www.jpnim.com Open Access eISSN: 2281-0692
Journal of Pediatric and Neonatal Individualized Medicine 2022;11(2):e110218
doi: 10.7363/110218
Received: 2021 Nov 28; revised: 2021 Dec 19; rerevised: 2022 Jan 20; accepted: 2022 Jan 20; published online: 2022 Oct 13

Original article

Neonatal surgical mortality in a Pediatric Surgical Centre with predicting risk factors

Obay A. Edan[1], Aws A. Al-hamdany[2], Sarmad Z. Al-dabbagh[2]

[1]Department of Surgery, College of Medicine, University of Mosul, Mosul, Iraq
[2]Pediatric Surgery Centre, Al-khansaa Teaching Hospital, Mosul, Iraq

Abstract

Background: Many factors affect neonatal mortality; some could be manipulated while others are not. The upgrade and advancement in pediatric anaesthesia, the establishment of Neonatal Intensive Care Units (NICUs), the introduction of total parenteral nutrition, and practising fetal surgery, all improved the mortality rate. However, on the contrary, dealing with low birth weight, structural or chromosomal abnormalities, which are sometimes combined altogether, increase neonatal surgical mortality (NSM) rate. We present this study to detect the overall NSM in a Pediatric Surgery Centre at the tertiary level and predict some risk factors to guide intervention that improves the outcome.

Methods: A retrospective study was conducted on 279 neonates with surgical conditions admitted to the Pediatric Surgery Centre in Al-khansaa Teaching Hospital (Mosul, Iraq) over 1 year (January 2019 to December 2019). The study evaluated the dependent (alive or dead) and independent variables (risk factors) that correlated to increased mortality.

Result: According to the patient's outcome, the survival rate was 82.1% (229/279), while 17.9% (50/279) died. Factors identified as predictors of NSM were prematurity (p-value < 0.0001), low and very low birth weight (p-value < 0.0001), multiple operations (p-value = 0.039), NICU admission (p-value < 0.0001) and ventilator need (p-value < 0.0001). Digestive system anomalies constitute the most common surgical indication with the highest mortality rate.

Conclusion: NSM in this study was comparably fair. Neonates with average gestational age and weight who had a single needed operation without

ventilator support had the greatest probability for survival. We recommend the wise investment in advanced NICUs and the urgent need for another study to detect the burden of associated congenital anomalies on the mortality rate in the neonate to improve the outcome in low resources developing countries.

Keywords

Neonatal, surgical mortality, risk factors, predicting.

Corresponding author

Obay A. Edan, Department of Surgery, College of Medicine, University of Mosul, Mosul, Iraq; ORCID: 0000-0001-5050-757X; email: obayabdedaan@uomosul.edu.iq.

How to cite

Edan OA, Al-hamdany AA, Al-dabbagh SZ. Neonatal surgical mortality in a Pediatric Surgical Centre with predicting risk factors. J Pediatr Neonat Individual Med. 2022;11(2):e110218. doi: 10.7363/110218.

Background

The pediatric surgical field is quite variable, regarding not only the type of the disease affecting children but also the related mortality, specifically neonatal surgical mortality (NSM), known as the silent killer. Neonatal mortality accounted for 53.1% of all under-5 years deaths [1]. The reported NSM varies from 4% to 80% [2].

Many factors affect neonatal mortality; some could be manipulated, the others could not. The upgrade and advancement in pediatric anaesthesia, the establishment of proper Neonatal Intensive Care Units (NICUs), the introduction of total parenteral nutrition, and practising fetal surgery, all improved mortality rates [3]. However, on the contrary, dealing with low birth weight, structural or chromosomal abnormalities, which are sometimes combined altogether, increase NSM rates [4].

The difference in the quality of health care services between developed and developing countries also play a role in the wide variation of NSM. It is mentioned that a neonate born in a developing country has a death risk of 14 times more than a neonate born in a developed country during the first 28 days of life [5].

In general NSM is mainly caused by congenital anomalies, genetic disorders, prematurity, the maternal complication of pregnancy and unintentional or accidental trauma. No matter the cause, NSM is considered a very stressful situation that should be lowered as much as possible [6].

The evaluation of neonatal mortality reflects the quality of care delivered in Obstetric Units and NICUs in any health services. We present this study to identify the NSM in a Pediatric Surgery Centre at the tertiary level in a developing country to upgrade the health information and care, which result in decreasing the mortality rate among neonates.

Objective

To detect the overall NSM and predict some risk factors to guide intervention that improves the outcome.

Patients and methods

A retrospective study was conducted on neonates with surgical conditions admitted to the Pediatric Surgery Centre in Al-khansaa Teaching Hospital (Mosul, Iraq) over 1 year (January 2019 to December 2019). The Neonatal Unit contains 8 incubators with 1 cardiac monitor and 1 portable oximeter, 2 sets for phototherapy and an oxygen source for each patient, and it is served by specialist pediatric surgeons of different levels of experience. The Unit is supported by 2 beds in the NICU with 2 ventilators and 1 portable X-ray machine. Echocardiogram, CT scan, and ultrasound machine are available only during morning working days.

A surgical neonate was defined as a neonate with a surgical problem born term or preterm but not older than 29 days of life at admission.

The dependent variable was the discharged status of the patient (alive or dead). In contrast, the independent variables (predicting risk factors) included gender, the weight at admission, the age at admission, the number of operations or reoperations needed at neonatal period, the need for NICU, the need for ventilation, the experience of working surgeon in years and the final diagnosis.

Patients whose parents refused admission or operation or were asked to transfer to another hospital and patients who needed reoperation beyond neonatal age were excluded from the study.

In order to calculate the NSM, we divided the patients into 2 groups (live and dead) according to discharged status. For the independent variable, we used MedCalc® software (MedCalc Software Ltd, 2020) to calculate the relative risk ratio (RR), 95% confidence interval (95% CI) and the p-value.

The patients were followed by their responsible surgeons after being discharged, and in this study, the post-operative follow-up was only during the neonatal period.

The study was approved by the institutional Ethical Committee in the Faculty of Medicine – University of Mosul.

Results

Dependent variable

The total neonatal admissions during the study period were 279 patients, and according to discharged status, 229 (82.1%) were alive, and 50 (17.9%) were dead. Out of those 50 cases, 30 (10.7%) cases were operated on, while the remaining were not operated either because they were beyond surgery or kept on conservative management but unfortunately deceased.

Independents variables

Gender

Out of 156 (55.9%) total male patients, 23 (8.2%) died (RR: 0.671, CI: 0.406-1.111, p-value: 0.121), while the total female patients were 123 (44.1%), of whom 27 (9.8%) died (RR: 1.488, CI: 0.899-2.463, p-value: 0.121) (**Tab. 1**).

Gestational age

Forty-four (15.8%) preterm patients were admitted, 20 (7.2%) died, with a statistically significant p-value < 0.0001 (RR: 3.560, CI: 2.235-5.670) (**Tab. 1**).

We divided the patients into four subgroups (according to the weight at the time of admission):

A. < 1.5 kg in 10 (3.6%) cases, 8 of them died with a significant p-value < 0.0001;
B. 1.5-2 kg in 24 (8.6%) cases, 13 of them died with a significant p-value < 0.0001;
C. 2-2.5 kg in 35 (12.5%) cases, 9 of them died with an insignificant p-value = 0.151;
D. > 2.5 kg in 210 (75.3%) neonates, 20 of them died with a significant protective p-value < 0.0001 (**Tab. 1**).

Multiple operations

Ten (3.6%) patients required reoperation or multiple operations during the neonatal period; 4 of them died with a statistically significant p-value equal to 0.039 (RR: 2.321, CI: 1.039-5.184) (**Tab. 1**).

NICU admission and ventilator need

Out of 51 (18.3%) patients who needed admission to NICU, 30 patients died with a significant p-value < 0.0001; 21 cases (7.5%) needed to be supported with artificial ventilation for different reasons and time, but 19 (6.8%) unfortunately died.

Surgeon experience

Fifty diagnoses were associated with neonatal death in our study, managed by 2 groups of pediatric surgeons with 173 patients in total. A group with more than 10 years of experience managed 80 (46.2%) cases, while the other group with less than 10 years of experience managed 93 (53.8%) cases. Both groups show insignificant RR, CI and p-values (**Tab. 1**).

Table 1. Independent variables with calculated p-value.

Variables		Number	Death	RR	95% CI	p-value
Gender	**Male**	156	23	0.671	0.406-1.111	0.121
	Female	123	27	1.488	0.899-2.463	0.121
Preterm		44	20	3.560	2.235-5.670	**< 0.0001**
Weight	**Group A (< 1.5 kg)**	10	8	5.123	3.379-7.768	**< 0.0001**
	Group B (1.5-2 kg)	24	13	3.910	2.453-6.233	**< 0.0001**
	Group C (2-2.5 kg)	35	9	1.581	0.845-2.958	0.151
	Group D (> 2.5 kg)	210	20	0.223	0.135-0.367	**< 0.0001**
Surgeon experience	**> 10 years**	80	18	0.653	0.399-1.071	0.092
	< 10 years	93	32	1.529	0.933-2.506	0.092
Multiple operations		10	4	2.321	1.039-5.184	**0.039**
NICU admission		51	30	6.705	4.160-10.809	**< 0.0001**
Ventilator need		21	19	7.530	5.263-10.773	**< 0.0001**

NICU: Neonatal Intensive Care Unit; RR: relative risk ratio; 95% CI: 95% confidence interval.

Mortality according to clinical diagnosis

The following sequence of order for the silent killer was observed in our study: necrotising enterocolitis and pyloric atresia with 100% mortality rate, followed by esophageal atresia with tracheoesophageal fistula with 66.6% mortality rate, gastroschisis (54.5% mortality rate), congenital diaphragmatic hernia (50% mortality rate), duodenal obstruction of different causes (50% mortality rate). All the above diagnoses show a significant correlation, with a significant p-value ranging between < 0.0001 and 0.013.

Other diagnoses, like omphalocele (26.6% mortality rate), Hirschsprung disease (22% mortality rate), small bowel atresia (20% mortality rate), anorectal malformation (7.5% mortality rate), all show no significant correlations to the mortality rate, with p-value ranging between 0.091 and 0.799.

There were 37 cases with a critical term of "suspected neonatal intestinal obstruction"; of them, only 4 (10.8%) cases died, with no significant correlation to the NSM (**Tab. 2**).

Discussion

Neonate undergoing surgery is a new story for the family and a challenging experience for the pediatric surgeon due to their fragile homeostasis doubled by the complex surgical condition and the stress of surgery with general anaesthesia [7].

The neonatal mortality rate is the mirror image for medical care; 10% of neonatal death is due to NSM [8], thus the latter significantly contribute to the overall neonatal mortality.

In our study, NSM was 17.9%, which is located in the mid-zone between 4% (in the United States) and 40% (in India) [9, 10].

We believe that such a big difference in NSM between developed and developing countries is due to better organisation of NICUs, better resources with highly qualified personnel and the advancement in fetal surgery in the developed countries [11].

Regarding gender as an independent variable to NSM, we found a non-significant prediction, and this finding differs from Broche-Candó et al., which mentioned a male predominance [12].

We believe that this is explained by the lower mortality in Hirschsprung disease and zero mortality in pyloric stenosis in our study because both are male predominant diseases.

Regarding prematurity, the low birth weight and very low birth weight are the main causes of death in the neonate and identified as risk factors for NSM by Djadou et al. and Monebenimp et al. [13, 14]. In our study, these 2 factors responsible for significant mortality, mainly due to multiple organ immaturity, lack of NICUs, and primitive health care, make this fragile neonate complain of fatal complications like hypothermia, digestive intolerance, infection and sepsis. In contrast, being full-term and/or having birth weight of more than 2.5 kg showed protective value against mortality, especially if the neonate had no life-threatening congenital anomalies and received proper diagnosis and management.

Impaired neonatal respiratory physiology in special cases like tracheoesophageal fistula, abdominal wall defects or prematurity is a well-known factor for increasing NSM. In our study, the NICU admissions and the need for artificial ventilation had a significantly worse correlation

Table 2. Mortality according to diagnosis.

Diagnosis		Number of cases	Death	Death %	RR	95% CI	p-value
1	**Necrotising enterocolitis**	4	4	100%	5.978	4.592-7.782	**< 0.0001**
2	**Pyloric atresia**	1	1	100%	5.673	4.400-7.315	**< 0.0001**
3	**Esophageal atresia with tracheoesophageal fistula**	24	16	66.6%	5.006	3.289-7.618	**< 0.0001**
4	**Gastroschisis**	11	6	54.5%	3.322	1.817-6.073	**0.0001**
5	**Diaphragmatic hernia**	6	3	50%	2.904	1.252-6.736	**0.013**
6	**Duodenal atresia**	6	3	50%	2.904	1.252-6.736	**0.013**
7	**Omphalocele**	15	4	26.6%	1.530	0.635-3.687	0.342
8	**Hirschprung disease**	9	2	22%	1.250	0.358-4.358	0.726
9	**Small bowel atresia**	20	4	20%	1.126	0.451-2.811	0.799
10	**Imperforate anus**	40	3	7.5%	0.381	0.124-1.166	0.091
11	**Suspected neonatal intestinal obstruction**	37	4	10.8%	-	-	-

RR: relative risk ratio; 95% CI: 95% confidence interval.

with NSM, also mentioned by Snajdauf et al. and Stey et al. [15, 16]. The proper NICU equipment with well-trained personnel plays a vital role in decreasing mortality, and these 2 variables are considered a manipulable risk for death, which should alert health care managers in developing countries to invest in this dark, dangerous zone.

Our study could not find a significant correlation between NSM and surgeon experience. It is probably because of a well-trained surgeon with a complete and competent training program, in addition to the associated congenital or chromosomal anomalies that lead to death no matter the experience.

The mortality of patients with necrotising enterocolitis globally declined from 45% to 29% [17]. It is relatively low compared to our results, which alert the need for early diagnosis and proper management with advanced, highly supported NICUs. The situation is the same with tracheoesophageal fistula, abdominal wall defects, duodenal obstruction and congenital diaphragmatic hernia; all showed significant worse correlation with NSM.

Esophageal atresia is a common birth defect globally with a survival rate of nearly 95% [18], compared to the 33.4% survival rate in our study, which is also far from other developing countries like India (with a 77.4% survival rate) [10]. Since there is no major change in surgical technique, this big variation may be due to delay in diagnosis, associated anomalies and primitive post-operative care and ventilation.

Regarding abdominal wall defects, the outcome in omphalocele was better than gastroschisis in our study, with a mortality rate of 26.6%, 54.5%, respectively but still higher than what was recorded by other studies like Maksoud-Filho et al. [19] in which the mortality was 25%; this may be due to lack of proper pre- and post-operative care and support, especially parenteral nutritional support.

In congenital diaphragmatic hernia, the prognosis is still unsatisfactory despite recent advances in surgical and medical management. The mortality rate was 50% in our study, which was comparable with other series like in the study by Jain et al. [20]. We all believe that, to decrease the mortality rate, we should focus on managing pulmonary hypertension and lung hypoplasia, the 2 most unfavourable prognostic factors.

Despite the uniform concept that any single bile vomit is surgical until proven otherwise, and absent abdominal distension does not exclude intestinal obstruction, still, there is a delay in diagnosis of duodenal atresia, which raises the mortality rate in our study to 50% compared to 6.4% mortality in Aydogdu et al. study [21].

It is worth mentioning that, with all the above diagnoses, the mortality rate is worse if there are associated anomalies – this needs another separate comprehensive study to figure out the exact relationship.

Finally, we firmly believe that the above-mentioned independent variables are highly modifiable by proper surgical training, advanced NICUs, proper data documentation, and continued auditing with pediatric and obstetric services to reach the best outcome.

Conclusion and recommendation

NSM in this study was comparably fair. The highest mortality was recorded in children born preterm, with low birth weight and with congenital digestive anomalies. Neonates with average gestational age and weight who had a single needed operation without the need for ventilator support had the greatest probability for survival.

We recommend the wise investment in advanced NICUs and urgent need for another study to detect the burden of associated congenital anomalies on the mortality rate in the neonate in order to improve the outcome in low resources developing countries.

Declaration of interest

The Authors declare that there is no conflict of interest. Funding source: none.

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