Asploro Journal of Biomedical and Clinical Case Reports
(ISSN: 2582-0370)
Review Article
DOI: https://doi.org/10.36502/2026/ASJBCCR.6462

A Narrative Review of Risk Factors for Postoperative Complications in Neonates: Integrating Patient, Surgical, and Anesthetic Determinants for Optimized Perioperative Care

Pan Jiang[1*]
[1]*Department of Anesthesiology, West China Hospital, Sichuan University, Chengdu, Sichuan, PR China*

Corresponding Author: **Pan Jiang**
Address: Department of Anesthesiology, West China Hospital, Sichuan University, No. 37, Guoxue Valley, Wuhou District, Chengdu 610041, Sichuan Province, China; Tel: +86 18345189256; Email:2379679983@qq.com
Received date: 08 August 2026; **Accepted date**: 17 August 2026; **Published date**: 24 August 2026

Citation: Jiang P. A Narrative Review of Risk Factors for Postoperative Complications in Neonates: Integrating Patient, Surgical, and Anesthetic Determinants for Optimized Perioperative Care. Asp Biomed Clin Case Rep. 2026 Aug 24;9(3):166-71.

Abstract

Objective: To review the main risk factors for postoperative complications in neonates and provide references for optimizing perioperative management.

Methods: Literature published between 2000 and 2024 in databases such as PubMed was retrieved. Patient-, surgical-, and anesthesia-related risk factors for postoperative complications in neonates were summarized and analyzed.

Results: The occurrence of postoperative complications in neonates is the result of multiple factors. Patient factors, such as prematurity, low birth weight, and severe comorbidities; surgical factors, such as emergency surgery and operation duration; and anesthesia- and perioperative management-related factors, such as preoperative status and intraoperative hemodynamic fluctuations, are all key elements affecting prognosis.

Conclusion: Identifying and evaluating high-risk factors and performing preoperative optimization and refined intraoperative management through multidisciplinary collaboration are important strategies to reduce the incidence of postoperative complications in neonates and improve their surgical outcomes.

Keywords

Newborn, Postoperative Complications, Risk Factors, Perioperative Management

Introduction

The neonatal period (within 28 days after birth) is the stage of life with the most dramatic physiological changes and the greatest vulnerability. Due to the incomplete development of the structure and function of various systems and organs, as well as poor self-regulation and compensatory capacity, neonates are highly susceptible to major organ injury, infections, and even death during the perioperative period, making them a recognized high-risk population [1,2]. With advancements in neonatal intensive care units (NICUs) and surgical techniques, the survival rate of neonates undergoing surgery has significantly improved; however, there remains a substantial disparity in mortality rates worldwide [3].

Previous studies have mostly focused on the surgical outcomes of individual conditions, such as esophageal atresia or congenital diaphragmatic hernia, lacking a comprehensive review of risk factors for postoperative complications in neonates. Although there have been studies exploring neonatal surgical risks, the definitions and descriptions of postoperative complications vary, making data integration and comparison difficult. Moreover, there is a lack of systematic analysis from the anesthesiologist's perspective regarding the interaction among patient factors, surgical factors, and anesthesia-related factors. This paper aims to summarize the main risk factors for postoperative complications in neonates by reviewing the existing literature, providing strategies for perioperative risk assessment and refined management, and offering a theoretical basis for reducing the incidence of complications and improving long-term outcomes in affected infants.

Literature Search Strategy

This study used keywords such as "Newborns/Neonates," "Postoperative Complications," and "Risk Factors" to search the PubMed database for English-language literature published between January 2000 and December 2024. The inclusion criteria were: (1) the study subjects were newborns; (2) the interventions involved surgical treatment (excluding cardiac surgery); and (3) the outcome indicators were related to postoperative complications or mortality. The exclusion criteria were: (1) populations other than newborns; (2) no surgical intervention performed; (3) cardiac surgery; and (4) studies focusing solely on extremely rare diseases or the technical details of a single surgical procedure. Ultimately, 10 representative studies were selected for review [4-13].

Analysis of Risk Factors for Postoperative Complications in Newborns

A comprehensive analysis of the existing literature indicates that the risk factors affecting postoperative complications in newborns can be categorized into three main types: patient factors, surgical factors, and anesthesia- and perioperative management-related factors (**Table-1**).

Table-1: Summary of Risk Factors for Postoperative Complications in Neonates

First Author and Year	Study Design	Sample Size	Primary Outcome Measures	Independent Risk Factors	Remarks
Lillehei CW, 2012[4]	Retrospective analysis	15,278	mortality	Premature birth, severe respiratory disease NEC 、 Neonatal sepsis, congenital heart disease	Large sample multicenter study
Catré D, 2013[5]	Retrospective analysis	437	complications	Reoperation, congenital diaphragmatic hernia, gestational age <32 weeks, abdominal surgery	
Catre D, 2013[6]	Retrospective analysis	437	mortality	ASA grade ≥ III, nec/ gastrointestinal perforation	
Stey AM, 2015[7]	Retrospective analysis	2907	adverse events	Infection cases, preoperative dialysis, hepatobiliary diseases, use of inotropic drugs	For large abdominal / thoracic surgery
Michelet D, 2017[8]	Retrospective analysis	168	complications	Corrected for gestational age <40 weeks, cardiac malformations, HMD or NEC, and preoperative ICU status	
Puri A, 2019[9]	Retrospective analysis	150	mortality	Operation time >120 minutes, prolonged ventilation, high-dose vasopressors, reoperation	Research in resource limited environment
Song L, 2019[10]	Retrospective analysis	142	mortality	NEC、 Be value before intubation and immediately after laparotomy ≤ -10 mmol/l	Single center study
Nasr VG, 2019[11]	Retrospective analysis	3,67,065	mortality	Weight <5kg, ASA grade≥ III, preoperative sepsis, inotropic drug support	Research on super large scale database
Ammar S, 2020[12]	Retrospective analysis	182	mortality	Low birth weight, preoperative intubation, operation time >2h	
Kammoun M, 2024[13]	Prospective observation	67	mortality	Reoperation, operation time ≥ 120 minutes, preoperative mechanical ventilation	The latest prospective study

Patient-Related Factors: Uncontrollable Baseline Risks:

The baseline condition of the patient is the underlying determinant of postoperative outcomes, with prematurity, low birth weight, and comorbidities being the core factors affecting prognosis. Multiple studies have consistently shown that the incidence of adverse events after surgery is significantly higher in preterm infants than in full-term infants [4,5,8]. The pathophysiological basis lies in the marked immaturity of various organ systems.

Cardiovascular System: Immature myocardial cells exhibit a disorganized structure, with significantly reduced ventricular compliance, poor tolerance to changes in volume load, and a high risk of heart failure [14]. Additionally, autonomic nervous regulation is not well developed. Under anesthesia, sympathetic nerve activity is suppressed, further reducing cardiovascular compensatory capacity and often necessitating reliance on vasoactive drugs to maintain circulatory stability [15,16].

Respiratory System: Preterm infants have insufficient alveolar surfactant production, low functional residual capacity (FRC), and underdeveloped respiratory centers, making them highly susceptible to postoperative apnea, atelectasis, and hypoxemia [17,18]. Moreover, their airways are narrow, with poor expectoration ability, leading to a high risk of reintubation [19].

Comorbidities: Congenital heart disease (CHD) is another significant risk factor [4,8]. Even when undergoing non-cardiac surgery, surgical stress, hypoxia, and hypercapnia can increase pulmonary vascular resistance, causing previously functionally closed ducts or the foramen ovale to reopen, resulting in right-to-left shunting, exacerbating hypoxia, and even triggering pulmonary hypertensive crises [20,21].

Necrotizing enterocolitis (NEC), a common and severe disease in preterm infants, not only has a high intrinsic mortality rate but can also trigger systemic inflammatory response syndrome (SIRS), leading to intestinal mucosal necrosis, perforation, and a cytokine storm, which can cause sepsis, septic shock, and multiple organ dysfunction, greatly increasing perioperative risk [4,6,8,10,22]. Although peritoneal drainage and laparotomy are effective treatments, postoperative complications such as intestinal strictures, short bowel syndrome, and liver and kidney dysfunction are frequent [23,24], significantly prolonging the duration of invasive ventilation and hospital stay, increasing medical costs, and reducing long-term quality of life.

Surgery-Related Factors: Controllable Intervention Window:

Compared with patient-related factors, surgery-related factors provide an important window for clinical intervention.

Emergency Surgery:

Multiple studies have confirmed that, compared with elective surgery, emergency surgery is significantly associated with higher morbidity and mortality [25,26]. This is not solely determined by the disease itself but is closely related to insufficient time for preoperative optimization in the emergency setting [25]. Neonates undergoing emergency surgery often have severe infections, shock, acid-base disturbances, and electrolyte imbalances, making it extremely difficult for anesthesiologists to stabilize their physiological status within a very short time. Therefore, establishing an efficient neonatal transport system and performing rapid and effective preoperative resuscitation and stabilization are key to improving the prognosis of emergency surgery.

Duration and Type of Surgery**:**

Prolonged surgery, generally defined as >2 hours, is recognized as a risk factor in multiple studies [9,10,12]. Longer surgeries mean longer anesthesia exposure, larger fluid shifts, a higher risk of hypothermia, and more intense stress responses. Although the impact of the type of surgery, e.g., abdominal surgery vs. thoracic surgery, remains controversial, it is generally believed that the complexity of the surgery and whether it involves intestinal necrosis or severe infection have a greater impact on prognosis than the surgical site alone [5,13].

Anesthesia and Perioperative Management Factors: The Core Role of the Anesthesiologist:

Anesthesia management extends throughout the entire perioperative period and is a critical component in improving neonatal outcomes.

Preoperative Status Optimization:

Preoperative Assessment and Optimization: An American Society of Anesthesiologists (ASA) classification of ≥III is a strong predictor of postoperative adverse events in neonates [6,11], as it comprehensively reflects the presence of severe systemic disease preoperatively. Being in the ICU preoperatively, requiring mechanical ventilation, or needing positive inotropic support all indicate that the patient's physiological reserve is nearing exhaustion, which predicts a higher risk [8,11-13].

Therefore, optimizing hemoglobin levels, improving nutrition, and stabilizing circulatory and respiratory function as much as possible before surgery are the cornerstones of risk reduction.

Intraoperative Precision Management:

Hemodynamic Management: The neonatal cardiovascular system is fragile and highly sensitive to changes in volume and vascular tone [14]. Intraoperative hypotension or hypertension, as well as tachycardia or bradycardia, may cause irreversible damage to the perfusion of vital organs. The use of vasoactive drugs during surgery is a necessary means of maintaining circulation, but their use also reflects the severity of the condition, and improper use may worsen microcirculatory disorders [7,9,11].

Fluid and Metabolic Management: Due to the relatively large body surface area and low apparent water loss in neonates, coupled with immature renal function, they have poor tolerance to fluid overload or deficit. Improper intraoperative fluid management can result in pulmonary edema or acute kidney injury. Although goal-directed fluid therapy (GDFT) is widely used in adults, the optimal strategy for neonates still needs to be explored [8]. Additionally, severe metabolic acidosis, e.g., immediate post-laparotomy base excess ≤ -10 mmol/L, can suppress myocardial contractility and reduce vascular responsiveness to catecholamines, which is closely associated with increased postoperative mortality [10].

Temperature Protection: Neonates have relatively large body surface areas and immature thermoregulatory centers, making them prone to intraoperative hypothermia. Hypothermia can lead to coagulation dysfunction, slowed drug metabolism, an increased risk of postoperative infection, and a series of other complications.

Choice of Anesthesia Method: Although the potential neurotoxicity of general anesthetics on the developing nervous system has raised significant concern, current evidence indicates that a single, short-duration general anesthesia has no significant long-term impact on neurodevelopment [27]. In contrast, regional blocks, such as neuraxial or nerve blocks, as part of multimodal analgesia, can help reduce the dose of general anesthetics, provide postoperative pain relief, and facilitate early extubation, which may be a beneficial adjunct for critically ill neonates [28].

Discussion and Prospects

The occurrence of postoperative complications in neonates is not the result of a single factor but rather a "risk cascade" resulting from the interaction among patient baseline risk, surgical trauma and stress, and the quality of anesthetic management. For an extremely low birth weight preterm infant (patient factor) requiring emergency laparotomy due to NEC (comorbidity) and experiencing intraoperative refractory acidosis and hypotension (anesthetic factors), the risk increases exponentially.

A notable feature of current studies is that reported risk factors differ across studies, and the definitions of postoperative complications have not yet been standardized, making high-quality meta-analyses difficult. Moreover, most studies are retrospective analyses and have inherent biases. In the future, it is necessary to establish a multicenter neonatal surgical anesthesia database in China, unify outcome indicators, and develop risk prediction models suitable for the Chinese population to achieve more precise risk stratification.

More importantly, improving neonatal surgical outcomes cannot rely solely on the efforts of a single discipline. Multidisciplinary collaboration (MDT) among neonatal surgery, neonatology, anesthesiology, and critical care is essential. From prenatal diagnosis and delivery planning to preoperative stabilization, intraoperative anesthesia, and postoperative intensive care, establishing a seamless closed-loop management system is the fundamental approach to reducing complications and improving long-term outcomes for neonates.

Conflict of Interest

The author has read and approved the final version of the manuscript. The author declares no conflicts of interest.

References

[1] Oestergaard MZ, Inoue M, Yoshida S, Mahanani WR, Gore FM, Cousens S, Lawn JE, Mathers CD; United Nations Inter-Agency Group for Child Mortality Estimation and the Child Health Epidemiology Reference Group. Neonatal mortality levels for 193 countries in 2009 with trends since 1990: a systematic analysis of progress, projections, and priorities. PLoS Med. 2011 Aug;8(8):e1001080. [**PMID**: 21918640]

[2] Lawn JE, Wilczynska-Ketende K, Cousens SN. Estimating the causes of 4 million neonatal deaths in the year 2000. Int J Epidemiol. 2006 Jun;35(3):706-18. [**PMID**: 16556647]

[3] Hasan MS, Islam N, Mitul AR. Neonatal Surgical Morbidity and Mortality at a Single Tertiary Center in a Low- and Middle-Income Country: A Retrospective Study of Clinical Outcomes. Front Surg. 2022 Feb 3;9:817528. [**PMID**: 35187058]

[4] Lillehei CW, Gauvreau K, Jenkins KJ. Risk adjustment for neonatal surgery: a method for comparison of in-hospital mortality. Pediatrics. 2012 Sep;130(3):e568-74. [**PMID**: 22926171]

[5] Catré D, Lopes MF, Madrigal A, Oliveiros B, Cabrita AS, Viana JS, Neves JF. Predictors of major postoperative complications in neonatal surgery. Rev Col Bras Cir. 2013 Sep-Oct;40(5):363-69. English, Portuguese. [**PMID**: 24573583]

[6] Catre D, Lopes MF, Madrigal A, Oliveiros B, Viana JS, Cabrita AS. Early mortality after neonatal surgery: analysis of risk factors in an optimized health care system for the surgical newborn. Rev Bras Epidemiol. 2013 Dec;16(4):943-52. [**PMID**: 24896599]

[7] Stey AM, Kenney BD, Moss RL, Hall BL, Berman L, Cohen ME, Kraemer K, Ko CY, Vinocur CD. A risk calculator predicting postoperative adverse events in neonates undergoing major abdominal or thoracic surgery. J Pediatr Surg. 2015 Jun;50(6):987-91. [**PMID**: 25824439]

[8] Michelet D, Brasher C, Kaddour HB, Diallo T, Abdat R, Malbezin S, Bonnard A, Dahmani S. Postoperative complications following neonatal and infant surgery: Common events and predictive factors. Anaesth Crit Care Pain Med. 2017 Jun;36(3):163-69. [**PMID**: 27671979]

[9] Puri A, Lal B, Nangia S. A Pilot Study on Neonatal Surgical Mortality: A Multivariable Analysis of Predictors of Mortality in a Resource-Limited Setting. J Indian Assoc Pediatr Surg. 2019 Jan-Mar;24(1):36-44. [**PMID**: 30686886]

[10] Song L, Gao Y. Thirty-day mortality after neonatal laparotomy in a Chinese tertiary hospital. Pediatr Int. 2019;61(6):601-605.

[11] Nasr VG, Staffa SJ, Zurakowski D, DiNardo JA, Faraoni D. Pediatric Risk Stratification Is Improved by Integrating Both Patient Comorbidities and Intrinsic Surgical Risk. Anesthesiology. 2019 Jun;130(6):971-80. [**PMID**: 30946056]

[12] Ammar S, Sellami S, Sellami I, Hamad AB, Hbaieb M, Jarraya A, Charfi M, Dhaou MB, Gargouri A, Mhiri R. Risk factors of early mortality after neonatal surgery in Tunisia. J Pediatr Surg. 2020 Oct;55(10):2233-37. [**PMID**: 32654833]

[13] Kammoun M, Jarraya A, Bradai H. Predictors of postoperative mortality among neonates after major-risk surgery: a one-year experience from a Tunisian hospital. J Neonatal Surg. 2024;13:1275.

[14] Wolf AR, Humphry AT. Limitations and vulnerabilities of the neonatal cardiovascular system: considerations for anesthetic management. Paediatr Anaesth. 2014 Jan;24(1):5-9. [**PMID**: 24330443]

[15] Hopkins DA, Gootman PM, Gootman N, Armour JA. Anatomy of medullary and peripheral autonomic neurons innervating the neonatal porcine heart. J Auton Nerv Syst. 1997 Jun 6;64(2-3):74-84. [**PMID**: 9203127]

[16] Buijs EA, Reiss IK, Kraemer U, Andrinopoulou ER, Zwiers AJ, Ince C, Tibboel D. Increasing mean arterial blood pressure and heart rate with catecholaminergic

drugs does not improve the microcirculation in children with congenital diaphragmatic hernia: a prospective cohort study. Pediatr Crit Care Med. 2014 May;15(4):343-54. [**PMID**: 24622167]

[17] McCann ME, Soriano SG. Progress in anesthesia and management of the newborn surgical patient. Semin Pediatr Surg. 2014 Oct;23(5):244-48. [**PMID**: 25459007]

[18] Erickson G, Dobson NR, Hunt CE. Immature control of breathing and apnea of prematurity: the known and unknown. J Perinatol. 2021 Sep;41(9):2111-23. [**PMID**: 33712716]

[19] Neumann RP, von Ungern-Sternberg BS. The neonatal lung--physiology and ventilation. Paediatr Anaesth. 2014 Jan;24(1):10-21. [**PMID**: 24152199]

[20] van der Griend BF, Lister NA, McKenzie IM, Martin N, Ragg PG, Sheppard SJ, Davidson AJ. Postoperative mortality in children after 101,885 anesthetics at a tertiary pediatric hospital. Anesth Analg. 2011 Jun;112(6):1440-47. [**PMID**: 21543787]

[21] Ramamoorthy C, Haberkern CM, Bhananker SM, Domino KB, Posner KL, Campos JS, Morray JP. Anesthesia-related cardiac arrest in children with heart disease: data from the Pediatric Perioperative Cardiac Arrest (POCA) registry. Anesth Analg. 2010 May 1;110(5):1376-82. [**PMID**: 20103543]

[22] Wei QZ, Wei BM, Huang QM, Chen YJ. Research progress of cell death mechanism in neonatal necrotizing enterocolitis. Guangxi Sci. 2023;30(2):355-62.

[23] Pierro A. The surgical management of necrotising enterocolitis. Early Hum Dev. 2005 Jan;81(1):79-85. [**PMID**: 15707718]

[24] Wang H, Wang Y, Deng C, Li L, Guo C. Prediction of intestinal failure from necrotizing enterocolitis following surgery: A multicenter retrospective review. Medicine (Baltimore). 2019 May;98(19):e15568. [**PMID**: 31083227]

[25] Tayade H, Lamture Y, Yeola M. Factors Affecting Survival in Nontraumatic Pediatric Abdominal Surgical Emergencies: A Contemporary Review. Cureus. 2022 May 10;14(5):e24891. [**PMID**: 35706742]

[26] Iniabasi U, Ilori Akpabio M, Ituen C. Factors associated with mortality in neonatal surgical emergencies in a developing tertiary hospital in Nigeria. J Pediatr. 2013;3(3):231-35.

[27] McCann ME, de Graaff JC, Dorris L, Disma N, Withington D, Bell G, Grobler A, Stargatt R, Hunt RW, Sheppard SJ, Marmor J, Giribaldi G, Bellinger DC, Hartmann PL, Hardy P, Frawley G, Izzo F, von Ungern Sternberg BS, Lynn A, Wilton N, Mueller M, Polaner DM, Absalom AR, Szmuk P, Morton N, Berde C, Soriano S, Davidson AJ; GAS Consortium. Neurodevelopmental outcome at 5 years of age after general anaesthesia or awake-regional anaesthesia in infancy (GAS): an international, multicentre, randomised, controlled equivalence trial. Lancet. 2019 Feb 16;393(10172):664-77. Erratum in: Lancet. 2019 Aug 24;394(10199):638. [**PMID**: 30782342]

[28] Hagander L, Kabir M, Chowdhury MZ, Gunnarsdóttir A, Habib MG, Banu T. Major neonatal surgery under local anesthesia: a cohort study from Bangladesh. World J Surg. 2015 Apr;39(4):953-60. [**PMID**: 25446485]