomes in resource-limited systems reflect both case mix and system capacity. These findings support transparent reporting of local case mix and resource use rather than attributing outcomes to isolated demographic characteristics.

Standardized reporting is essential. The STROBE statement recommends explicit definition of study design, participants, outcomes, statistical methods, missing data, limitations, and generalizability. Surgical complications are ideally graded by the Clavien-Dindo system according to the treatment required. In the present cohort, treatment-level information required for valid retrospective Clavien-Dindo assignment was not consistently available; therefore, complications are reported by clinically recorded category and event burden, and this limitation is stated explicitly rather than imposing an unsupported severity grade.

The original analysis attempted to identify factors influencing outcomes, but the cohort contained only 19 patients with complications. Such an event count is inadequate for a stable multivariable prediction model with several candidate variables and would create a high risk of overfitting. The revised manuscript therefore reframes the work as a prospective service-level cohort describing morbidity, recovery milestones, and critical-care utilization, with exploratory unadjusted comparisons only.

The objective was to quantify early postoperative morbidity and complication-event patterns among children undergoing abdominal surgery in a general surgery-led tertiary hospital. Secondary objectives were to describe NICU/ICU utilization, length of stay, gastrointestinal recovery milestones, disposition, and mortality, and to generate institution-specific targets for future quality-improvement studies.

Materials and Methods

Study design and setting

A prospective observational cohort study was conducted in the Department of General Surgery at GMERS Medical College and Hospital, Valsad, Gujarat, India, from March 2024 to October 2025. The hospital is a government tertiary referral institution serving urban and rural populations. Pediatric abdominal surgical care was delivered by general surgeons in collaboration with pediatricians, anesthesiologists, neonatal/pediatric critical-care teams, nursing staff, and referral services. The manuscript was revised in accordance with the STROBE reporting framework.

Participants

All consecutive patients aged <18 years who underwent an operation involving abdominal access during the study period were eligible. Elective and emergency operations and open, laparoscopic, and converted procedures were included. Patients managed non-operatively, undergoing only endoscopic or image-guided intervention, undergoing a minor procedure without intra-abdominal access, or lacking guardian consent were excluded. Follow-up was planned through 90 postoperative days; however, the available outcome dataset was dominated by index-admission events, and no claim of complete 90-day event ascertainment is made.

Variables and outcomes

Baseline variables included age group, sex, socioeconomic category, diagnosis, and operation. Recovery variables included NICU/ICU requirement, duration of critical-care stay, total hospital stay, postoperative day of return of bowel sounds, and postoperative day of initiation of enteral feeding.

The primary outcome was any recorded postoperative complication. Recorded complication categories were wound infection, fever, paralytic ileus, and sepsis. More than one complication could occur in the same patient; consequently, complication-category percentages are not mutually exclusive and their sum exceeds the patient-level complication rate. The total complication-event burden was calculated by summing all recorded events. The dataset did not contain sufficiently detailed treatment-level information to assign Clavien-Dindo grades reliably. Final disposition was categorized as discharged, referred to a higher center, or death.

Bias and data quality

Consecutive enrollment was used to reduce selection bias. Data were collected on a structured case record form. Because the study included heterogeneous diagnoses and procedures, no pooled causal interpretation was planned in the revised analysis. Outcome definitions were restricted to variables explicitly available in the study records. Missing-data counts were not reported in the source dataset; therefore, analyses were based on available observations and this is acknowledged as a limitation.

Statistical analysis

Categorical variables are presented as frequency and percentage. Continuous variables are presented as mean ± standard deviation and, where available, median, interquartile range, and range. Wilson 95% confidence intervals were calculated for key proportions. Exploratory comparisons used chi-square or Fisher exact tests for categorical variables and Mann-Whitney U or Kruskal-Wallis tests for continuous variables, as appropriate. All comparisons were two-sided with $p<0.05$ considered statistically significant. No multivariable regression was performed because only 19 primary-outcome events were observed; fitting several predictors to this event count would yield unstable and potentially overfitted estimates. Exploratory associations are therefore reported as unadjusted and hypothesis-generating.

Ethics

Institutional Ethics Committee approval was obtained before study commencement. Written informed consent was obtained from parents or legal guardians, with assent from older children where applicable. The ethics approval number and date should be inserted in the final submission: [IEC number/date].

Results

Participants and case mix

Sixty pediatric patients underwent abdominal surgery and were included in the analysis. Neonates formed nearly half the cohort, and 70.0% of patients were younger than one year. Males constituted 58.3%. The socioeconomic distribution was concentrated in the upper-lower and lower categories (Table 1).

Table 1: Baseline demographic and socioeconomic characteristics of the study cohort (N = 60)

Characteristic	Category	N	%
Age	Neonate (0-28 days)	28	46.67
	Infant (29 days-1 year)	14	23.33
	Child (1-12 years)	10	16.67
	Adolescent (>12 years)	8	13.33
Sex	Male	35	58.33
	Female	25	41.67
Socioeconomic status	Upper	4	6.67
	Upper middle	9	15.00
	Lower middle	13	21.67
	Upper lower	21	35.00
	Lower	13	21.67

Note: Data are presented as n (%) unless otherwise indicated. Age categories are defined as neonate (0–28 days), infant (29 days–1 year), child (1–12 years), and adolescent (>12 years).

Intestinal obstruction was the most frequently recorded diagnosis (33.3%), followed by Hirschsprung disease (18.3%), intussusception (15.0%), and congenital diaphragmatic hernia (13.3%). The operative spectrum was correspondingly diverse (Table 2). This table is presented to define case mix; pooled outcome comparisons across these categories are exploratory and not interpreted as procedure-effect estimates.

Table 2: Distribution of diagnoses and operative procedures in the study cohort (N = 60)

Domain	Category	N	%
Diagnosis	Intestinal obstruction	20	33.33
	Hirschsprung disease	11	18.33
	Intussusception	9	15.00
	Congenital diaphragmatic hernia	8	13.33
	Other abdominal conditions	7	11.67
	Malrotation	5	8.33
Operation	Pull-through procedure	11	18.33
	Bowel resection	9	15.00
	Exploratory laparotomy	9	15.00
	Reduction/resection	9	15.00
	CDH repair	8	13.33
	Other procedures	7	11.67
	Ladd procedure	5	8.33
	Adhesiolysis	2	3.33

Note: Data are presented as n (%). Diagnosis and operation categories describe the case mix and are not mutually comparable for causal or procedure-effect inference.

Illustrative clinical course: An 8-day-old female neonate with an omphalocele measuring approximately 4 × 4 cm underwent operative reduction of the omphalocele contents. Intraoperatively, twisting of the omphalocele sac with compromised bowel orientation was noted. Following the initial procedure, the patient developed clinical features suggestive of intestinal obstruction and required re-exploration by exploratory laparotomy on postoperative day 5. The subsequent postoperative course, including the surgical-site findings and discharge status, illustrates the complexity of neonatal abdominal surgical care and the potential for early postoperative morbidity in this heterogeneous cohort (Fig. 1).

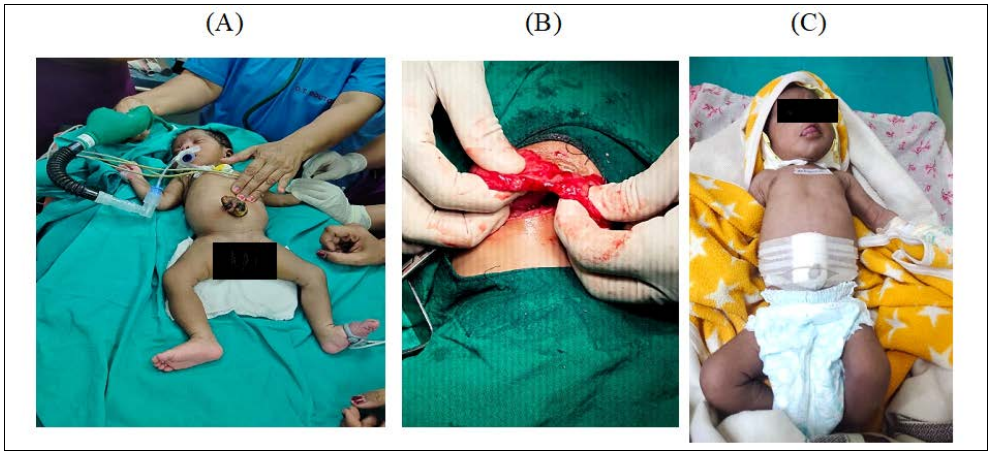

Fig 1: Illustrative clinical and operative course of neonatal abdominal surgery. (A) Preoperative appearance of the omphalocele in an 8-day-old neonate; (B) intraoperative findings during reduction and subsequent exploratory laparotomy; and (C) postoperative surgical-site appearance on postoperative day 3 following re-exploration showing mild discharge from surgical site.

Critical-care use and recovery milestones

Forty patients required NICU/ICU care (66.7%; 95% CI 54.1-77.3). Mean critical-care stay was 7.93 ± 3.77 days and mean total hospital stay was 18.10 ± 5.20 days. Return of bowel sounds occurred at a mean of 4.38 ± 1.42 postoperative days, while enteral feeding began at 6.33 ± 1.48 days (Table 3). These values provide institution-specific benchmarks for future enhanced-recovery interventions.

Table 3: Critical-care utilization and postoperative recovery milestones

Outcome	Summary
NICU/ICU requirement	40/60 (66.67%; 95% CI 54.1-77.3)
Critical-care stay	Mean 7.93 ± 3.77 days; median 7.5 (IQR 5.0-11.0); range 2-14
Hospital stay	Mean 18.10 ± 5.20 days; median 17.0 (IQR 15.0-22.0); range 10-29
Return of bowel sounds	Mean POD 4.38 ± 1.42; median POD 5
Initiation of enteral feeding	Mean POD 6.33 ± 1.48; median POD 6

Note: Data are presented as n (%) or mean ± standard deviation; median, interquartile range (IQR), and range are provided where available. NICU/ICU, neonatal intensive care unit/intensive care unit; POD, postoperative day.

Postoperative morbidity and disposition

Nineteen patients experienced at least one postoperative complication (31.7%; 95% CI 21.3-44.2). Because complications were non-mutually exclusive, the four recorded categories represented 37 events among 19 affected patients, equivalent to 1.95 recorded events per affected patient. Wound infection was the dominant morbidity signal, affecting one-quarter of the entire cohort. Fever was also frequent but was retained as a recorded clinical event rather than equated with infection in the absence of microbiological or diagnostic detail. Two patients developed sepsis. Fifty-five patients were discharged, four were referred, and one died (Table 4).

Table 4: Postoperative complications and final disposition of the study cohort (N = 60)

Outcome	n	%	95% CI
Any complication	19	31.67	21.3-44.2
Wound infection	15	25.00	15.8-37.2
Fever	13	21.67	13.1-33.6
Paralytic ileus	7	11.67	5.8-22.2
Sepsis	2	3.33	0.9-11.4
Discharged	55	91.67	81.9-96.4
Referred	4	6.67	Not calculated
Death	1	1.67	0.3-8.9

Note: Data are presented as n (%), with Wilson 95% confidence intervals (CI) where calculated. Complication categories are not mutually exclusive; therefore, their percentages may sum to more than the patient-level complication rate. CI was not calculated for referral because it was not specified in the available analysis.

Exploratory unadjusted comparisons

Complication proportions varied by age group, from 12.5% among adolescents to 60.0% among children aged 1-12 years, but the overall comparison was not statistically significant (p=0.124). Critical-care stay differed numerically across diagnoses but not statistically (Kruskal-Wallis p=0.146). Hospital stay was similar in patients with and without complications (p=0.817). Procedure-specific complication proportions ranged from 0% to 44.4%, with no significant overall association (p=0.901). These estimates are imprecise because several subgroups contained fewer than 10 patients and should not be interpreted as evidence of equivalence or independent risk (Table 5).

Table 5: Exploratory unadjusted comparisons of postoperative outcomes by selected patient and operative characteristics

Exploratory comparison	Observed result	p value	Interpretation
Age group vs any complication	Neonate 7/28; infant 5/14; child 6/10; adolescent 1/8	0.124	Unadjusted; sparse cells
Diagnosis vs critical-care stay	Mean 6.75-11.00 days across groups	0.146	Heterogeneous diagnoses
Hospital stay by complication status	17.90 ± 4.87 vs 18.42 ± 5.99 days	0.817	No detectable difference
Operation vs any complication	0%-44.44% across procedures	0.901	Underpowered subgroup comparison
Sex vs disposition	1 death in males; referrals 2 in each sex	0.661	Sparse outcome categories

Note: Data are presented as observed values with two-sided p values. All comparisons were unadjusted and exploratory. Sparse subgroup sizes and the small number of complication events limit statistical power; therefore, these findings should not be interpreted as evidence of independent risk factors or equivalence between groups

Discussion

This prospective cohort provides a service-level description of pediatric abdominal surgical care in a general surgery-led government tertiary hospital. Three findings are most relevant. First, the cohort was neonatal- and infant-dominant, distinguishing it from procedure-specific studies of older children and from broad perioperative cohorts in which elective surgery and lower-risk ASA categories predominate [4,5]. Second, postoperative morbidity and critical-care utilization were substantial: almost one-third experienced a complication and two-thirds required NICU/ICU care. Third, wound-related events and delayed enteral feeding emerged as potentially modifiable institutional targets, while the low number of outcome events prevented reliable identification of independent predictors [11, 12].

The observed complication rate of 31.7% was higher than the 9.7% reported in the South African Paediatric Surgical Outcomes Study and the 18.0% reported in the multicountry ASOS-Paeds cohort [4, 5]. Infective complications predominated in both studies, consistent with the wound-related morbidity observed in the present cohort [4, 5]. Direct numerical comparison, however, is constrained by differences in case mix, urgency, ASA physical status, surgical severity, outcome definitions, and duration of follow-up. The present cohort contained a much larger proportion of neonates and abdominal congenital or obstructive pathology. Multicentre studies from low-resource settings have shown particularly adverse outcomes among neonates and children requiring emergency surgery, but the current dataset did not capture the standardized severity variables required to determine whether those mechanisms explain the observed morbidity [5, 13].

Wound infection affected 25.0% of patients and represented the clearest quality-improvement signal. International prospective data confirm that surgical-site infection is a major source of morbidity after gastrointestinal surgery in children and that its burden is higher in low- and middle-income settings [14]. Pediatric studies have associated SSI with neonatal age, intensive-care admission, prolonged procedures, devices, drains, emergency surgery, and contaminated wounds [15, 17]. The present study did not document standardized CDC SSI categories, wound class, microbiology, antibiotic-prophylaxis timing, drain exposure, operative duration, or post-discharge surveillance. The revised interpretation is therefore deliberately narrow: wound-related morbidity was frequent and warrants a prospective audit using standardized diagnostic definitions and process indicators rather than causal attribution to any single factor.

The total of 37 complication events among 19 affected patients demonstrates that patient-level incidence alone understates morbidity burden. Nearly two events were recorded per affected patient. Surgical outcome reporting should distinguish the occurrence of any complication from the number and severity of individual events. The Clavien-Dindo classification grades complications according to the treatment required and improves comparability across surgical studies [2, 3]. Future data collection should therefore record event onset, diagnostic criteria, treatment, reintervention, organ support, readmission, and the highest Clavien-Dindo grade per patient. Because these treatment-level details were unavailable, retrospective grading was not attempted.

Critical-care utilization was high, with 66.7% requiring NICU/ICU admission and a mean critical-care stay of approximately eight days. In a neonatal-dominant abdominal cohort, planned postoperative ventilation, physiological immaturity, sepsis risk, and the need for close monitoring may all contribute to critical-care use. Large African pediatric surgical cohorts have demonstrated that hospital resources, safe anesthesia environments, emergency status, and failure-to-rescue capacity influence postoperative outcomes [4, 5]. In the present study, however, intensive-care admission criteria, ventilation, vasoactive support, and illness-severity scores were not captured. ICU/NICU use is therefore reported as a resource-utilization endpoint and not interpreted as an independent marker of poor outcome.

Gastrointestinal recovery was relatively slow: bowel sounds returned after a mean of 4.4 days and enteral feeding began after 6.3 days. Pediatric ERAS studies and meta-analyses indicate that protocolized perioperative pathways can reduce time to first feeding, time to full enteral nutrition, opioid exposure, and length of stay without a demonstrable increase in major complications or readmissions in appropriately selected children [7, 10, 18, 19]. A systematic review focused on bowel anastomosis similarly found no significant increase in anastomotic leak, wound dehiscence, abdominal distension, vomiting, or septic complications with feeding initiated within 48 hours [18]. Nevertheless, the present study did not test an ERAS intervention, and feeding readiness differs substantially among congenital

diaphragmatic hernia repair, bowel resection, pull-through surgery, and operations for obstruction. The observed milestones should therefore be treated as baseline service indicators for a future diagnosis-stratified feeding protocol rather than evidence that earlier feeding would have been appropriate for every patient.

Observed mortality was 1.7%, broadly similar to the 1.1% in-hospital mortality reported in the South African cohort but lower than the 2.3% reported across 31 African countries [4, 5]. These comparisons must be interpreted cautiously because only one death occurred, producing a wide confidence interval, and four patients were referred without definitive post-transfer outcomes. Studies of common pediatric surgical conditions in sub-Saharan Africa have shown that neonatal status, diagnosis, physiological risk, transfusion, delayed presentation, and access to specialist perioperative care materially influence mortality [13]. The present study cannot examine those determinants and cannot claim complete 90-day survival. The defensible conclusion is that observed in-hospital mortality was low while postoperative morbidity and resource utilization remained substantial.

No multivariable model was fitted. This is a methodological correction rather than a weakness that can be repaired by reanalyzing aggregate tables. With only 19 patients experiencing the primary outcome, a model containing age, diagnosis, operation, sex, socioeconomic status, and critical-care variables would be vulnerable to overfitting, unstable coefficients, and exaggerated apparent associations [11, 12]. Contemporary prediction-model guidance recommends sample-size planning based on outcome prevalence, number of candidate parameters, anticipated model performance, and shrinkage rather than a simplistic events-per-variable rule [11]. A future multicentre or longer-duration cohort should prespecify a limited set of clinically justified variables such as urgency, ASA status, nutritional indices, contamination class, operative duration, transfusion, and preoperative sepsis, several of which have been associated with complications in larger pediatric cohorts [4, 15, 17].

The study's novelty lies in context-specific benchmarking of a neonatal-dominant, heterogeneous abdominal surgical service in a general surgery-led public hospital. It should not be presented as a comparison of operations or as practice-changing evidence. Its value is in identifying measurable institutional targets supported by the wider literature: standardized 30-day complication surveillance [1, 14], treatment-based severity grading [2, 3], pediatric SSI-prevention metrics [15, 17], diagnosis-specific enhanced-recovery and feeding pathways [7, 10, 18, 19], and complete follow-up after referral. These targets convert a descriptive audit into a reproducible quality-improvement agenda while preserving appropriate limits on causal interpretation.

Conclusion

In this neonatal-dominant prospective cohort of pediatric abdominal operations at a general surgery-led government tertiary hospital, one-third of patients experienced a recorded postoperative complication and two-thirds required NICU/ICU care. Wound infection was the most frequent morbidity, and enteral feeding began at a mean of more than six postoperative days. Observed mortality was low but imprecisely estimated, and outcomes after referral were unavailable. The study provides a local baseline for quality improvement rather than evidence of independent predictors or practice-changing effectiveness. The next phase should be a larger, diagnosis-stratified prospective cohort using standardized complication definitions, Clavien-Dindo grading, complete 30-day follow-up, and prespecified infection-prevention and enhanced-recovery process measures.

Declarations

Ethics approval and consent to participate: Approved by the Institutional Ethics Committee; approval number and date to be inserted. Written guardian consent and age-appropriate assent were obtained.

Consent for Publication: Not applicable

Competing Interests: The authors declare no competing interests.

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