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Mortality Analysis in Neonates with Gastroschisis: A Retrospective Study at Dr. Sardjito General Hospital, Yogyakarta (2007–2012)

Novita Herowati[1,2*], Nunik Agustriani[3], Akhmad Makhmudi[3]

[1]Department of Surgery, Faculty of Medicine, Jenderal Soedirman University, Purwokerto, Indonesia
[2]Central Surgical Installation, RSUD dr. R. Goeteng Taroenadibrata, Purbalingga
[3]Department of Pediatric Surgery, Faculty of Medicine, Gadjah Mada University, Yogyakarta, Indonesia

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ABSTRACT

Background: *Gastroschisis is a congenital abdominal wall defect that poses a significant risk of morbidity and mortality in neonates, particularly in low- and middle-income settings. Despite advances in neonatal care and surgical techniques, survival outcomes remain variable and influenced by multiple clinical factors.* ***Objective:*** *To analyze the clinical and laboratory factors associated with mortality among neonates with gastroschisis treated at Dr. Sardjito General Hospital, Yogyakarta, Indonesia, between 2007 and 2012.* ***Methods:*** *This was a retrospective observational study involving 35 neonates diagnosed with gastroschisis. Data were collected from medical records, including birth weight, gestational age, timing of surgery, hemoglobin and platelet levels, albumin status, bowel necrosis, sepsis status, and anatomical characteristics of the abdominal wall defect. Univariate and multivariate logistic regression analyses were performed to identify significant predictors of mortality.* ***Results:*** *The overall mortality rate was high. Sepsis was found to be the only independent predictor of mortality (p = 0.037; OR 14.29; 95% CI: 1.179–173.261). Other factors significantly associated with mortality in univariate analysis included low birth weight (p = 0.043), small defect-to-bowel disproportion (p = 0.020), and postoperative hemoglobin <13 g/dL (p = 0.019). Postoperative thrombocytopenia and bowel necrosis showed a strong trend toward higher mortality but did not reach statistical significance. Gestational age, albumin levels, and timing of surgery were not significantly associated with mortality.* ***Conclusion:*** *Sepsis remains the most critical factor associated with mortality in neonates with gastroschisis. Early infection control, optimal perioperative hematologic management, and timely surgical intervention are essential to improve survival outcomes. These findings highlight the need for standardized protocols and further prospective studies to reduce mortality in this vulnerable population.*

1. INTRODUCTION

Gastroschisis is a congenital defect of the anterior abdominal wall, typically located to the right of the umbilical cord insertion, through which the abdominal contents—most commonly the small intestine—herniate without a protective sac. The exposed viscera are directly subjected to the intrauterine and external environments, increasing the risk of inflammation, edema, fluid loss, and infection. Unlike omphalocele, gastroschisis is usually an isolated defect, rarely associated with chromosomal or other congenital anomalies, thus presenting a unique clinical and prognostic profile. Globally, the incidence of gastroschisis varies widely, ranging from 0.4 to 3 per 10,000 live births. In high-income countries such as the United States and regions of Europe, the average reported prevalence is approximately 1 in 4,000 live births, with a consistent upward trend observed over recent decades. This increase remains a subject of active investigation, with several studies suggesting a strong association with young maternal age (particularly <20 years), low maternal nutritional status, cigarette smoking, alcohol consumption during pregnancy, and exposure to over-the-counter vasoactive medications such as pseudoephedrine and

*Corresponding author

E-mail addresses: novita.herowati@unsoed.ac.id (Novita Herowati)

phenylpropanolamine. Notably, current evidence indicates that gastroschisis is not linked to genetic or hereditary factors (Kumar et al., 2008).

Advancements in neonatal intensive care and surgical management have dramatically improved survival rates for infants born with gastroschisis, reaching up to 90–95% in centers with well-established protocols and facilities. The relatively favorable outcomes, compared to other abdominal wall defects such as omphalocele, are largely attributed to the absence of complex associated anomalies and improved techniques in surgical repair, such as staged silo closure and optimized perioperative care (Kumar et al., 2008).

In low- and middle-income countries (LMICs), however, the prognosis remains poor due to limited access to prenatal diagnostics, delayed surgical intervention, inadequate neonatal intensive care support, and high rates of postoperative complications, including sepsis, nutritional deficiencies, and multi-organ failure. Indonesia, a nation with a population exceeding 240 million and a crude birth rate of approximately 35 per 1,000 population, is estimated to have over 2,100 new cases of gastroschisis annually. This places a significant burden on pediatric surgical services, particularly in government referral hospitals and regional healthcare centers. Based on observational data from the institution in which this study is conducted, the survival rate of neonates with gastroschisis remains suboptimal despite recent improvements in neonatal care.

As one of the largest tertiary referral centers in central Indonesia, Dr. Sardjito General Hospital receives a high volume of neonatal surgical emergencies, making it an ideal setting to assess mortality outcomes in gastroschisis. Unlike studies conducted in high-income countries, research from LMICs remains scarce and often lacks detailed stratification across perioperative variables. There is also a limited understanding of how clinical variables such as timing of surgery, infection, and nutritional status interact in determining outcomes in low-resource contexts.

Understanding the determinants of mortality in neonates with gastroschisis is crucial for targeted interventions and health policy formulation. While previous literature has explored individual risk factors such as bowel necrosis, low birth weight, and sepsis, comprehensive data from LMIC settings—where resource constraints amplify these risks—are limited. Identifying independent predictors of mortality may inform context-specific clinical protocols and guide resource allocation in neonatal surgical units across Indonesia and similar settings. This study aims to analyze mortality-related predictors across preoperative, intraoperative, and postoperative variables in neonates treated for gastroschisis over a six-year period in a tertiary hospital setting in Indonesia.

2. METHOD

This study employed a retrospective case-control design to identify predictors of mortality in neonates diagnosed with gastroschisis. The investigation was conducted at Dr. Sardjito General Hospital, Yogyakarta, Indonesia, utilizing medical records from the period of January 2007 to December 2012. The analysis focused on the association between selected clinical variables and neonatal mortality outcomes.

The study population consisted of all neonates diagnosed with gastroschisis who were admitted to the Pediatric Surgery Division of the hospital during the study period, regardless of whether they had undergone surgical treatment. A total of 35 neonates met the inclusion criteria and were selected through consecutive non-probability sampling. Data were obtained by computerized searches of hospital records using the ICD-X diagnostic code Q79.3 for gastroschisis. Inclusion criteria encompassed neonates with a confirmed diagnosis of gastroschisis, based on clinical history, physical examination, and radiologic findings, all of which were recorded in the medical charts.

Several independent variables were evaluated in this study. These included birth weight (classified as either less than 2500 grams or 2500 grams and above), gestational age (defined as preterm for neonates born at or before 37 weeks of gestation and term for those born after 37 weeks), sex (male or female), and age at surgery (less than 24 hours or more than 24 hours after birth). Additional variables included the type of eviscerated bowel (with or without liver involvement), bowel disproportion (categorized based on whether the length of the exposed

bowel was disproportionately large relative to the abdominal cavity), and the presence of bowel necrosis, which was defined as positive if documented in the intraoperative findings. Laboratory parameters such as hemoglobin, platelet count, and albumin levels after surgery were also included, each categorized as either normal or abnormal based on clinical thresholds. Hemoglobin was considered normal if greater than 13 g/dL, platelet count if more than 150,000/mm^3, and albumin level if above 2.6 g/dL. Sepsis was defined using the criteria for systemic inflammatory response syndrome (SIRS), which included clinical signs such as abnormal body temperature (above 38°C or below 36°C), respiratory distress, lethargy, poor peripheral perfusion, and metabolic derangements like hypoglycemia, hyperglycemia, or metabolic acidosis. Confirmation of infection through blood culture was also required for a diagnosis of sepsis.

The dependent variable in this study was neonatal mortality. Data analysis was performed using SPSS version 17. All categorical variables were analyzed using the Chi-square test, with a significance level set at $p \leq 0.05$. To estimate the strength of association between each independent variable and the outcome, odds ratios (ORs) were calculated along with 95% confidence intervals. Furthermore, multivariate analysis was conducted to determine the most significant predictors contributing to neonatal death in patients with gastroschisis..

3. RESULT AND DISCUSSION

Result

Table 1. Clinical Characteristics of Neonates with Gastroschisis

Variable	Category	Frequency	Percentage (%)
Birth Weight	<2500 grams	25	71.4
Birth Weight	≥2500 grams	10	28.6
Gestational Age	Full Term	17	48.6
Gestational Age	Premature	18	51.4
Type of Bowel Protrusion	Without Liver	35	100
Gastroschisis Disproportion	Small	27	77.2
Gastroschisis Disproportion	Large	8	22.8
Necrosis	Negative	30	85.7
Necrosis	Positive	5	14.3
Hemoglobin After Surgery	<13 g/dL	12	34.3
Hemoglobin After Surgery	≥13 g/dL	23	65.7
Platelets After Surgery	≥150,000/mmÂ³	19	54.3
Platelets After Surgery	<150,000/mmÂ³	16	45.7
Albumin After Surgery	≥2.6 g/dL	12	34.3
Albumin After Surgery	<2.6 g/dL	23	65.7
Sepsis	Negative	17	48.6
Sepsis	Positive	18	51.4
Age of Baby at Surgery	≤24 hours	25	71.4
Age of Baby at Surgery	>24 hours	10	28.6
Total		**35**	**100**

In this study, the majority of patients with gastroschisis (71.4%) had a birth weight of ≥2500 grams, indicating that this condition is not exclusively associated with low birth weight. Although 28.6% of patients were classified as low birth weight, this finding suggests that gastroschisis may also occur in neonates with normal birth weight, thus challenging the assumption that low birth weight is a primary determinant of neonatal morbidity in such cases.

The gestational age distribution was nearly equal, with 48.6% of the infants born at term and 51.4% born preterm. This shows that while prematurity remains a clinical concern, gastroschisis is not limited to preterm births. Clinical complexity increases in premature infants due to physiological immaturity, particularly in immune response and organ development. All patients (100%) presented with bowel evisceration without liver involvement. This reinforces the typical characterization of gastroschisis as an isolated bowel defect, which carries a better prognosis compared to cases involving other intra-abdominal organs such as the liver, which are often associated with a higher risk of complications.

A total of 77.2% of patients exhibited a small disproportion between the abdominal wall defect and the eviscerated bowel. This condition is generally linked to a more favorable outcome, as it reduces the risk of serious complications such as strangulation and intestinal necrosis. Most patients (85.7%) did not develop intestinal necrosis, a positive indicator in the management of gastroschisis. The absence of necrosis reflects effective early management and is associated with significantly reduced morbidity and mortality. Hematologically, 65.7% of patients experienced a postoperative hemoglobin decline to below 13 g/dL. This reduction may be attributed to intraoperative blood loss or a systemic inflammatory response, which is commonly observed in neonates undergoing major surgery.

Postoperative platelet levels were also decreased in nearly half of the patients (45.7%), indicating thrombocytopenia that warrants clinical attention. This condition may increase the risk of bleeding and is often associated with neonatal sepsis or severe inflammation due to evisceration. In 65.7% of cases, postoperative serum albumin levels were below 2.6 g/dL, suggesting hypoalbuminemia as a result of poor nutritional status or heightened systemic inflammation. Clinically, low albumin levels are strongly associated with delayed wound healing and a less favorable prognosis.

Signs of sepsis were observed in 51.4% of the patients, underscoring the significance of systemic infection as a serious and common complication in neonates with gastroschisis. Direct exposure of the bowel to the external environment renders these patients highly vulnerable to microbial invasion, necessitating aggressive antimicrobial therapy and vigilant monitoring. Finally, the majority of surgical interventions (71.4%) were performed within the first 24 hours of life, reflecting adherence to modern, aggressive management protocols aimed at reducing infection risk, preventing fluid loss, and minimizing long-term complications. This approach aligns with international standards for the optimal management of gastroschisis cases.

Table 2. Association Between Birth Weight and Mortality

Birth Weight	Died (n/%)	Survived (n/%)	P-value	Odds Ratio (OR)	95% Confidence Interval (CI)	Remarks
< 2500 grams	12 (85.71%)	2 (14.29%)				
≥ 2500 grams	11 (44.0%)	14 (56.0%)	0.043	4.750	0.995 – 22.673	Significant

Low birth weight (LBW) (<2500 g) significantly increases the risk of mortality in neonates with gastroschisis. This finding is consistent with the literature, such as Clark RH et al. (2011), which states that infants with low birth weight tend to have immature organs and underdeveloped immune systems, making them more vulnerable to infections and postoperative metabolic complications.Table 5. Association Between Gestational Age and Mortality

Table 3. Association Between Gestational Age and Mortality

Gestational Age	Died (n/%)	Survived (n/%)	P-value	Odds Ratio (OR)	95% Confidence Interval (CI)	Remarks
< 37 weeks (Preterm)	15 (62.5%)	9 (37.5%)				

Gestational Age	Died (n/%)	Survived (n/%)	P-value	Odds Ratio (OR)	95% Confidence Interval (CI)	Remarks
≥ 37 weeks (Term)	8 (50.0%)	8 (50.0%)	0.122	0.722	0.122 – 13.443	Not significant

Although prematurity is often associated with poor prognosis, this study found no significant impact on mortality. This may be attributed to early intervention and intensive management in the neonatal intensive care unit (NICU), which could mitigate the adverse effects of prematurity

Table 4. Association Between Mortality and Gastroschisis Disproportion

Disproportion Type	Died (n/%)	Survived (n/%)	P-value	Odds Ratio (OR)	95% Confidence Interval (CI)	Remarks
Small Disproportion	8 (100.0%)	0 (0.0%)				
Large Disproportion	15 (55.6%)	12 (44.4%)	0.020	Not specified*	-	Significant

A small disproportion (a small abdominal wall defect relative to the volume of herniated bowel) increases the risk of bowel strangulation and ischemia, which may lead to death. This supports the theory that intraluminal pressure and delayed reperfusion play a role in the pathogenesis of severe gastroschisis complications (Rollins MD et al., J Pediatr Surg, 2020).

Table 5. Association Between Mortality and Type of Eviscerated Bowel

Type of Eviscerated Bowel	Died (n/%)	Survived (n/%)	P-value	Odds Ratio (OR)	95% Confidence Interval (CI)	Remarks
With liver (hepar)	0 (–)	0 (–)	Not analyzed	–	–	No cases in this group
Without liver (only bowel)	23 (–)	14 (–)	–	–	–	All subjects fell here

Bowel herniation without liver involvement tends to have a better prognosis. The involvement of the liver, as seen in cases of "complex gastroschisis," is theoretically associated with a higher risk of mortality due to vascular complications and reduced metabolic reserves.

Table 6. Association Between Mortality and Bowel Necrosis

Necrosis Status	Died (n/%)	Survived (n/%)	P-value	Odds Ratio (OR)	95% Confidence Interval (CI)	Remarks
Positive	5 (100.0%)	0 (0.0%)	0.081	Not computable*	–	Not significant
Negative	18 (60.0%)	12 (40.0%)				

Although the results were not statistically significant, the data indicate that necrosis carries a high risk of mortality. This is consistent with studies showing that necrosis leads to impaired absorption and severe infections that neonates are often unable to overcome (Bradnock TJ et al., 2021, *Lancet Child Adolesc Health*).

Table 7. Association Between Mortality and Postoperative Hemoglobin Levels

Hemoglobin Level (Post-op)	Died (n/%)	Survived (n/%)	P-value	Odds Ratio (OR)	95% Confidence Interval (CI)	Remarks
< 13 g/dL	11 (91.67%)	1 (8.33%)				
≥ 13 g/dL	12 (52.17%)	11 (47.83%)	0.019	10.083	1.112 – 91.417	Significant

Low postoperative hemoglobin may reflect significant bleeding, inflammatory anemia, or intraoperative blood loss. Reduced hemoglobin levels decrease tissue oxygenation capacity and worsen postoperative prognosis in neonates.

Table 8. Association Between Mortality and Postoperative Platelet Count

Platelet Count (Post-op)	Died (n/%)	Survived (n/%)	P-value	Odds Ratio (OR)	95% Confidence Interval (CI)	Remarks
< 150,000/mm³	13 (81.25%)	3 (18.75%)				
≥ 150,000/mm³	10 (52.63%)	9 (47.37%)	0.076	3.900	0.832 – 18.283	Not significant

Thrombocytopenia reflects systemic inflammatory processes or sepsis. Although not statistically significant, the trend indicates an increased risk of mortality, supporting the theory that neonatal thrombocytopenia is an important prognostic indicator (Neonatal Sepsis Review, WHO 2023).

Table 9. Association Between Mortality and Postoperative Albumin Levels

Albumin Level (Post-op)	Died (n/%)	Survived (n/%)	P-value	Odds Ratio (OR)	95% Confidence Interval (CI)	Remarks
< 2.6 g/dL	14 (60.87%)	9 (39.13%)				
≥ 2.6 g/dL	9 (60.0%)	6 (40.0%)	0.940	1.050	0.272 – 4.048	Not significant

Postoperative hypoalbuminemia did not show a significant correlation in this study. However, clinical theory suggests that low albumin levels are associated with delayed wound healing and poor nutritional status.

Table 10. Association Between Mortality and Sepsis

Sepsis Status	Died (n/%)	Survived (n/%)	P-value	Odds Ratio (OR)	95% Confidence Interval (CI)	Remarks
Positive	16 (88.89%)	2 (11.11%)				
Negative	7 (41.18%)	10 (58.82%)	0.003	11.429	1.968 – 66.355	Significant

Sepsis is a strong predictor of mortality, consistent with various recent studies. Gastroschisis exposes the intestines to the external non-sterile environment, making them highly susceptible to contamination and systemic infection.

Table 11. Association Between Age at Surgery and Mortality

Age at Surgery	Died (n/%)	Survived (n/%)	P-value	Odds Ratio (OR)	95% Confidence Interval (CI)	Remarks
≤ 24 hours	17 (68.0%)	8 (32.0%)				

Age at Surgery	Died (n/%)	Survived (n/%)	P-value	Odds Ratio (OR)	95% Confidence Interval (CI)	Remarks
> 24 hours	4 (40.0%)	6 (60.0%)	0.652	0.706	0.155 – 3.224	Not significant

Timing of surgery did not have a significant effect on mortality. However, in clinical practice, intervention within the first 24 hours is still recommended to prevent complications such as dehydration and infection.

Table 12. Multivariate Analysis of Factors Associated with Mortality (Wald Test)

Variable	Wald Statistic	df	P-value	Odds Ratio (Exp B)	95% Confidence Interval (CI)	Remarks
Birth Weight	2.890	1	0.089	9.190	0.712 – 118.691	Not significant
Disproportion	0.000	1	0.999	2.6×10^9	0 – ∞	Not significant
Hemoglobin	9.350	1	0.149	0.228	0.149 – 34.718	Not significant
Sepsis	4.364	1	0.037	14.290	1.179 – 173.261	**Significant**

Sepsis has been proven to be the most influential independent factor associated with neonatal mortality in gastroschisis. Therefore, sepsis prevention and infection control strategies should be top priorities in the clinical management of this condition.

Discussion

This study evaluated multiple clinical and laboratory variables to determine their association with mortality in neonates with gastroschisis. Among all the factors analyzed, sepsis emerged as the strongest independent predictor of mortality in both univariate and multivariate analyses ($p = 0.003$ and $p = 0.037$, respectively). This finding is consistent with a large body of evidence emphasizing the critical role of infection in surgical neonates. Gastroschisis exposes the bowel to the external environment without protective peritoneum, making neonates particularly susceptible to bacterial translocation, systemic inflammatory response, and septic shock. Bradnock et al. (2021) identified sepsis as a leading contributor to mortality in gastroschisis, aligning with our results and supporting early and aggressive antimicrobial management.

Another key variable was postoperative hemoglobin concentration. Neonates with hemoglobin <13 g/dL had a significantly higher mortality rate ($p = 0.019$), and although this variable did not remain significant in multivariate regression, its clinical importance is notable. Anemia in neonates, especially following major abdominal surgery, is associated with impaired oxygen delivery, compromised wound healing, and increased susceptibility to infection. Soghier et al. (2020) emphasized the importance of optimizing hemoglobin levels during perioperative care in neonates, as insufficient oxygenation can exacerbate multiorgan dysfunction.

The analysis also highlighted the relevance of anatomical disproportion, where a smaller abdominal wall defect relative to the volume of herniated bowel was significantly associated with increased mortality ($p = 0.020$). This may be due to increased risk of bowel strangulation and compromised mesenteric perfusion in cases with smaller fascial openings. This aligns with studies by Rollins and colleagues (J Pediatr Surg, 2020), who reported that tighter abdominal defects are associated with higher rates of ischemia and subsequent necrosis, which can precipitate septic complications and poor outcomes.

Interestingly, birth weight (<2500 g) was significantly associated with mortality in univariate analysis ($p = 0.043$), suggesting that neonates with low birth weight have diminished physiological reserves, impaired immune responses, and higher vulnerability to surgical stress. However, this variable did not retain statistical significance in the multivariate model, possibly due to its interaction with other dominant factors such as sepsis and hemoglobin levels. Prior

studies, including Clark RH et al. (2011), have consistently shown that low birth weight increases the risk of neonatal surgical mortality, particularly when combined with other risk factors. Gestational age, as shown in Table 4 did not demonstrate a significant association with mortality ($p = 0.122$). This suggests that preterm delivery, while often considered a poor prognostic factor, may not independently determine survival in gastroschisis if managed within modern neonatal intensive care units. Advances in supportive care, thermoregulation, parenteral nutrition, and infection control have significantly improved outcomes for premature neonates undergoing complex abdominal surgery (WHO, 2023 Neonatal Guidelines).

Postoperative platelet count showed a borderline association with mortality ($p = 0.076$), with lower platelet counts associated with increased deaths. Thrombocytopenia may reflect underlying systemic inflammation, coagulopathy, or evolving sepsis, all of which can worsen prognosis. Although not statistically significant, this trend aligns with studies indicating that thrombocytopenia serves as a marker for disease severity in neonates with surgical complications (Aly H. et al., 2022). In contrast, postoperative albumin levels did not correlate significantly with mortality ($p = 0.940$). While hypoalbuminemia is generally recognized as a marker of malnutrition and systemic inflammation, its prognostic value may be limited in the acute postoperative period. Additionally, neonates with gastroschisis often require prolonged fasting and parenteral nutrition, which can influence albumin dynamics irrespective of outcome. The lack of association in this study suggests that albumin alone should not guide prognostication but may still reflect overall nutritional status.

The evaluation of bowel necrosis (Table 6) showed that all neonates with confirmed necrosis died, although statistical significance was not achieved ($p = 0.081$). The absolute mortality in this subgroup underscores the lethal nature of bowel ischemia in gastroschisis. Bowel necrosis leads to bacterial translocation, metabolic acidosis, and sepsis, creating a cascade of events that are difficult to reverse in neonates with immature physiology. This finding emphasizes the importance of early surgical evaluation and timely intervention to prevent progression to necrosis. Table 13 analyzed the age at surgery, comparing outcomes between neonates operated within the first 24 hours and those after. No significant difference in mortality was observed ($p = 0.652$), suggesting that while early surgery is recommended to minimize fluid loss and infection, survival may depend more on the quality of perioperative care and infection control than the exact timing alone. This finding is in line with recent evidence from multicenter studies which suggest that delays up to 48 hours do not necessarily worsen outcomes if adequate supportive care is provided (Wells et al., 2022).

Finally, the multivariate logistic regression (Table 12) confirmed that sepsis was the only independent predictor of mortality. Birth weight, hemoglobin, and disproportion—while relevant in univariate analysis—did not maintain significance in the adjusted model. This underlines the overwhelming impact of systemic infection in the prognosis of gastroschisis. Taken together, these results suggest that optimizing infection prevention, early diagnosis, and aggressive treatment of sepsis should be prioritized in any clinical protocol for managing gastroschisis in neonates.

4. CONCLUSION

This study analyzed factors associated with mortality in neonates with gastroschisis treated at Dr. Sardjito General Hospital, Yogyakarta, from 2007 to 2012. Among the 37 cases reviewed, the overall mortality rate remained high. Sepsis was identified as the most significant independent predictor of death. Additionally, low postoperative hemoglobin levels, small abdominal wall defect disproportion, and low birth weight were also associated with increased mortality. Other variables such as platelet count, albumin level, gestational age, and timing of surgery showed no statistically significant correlation. These findings underscore the importance of early infection detection, aggressive sepsis management, and close hematologic monitoring in improving outcomes for neonates with gastroschisi.

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