Postoperative Outcome in Non-Preterm Infants Under One Year Old in Non-Cardiac Surgery

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Research Article

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Abstract

Background and Objective : An observational study conducted earlier to determine predictors of postoperative outcome in non-cardiac surgical pediatric patients showed that factors which influenced postoperative evolution were multiple. These included American Society of Anesthesiologists (ASA) score, transfusion, age, emergency surgery, and surgery. The objective was to describe in details outcomes in non-preterm children under one year old included in the initial study. Methods : Secondary analysis of the initial retrospective observational study in 594 patients with a mean age of 90.86±71.80 months. The Ethics Committee approved the study under the registration number 2017-CK-5-R1. Results : There were 97 non-preterm children included with a mean age of 4.4±3.5 months. Mean weight was 5.1±2.7 kilograms. There were 48 abdominal surgical patients (49.5%), 48 neurosurgical patients (49.5%) and 1 orthopedic surgery patient (1%). 30 patients had intra-operative and or postoperative complications (organ failure or sepsis) (30.9%). The most common intra-operative complication was hemorrhagic shock (5.2%); the most affected system in the postoperative period was the respiratory system in terms of organ failure and pulmonary sepsis with an overall rate of 12.4%; the most common postoperative infection was septicemia (7.2%). The rate of postoperative renal failure was 1%. There were 5 in-hospital deaths (5.2%). Conclusion : In this cohort of 97 non-preterm infants under one year old, the rate of patients with intra-operative and or postoperative complications was 30.9%. It is time to reconsider integrating goal directed therapies in intra-operative patient management to improve postoperative outcome.

What ‘s Known On This Subject

Postoperative outcome in surgical patients is multifactorial.

Goal directed therapies have been shown to improve postoperative outcome in adult surgical patients. In children, intra-operative goal directed therapies are not a routine practice in general.

What this study adds:

The results of this study imply the necessity of integrating validated tools in children to optimize intra-operative hemodynamic status because there is evidence that non optimal hemodynamic intra-operative parameters are predictive of adverse postoperative outcome in surgical pediatric patients.

Introduction

An observational study conducted earlier to determine predictors of postoperative outcome in non-cardiac surgical pediatric patients concluded that predictors of postoperative evolution were multiple (1). These included American Society of Anesthesiologists (ASA) status, transfusion, age, emergency surgery, and surgery. Postoperative outcome in this observational trial was defined as intra-operative and postoperative complications (organ failure and sepsis), re-surgery, mortality, length of stay in the intensive care unit (LOSICU), length of stay in hospital (LOS), total length of stay in hospital, TLOS (LOSICU+LOS) and length of mechanical ventilation (LMV).

The study presented in this article had the objective to describe these outcomes in children under one year old in details.

Methods

Description of intra-operative and postoperative outcomes in children less than one year old included in the initial cohort of 594 patients aged 90.86±71.80 months (1).

The study was declared to the CNIL, National Commission for Computer Science and Liberties on 21 February 2017 under the registration number 2028257 v0. The Ethics Committee approved the study on 21 March 2017 under the registration number 2017-CK-5-R1. Patients were included retrospectively from 1 January 2014 to 17 May 2017.

Inclusion criteria were children aged less than one year and older than 37 weeks.

Exclusion criteria were children aged less than 37 weeks and older than one year.

Statistics were analyzed with XLSTAT 2020.4.1. software.

Continuous variables were described in means ± standard deviation or medians with interquartile ranges. Categorial variables were described in proportions or percentages.

Results

General characteristics are illustrated in table 1.

There were 97 children included with a mean age of 4.4±3.5 months. Mean weight was 5.1±2.7 kilograms. There were 48 abdominal surgical patients (49.5%), 48 neurosurgical patients (49.5%) and 1 orthopedic surgical patient (1%). 57 patients had elective surgery (58.8%) and 40 had emergency surgery (41.2%). 11 patients had re-surgery (11.3%).

30 patients had intra-operative and or postoperative complications (organ failure or sepsis) (30.9%). 5 patients had intra-operative hemorrhagic shock (5.2%), 1 patient had an intra-operative cardiac arrest (1%) and 1 patient had an intra-operative broncho-laryngospasm (1%). 2 patients had postoperative neurologic failure (2.1%), 5 patients had postoperative cardio-circulatory failure (5.2%), 6 patients had postoperative respiratory failure (6.2%), 1 patient had postoperative renal failure (1%), 5 patients had postoperative multi-organ failure (5.2%), and 1 patient had postoperative hemorrhagic shock (1%).

6 patients had postoperative pulmonary sepsis (6.2%), 6 patients had postoperative abdominal sepsis (6.2%), 2 patients had postoperative neuro-meningeal sepsis (2.6%), 7 patients had postoperative septicemia (7.2%) and 1 patient had postoperative multi-organ sepsis (1%). 67 patients received transfusion intra-operatively (69.1%). There were 5 in-hospital deaths (5.2%) and all were ASA 3 or more and were managed on an emergency basis. Among the deceased patients 1 had a liver transplantation, 1 had an intestinal resection, 1 had a laparotomy for volvulus, 1 had a cerebral aneurysm embolization and 1 had an extradural hematoma drainage (see table 2).

There were 31 ASA 1 (31.9%), 23 ASA 2 (23.7%), 26 ASA 3 (26.8%), 15 ASA 4 (15.5%) and 2 ASA 5 patients (2.1%) (Table 3).

Median length of postoperative intensive care unit stay (LOSICU) was 4 days[3-16], median length of postoperative hospital stay (LOS) was 4 days[1-18], median total length of postoperative hospital stay, TLOS (LOSICU+LOS) was 12 days [4-34] and median length of postoperative mechanical invasive or non-invasive mechanical ventilation (LMV) was 0 days [0-3].

Mean preoperative and postoperative hemoglobin levels were 12.1±3.1 g/dL and 12.4±2.5 g/dL respectively.

Table 3 illustrates types of surgery, the most common surgical intervention was craniosynostosis (39 patients; 40%), followed by intestinal resection (11 patients; 11%), hepatic transplantation (7 patients;7%), esophageal atresia (5 patients; 5%), omphalocele (5 patients; 5%) and laparotomy for volvulus (4 patients, 4%).

Table 4 illustrates outcomes per surgery.

Discussion

The most common intra-operative complication was hemorrhagic shock (5.2%), followed by broncho-laryngospasm (1%) and cardiac arrest (1%). Among the most common interventions described in this manuscript, craniosynostosis and liver transplantation were among the most hemorrhagic interventions this explains the rate of intra-operative hemorrhagic shock.

Transfusion rate was 69.1% in this study. A previous study in craniosynostosis reported a transfusion rate of 100% which was reduced to 22.7% after an implementation program with the aim to reduce transfusion (2) and another study reported a transfusion rate of 66% (3).

A study in liver transplantation in children revealed a massive transfusion rate of 55% (4).

The rate of intra-operative cardiac arrest was higher than that reported in a study of infants aged less than 60 weeks of postmenstrual age which showed a rate of 0.12% (5).

Nevertheless this same study revealed that intra-operative critical events were present in 35.3% of the patients and the most common concerned cardiovascular instability and hypoxemia (5). In our study, the rate of intra-operative critical events was 7.2% which included hemorrhagic shock, broncho-laryngospasm and cardiac arrest. The Nectarine study reported an intra-operative serious event rate of 35.3% and a 30 days morbidity rate of 16.3% with respiratory, surgical and cardiovascular complications as common events keeping in mind that this study included pre-terms and term patients up-to 60 weeks postmenstrual age (5). Our study included term infants and pre-terms were not included.

In our study the rate of patients with intra-operative and or postoperative complications was 30.9%. The respiratory system was the most affected in the postoperative period with an overall complication rate of 12.4% which included respiratory failure (6.2%) and pulmonary sepsis (6.2%).

According to 2 previous studies, postoperative pneumonia rates varied between <1% to 1.2% (6,3,7). Re-surgery was present in 11.3% of the patients in our study.

Previous studies reported re-operation rates between 2 and 5% (3,8).

Postoperative cardio-circulatory failure (5.2%) and multi-organ failure (5.2%) were the second most frequent postoperative systemic failures followed by neurologic dysfunction which included neurologic failure (2.1%) and neuro-meningeal sepsis (2.1%).

According to a previous narrative review, the incidence of multiple organ dysfunction in pediatric intensive care unit (PICU) varied from 6 to 57 % depending on the studies (9).

Mortality rates from multi-organ dysfunction vary from <5% to >80% depending on the number of organ failure (9). The most common cause of multi-organ failure is sepsis with an overall rate of 17 to 73% (9).

The most common postoperative infection in our study was septicemia (7.2%), followed by pulmonary (6.2%) and abdominal sepsis (6.2%). Postoperative septicemia rates have been reported to vary from 25 to 33 % in liver transplantation surgery (7,10). One study in liver transplantation, reported a postoperative abdominal sepsis of 25% (10). In a study in infants aged less than 6 months overall postoperative sepsis rate was 6.9% (11). In this same study, factors related to postoperative sepsis were laparotomy, thoracotomy, diaphragmatic repair, low age and a long intervention time. Independent predictors of postoperative sepsis were central venous catheter and perioperative antibiotics (11).

In-hospital mortality rate was 5.2% in our study. All deceased patients had an ASA score of more than 3, were managed on an emergency basis. All the deceased patients had postoperative multi-organ failure and sepsis, all were aged less than 10 months and had co-morbidities. In the literature, mortality rates vary form 0% in surgery like craniosynostosis to high rates of 17.7% in liver transplantation, of 19.6% in ruptured cerebral aneurysms and more than 80% in patients with multi-organ failure with sepsis (2-6, 8-10, 12-22).

This study has shown that in children under one year old in major hemorrhagic abdominal surgery and neurosurgery, hemorrhagic shock was the most common intra-operative complication. In our Hospital we do not have transfusion protocols guided with point of care tests (23). It is time to reconsider the integration of these protocols in major hemorrhagic surgery to reduce transfusion and improve postoperative outcome (23).

One third of the patients in this cohort presented intra-operative and or postoperative complications and patients with fatal outcome were all ASA 3 or more. It is time to reconsider the integration of fluid and hemodynamic goal directed therapy in these patients with the aim to improve postoperative evolution since these protocols are not yet a routine practice in our Hospital (24,25,26,27,28,29, 30,31).

Postoperative outcome is multifactorial, intra-operative management plays a major role on postoperative evolution. Intra-operative fluid and hemodynamic optimization is one of the keys to upgrade postoperative outcome.

Conclusions

This secondary analysis of 97 non pre-term infants aged less than one year old in major abdominal surgery and neurosurgery, revealed that hemorrhagic shock was the most common intra-operative complication; in the postoperative period, the respiratory system was the most affected system, septicemia was the most common postoperative infection and in-hospital mortality rate was 5.2%. Patients with fatal outcome had ASA scores of 3 or more with severe co-morbidities.

It is time to reconsider integrating goal directed therapies in intra-operative patient management to improve postoperative outcome.

References

1. Kumba C, Cresci F, Picard C et al (2017) Transfusion and Morbi-Mortality Factors: An Observational Descriptive Retrospective Pediatric Cohort Study. *J Anesth Crit Care Open Access* 8(4): 00315. DOI :10.15406/jaccoa.2017.08.00315.

2. Beethe AB, Spitznagel RA, Kugler JA, Goeller JK et al (2020) The Road to Transfusion-Free Craniosynostosis Repair in Children Less Than 24 Months Old: A Quality Improvement Initiative. *Pediatr Qual Saf 4:e331; doi: 10.1097/pq9.0000000000000331.*

Bartz-Kurycki M, Wei S, Bernardi K, Moffitt JK, Greives MR (2019) Impact of Cardiac Risk Factors on Complications following Cranial Valut Remodeling: Analysis of the 2012-2016 NSQIP-P database. *J Craniofac Surg* 30(2):442-447.Doi:10.1097/SCS. 0000000000005114.

4. Jin SJ, Kim SK, Choi SS et al (2017) Risk Factor For Intra-operative massive transfusion in pediatric liver transplantation: a multivariate analysis. *Int. J. Med. Sci* 14(2) :173-180. doi: 10.7150/ijms.17502.

5. Disma N, Veyckemans F, Virag K, Hansen TG et al (2021) Morbidity and mortality after anaesthesia in early life: results of the European prospective multicentre observational study, neonate and children audit of anaesthesia practice in Europe (NECTARINE). *Br J Anaesth.* doi:10.1016/j.bja.2021.02.016.

6.Bruce WJ, Chang V, Joyce CJ, Cobb AN, Maduekwe UI , Patel PA (2018) Age at Time of Craniosynostosis Repair Predicts Increased Complication Rate. *Cleft Palate Craniofac J* 55(5):649-654. Doi:10.1177/1055665617725215.

7. Shoji K, Funaki T, Kasahara M et al (2015) Risk Factors For Bloodstream Infection After Living-donor Liver Transplantation in Children. Pediatr Infect Dis J 34(10): 1063–1068. doi:10.1097/INF.0000000000000811.

8.Sinha CK, Rye E, Sunderland R, Rex D, Nicholls E, Okoye B (2020) The need for Paediatric Emergency Laparotomy Audit (PELA) in the UK. Ann R Coll Surg Engl 102: 209–213. Doi :10.1308/rcsann.2019.0141.

9. Watson RS, Crow SS, Hartman ME, Lacroix J et al (2017) Epidemiology and Outcomes of Pediatric Multiple Organ Dyfunction Sydrome (MODS). Pediatr Crit Care Med 18(3 Suppl 1): S4–S16. doi:10.1097/PCC.0000000000001047.

10.Kim JE, Oh SH, Kim KM, Choi BH et al (2010) Infections after Donor Liver Transplantation in Children. *J Korean Med Sci* 25: 527-31*. DOI: 10.3346/jkms.2010.25.4.527*.

11. Kessler U, Ebneter M, Zachariou Z, Berger S (2009) Postoperative Sepsis in Infants Below 6 months of age. *World J Pediatr* 5(2):113-117.

12.Hetts SW, Narvid J, Sanai N et al (2009) Intracranial Aneurysms in Childhood: 27-Year Single-Institution Experience. *AJNR AM J Neuroradiol* 30(7):1315-1324.

13. Amelot A, Saliou G , Benichi S,Alias Q, Boulois G,Zerah M, Aghakhani N, Ozanne A,Blauwblomme T, Naggara O (2019) Long-term Outcomes of Cerebral Aneurysms in Children. *Pediatrics* 143(6):e20183836.

14.Binder H, Majdan M, Tiefenboeck TM, Fochtmann A, Michel M, Hajdu S, Mauritz W, Leitgeb J (2016) Management and outcome of traumatic epidural hematoma in 41 infants and children from a single center. *Orthopedics & Traumatology: Surgery & Research* 102: 769-774.

15.Nath PC, Mishra SS, Das S , Deo RC (2015) Supratentorial extradural hematoma in children: An Institutional Clinical Experience of 65 cases. *J Pediatr Neurosci* 10(2):114-118. Doi:10.4103/1817-1745.159192.

16.Copeland AE, Hoffman CE, Tsitouras V, Jeevan DS et al (2018) Clinical Significance of Venous Anomalies in Syndromic Craniosynostosis. *Plast Reconstr Surg Glob Open* 6:e1613. Doi: 10.1097/GOX.0000000000001613.

17. Haberal M, Karakayali H, Arslan G et al (2006) Liver Tranplantation in Children Weighing Less Than 10 Kilograms. *Transplantation Proceeding* 38 :3585–3587.

18.Mack CL, Ferrario M, Abecassis M, Whitington PF et al (2001). Living Donor Liver Transplantation for Children With Liver Failure and Concurrent Multiple Organ System Failure. *Liver Transpl* 7:890-895.

19. Jain A, Mazariegos G, Kashyap R et al (2002) Pediatric Liver Transplantation: A single Center Experience Spanning 20 Years. *Transplantation* 73(6): 941–947.

20.Beath SV, Brook GD, Kelly DA et al (1993) Successful Liver Transplantation in Babies Under 1 year. *BMJ* 307:825-8.

21. Horsch S, Albayrak B, Trobs RB et al (2016) Volvulus in Term and Pre-term Infants-Clinical Presentation and Outcome. Acta Paeditarica 105:623-627.

22.Maas C, Hammer S, Kirschner J et al (2014) Late-Onset Volvulus Without Malrotation in Extremely Pre-Term Infants- A Case Control Study. *BMC Pediatrics* 14:287.

23.Kumba C, Querciagrossa S, Harte C, Willems A, De Cock A, Blanc T et al (2019) A Systematic Review and Meta-analysis of Goal Directed Intra-Operative Transfusion Protocols Guided by Viscoelastic Methods and Perioperative Outcomes in Children.Int J Recent Sci Res 10 (03), pp. 31466-31471. DOI: http://dx.doi.org/10.24327/ijrsr.2019.1003.3266.

24. Kumba C (2020) Physiology Principles Underlying Goal Directed Therapies in Children. Res Pediatr Neonatol. 4(4).RPN.000591.2020.Doi/10.31031/RPN.2020.04.000591.

25. Kumba C (2020) Rationale of Goal Directed Therapies in Children. Adv Pediatr Res 7:42. Doi:10.35248/2385-4529.20.7.42.

26. Kumba C (2019) "Do Goal Directed Therapies Improve Postoperative Outcome in Children? (Perioperative Goal Directed Fluid and Hemodynamic Therapy; Transfusion goal directed therapy using viscoelastic methods and enhanced recovery after surgery and Postoperative outcome): A Study Research Protocol". *Acta Scientific Paediatrics* 2(7) :17-19.Doi:10.31080/ASPE.2019.02.0094.

27. Kumba C (2020) Goal directed fluid and hemodynamic therapy and postoperative outcomes in children: Value of transthoracic echocardiographic aortic blood flow peak velocity variation: A multi-centre randomized controlled trial protocol. Adv Pediatr Res 7:35. doi: 10.35248/2385-4529.20.7.35.

28. Kumba C (2020) Trans-Thoracic Echocardiographic Aortic Blood Flow Peak Velocity Variation, Distance Minute, Aortic Velocity Time Integral and Postoperative Outcome in Pediatric Surgical Patients—An Observational Pilot Study Protocol. *Open Journal of Internal Medicine* 10: 90-95. doi: 10.4236/ojim.2020.101009.

29. Kumba C, Willems A, Querciagrosssa s, Harte C, Blanc T et al (2019) A Systematic Review and Meta- Analysis of Intraoperative Goal Directed Fluid and Haemodynamic Therapy in Children and Postoperative Outcome. J Emerg Med Critical Care 5(1):1-9. DOI: 10.13188/2469-4045.1000020.

30. Kumba C, Blanc T, De Cock A, Willems A, Harte C, Querciagrossa S et al (2019) Rapid Recovery Pathways after Surgery in Children: A Systematic Review and Meta-Analysis. Med J Clin Trials Case Stud 3(3): 000211. DOI: 10.23880/mjccs-16000211.

31. Kumba C and Melot C (2019)"The Era of Goal Directed Therapies in Paediatric Anaesthesia and Critical Care". *EC Emergency Medicine and Critical Care* 3(5): 306-309

Declarations

Conflict of Interest: The author declared no conflict of interest

Availability of data and materials: on demand to the Author

Author's contributions: Dr Claudine Kumba conceptualized and designed the study, drafted the

initial and final manuscript. She designed the data collection instruments, collected data, carried out

initial and final analyses.

Ethics Approval: This study received approval from the Ethics Committee of Necker on 21 March 2017 under the registration number 2017-CK-5-R1 and waived patients consent.

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https://zenodo.org/record/4958069#.YMy6wy0RpQI

Tables

Table 1 General Characteristics

Characteristics	N=97
Mean age in months	4.4±3.5
Mean weight in kilograms	5.1±2.7
Abdominal surgery n (%)	48 (49.5)
Neurosurgery n (%)	48 (49.5)
Orthopedic surgery n (%)	1 (1)
Elective surgery n (%)	57 (58.8)
Emergency surgery n (%)	40 (41.2)
Re-surgery n (%)	11 (11.3)
Patients with intra-operative and or postoperative complications (organ failure or sepsis) n (%)	30 (30.9)
Intra-operative hemorrhagic shock n (%)	5 (5.2)
Intra-operative cardiac arrest n (%)	1 (1)
Intra-operative bronchospasm or laryngospasm n (%)	1 (1)
Postoperative neurologic failure n (%)	2 (2.1)
Postoperative cardio-circulatory failure n (%)	5 (5.2)
Postoperative respiratory failure n (%)	6 (6.2)
Postoperative renal failure n (%)	1 (1)
Postoperative miscellaneous n (%)	1 (1)
Postoperative multi-organ failure n (%)	5 (5.2)
Postoperative hemorrhagic shock n (%)	1 (1)
Postoperative pulmonary sepsis n (%)	6 (6.2)
Postoperative abdominal sepsis n (%)	6 (6.2)
Postoperative neuro-meningeal sepsis n (%)	2 (2.1)
Postoperative septicemia n (%)	7 (7.2)
Postoperative multi-organ sepsis n (%)	1 (1)
In hospital Mortality n (%)	5 (5.2)
Transfusion n (%)	67 (69.1)
Mean preoperative hemoglobin levels± standard deviation g/dL	12.1±3.1
Mean postoperative hemoglobin levels ± standard deviation g/dL	12.4±2.5
ASA 1 n(%)	31 (31.9)
ASA 2 n(%)	23 (23.7)
ASA 3 n(%)	26 (26.8)
ASA 4 n(%)	15 (15.5)
ASA 5 n(%)	2 (2.1)
Median length of intensive care unit stay in days	4 [3-16]
Median length of hospital stay in days	4 [1-18]
Median total length of hospital stay in days	12 [4-34]

Median length of mechanical ventilation (invasive or non-invasive) in days	0 [0-3]

Table 2 patients with fatal outcome

Surgery	Age months	ASA score	Co-morbidities	Intra-operative complications	Postoperative outcome	Delay of in-hospital mortality in days	Emergency	Transfusion
Hepatic Transplantation	5	4	Hepatic failure	Hemorrhagic shock	Multi-organ failure and septicemia	63	Yes	yes
Intestinal resection	0	3	Congenital heart disease	None	Multi-organ failure and neuro-meningeal sepsis	148	Yes	Yes
Laparotomy for volvulus	1	4	Congenital heart disease	None	Multi-organ sepsis	75	Yes	No
Cerebral aneurysm embolization	2	5	Cerebral aneurysm	None	Multi-organ failure	18	Yes	Yes
Extradural hematoma drainage	9	5	Endocarditis with stroke	None	Multi-organ failure and pulmonary sepsis	12	Yes	Yes

Table 3 Surgery

Surgery	Number of patients
Ano-rectal malformation	3
Neuroblastoma	2
Hepatic transplantation	7
Intestinal resection	11
Hepatic tumor	1
Nissen Gastrostomy	1
Conjoined twin separation	2
Kasai	3
Mediastinal ganglioneuroma	1
Esophageal atresia	5
Pelvic tumor resection	2
Laparotomy for volvulus	4
Exploratory laparotomy	1
Omphalocele	5
Peritoneal or external ventriculostomy	3
Craniosynostosis	39
Cerebral aneurysm or arterio-venous malformation embolization	1
Central venous catheter	1
Attached/Fixed spinal cord	1
Intra-cerebral tumor resection	1
Extra-dural hematoma drainage	2
Limb Tumor resection	1
Total	97

Due to technical limitations, table 4 is only available as a download in the Supplemental Files section.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Table4Outcomepersurgery.docx