Acta Scientific PAEDIATRICS (ISSN: 2581-883X)

Volume 4 Issue 8 August 2021

Research Article

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

Claudine Kumba*

Department of Pediatric and Obstetric Anesthesia and Critical Care, Hôpital Universitaire Necker Enfants Malades, Assistance Publique Hôpitaux de Paris, APHP, Université de Paris, Paris, France

***Corresponding Author:** Claudine Kumba, Department of Pediatric and Obstetric Anesthesia and Critical Care, Hôpital Universitaire Necker Enfants Malades, Assistance Publique Hôpitaux de Paris, APHP, Université de Paris, Paris, France.

Received: May 10, 2021

Published: July 05, 2021

Abstract

Background: 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.

Objectives: 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 4.44 ± 3.49 months.

Mean weight was 5.13 ± 2.74 kilograms. There were 48 abdominal surgical patients (49.49%), 48 neurosurgical patients (49.49%) and 1 orthopedic surgery patient (1.03%). 30 patients had intra-operative and or postoperative complications (organ failure or sepsis) (30.93%). The most common intra-operative complication was hemorrhagic shock (5.16%); 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 12.38%; the most common postoperative infection was septicemia (7.22%). The rate of postoperative renal failure was 1.03%. There were 5 in-hospital deaths (5.16%) and all were ASA III, IV and V patients managed on an emergency basis.

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 30.93%. Patients with fatal outcome had an ASA score III or more and were managed on an emergency basis.

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

Keywords: Children Under One Year Old; Outcome; Non-Cardiac Surgery

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).

Objective of the Study

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 of Necker 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. Categoric variables were compared with Fischer's exact test. A p-value of less than 0.05 was considered significant.

Results

General characteristics are illustrated in table 1.

There were 97 children included with a mean age of 4.44 ± 3.49 months. Mean weight was 5.13 ± 2.74 kilograms. There were 48 abdominal surgical patients (49.49%), 48 neurosurgical patients (49.49%) and 1 orthopedic surgical patient (1.03%). 57 patients had elective surgery (58.76%) and 40 had emergency surgery (41.24%). 11 patients had re-surgery (11.34%). 30 patients had in-

Characteristics	N = 97
Mean age in months	4.44 ± 3.49
Mean weight in kilograms	5.13 ± 2.74
Abdominal surgery n (%)	48 (49.49)
Neurosurgery n (%)	48 (49.49)
Orthopedic surgery n (%)	1 (1.03)
Elective surgery n (%)	57 (58.76)
Emergency surgery n (%)	40 (41.24)
Re-surgery n (%)	11 (11.34)
Patients with intra-operative and or post-operative complications (organ failure or sepsis) n (%)	30 (30.93)
Intra-operative hemorrhagic shock n (%)	5 (5.16)
Intra-operative cardiac arrest n (%)	1 (1.03)
Intra-operative bronchospasm or laryngo-spasm n (%)	1 (1.03)
Postoperative neurologic failure n (%)	2 (2.06)
Postoperative cardio-circulatory failure n (%)	5 (5.16)
Postoperative respiratory failure n (%)	6 (6.19)
Postoperative renal failure n (%)	1 (1.03)
Postoperative miscellaneous n (%)	1 (1.03)
Postoperative multi-organ failure n (%)	5 (5.16)
Postoperative hemorrhagic shock n (%)	1 (1.03)
Postoperative pulmonary sepsis n (%)	6 (6.19)
Postoperative abdominal sepsis n (%)	6 (6.19)
Postoperative neuro-meningeal sepsis n (%)	2 (2.06)
Postoperative septicemia n (%)	7 (7.22)
Postoperative multi-organ sepsis n (%)	1 (1.03)
In hospital Mortality n (%)	5 (5.16)
Transfusion n (%)	67 (69.07)
Mean preoperative hemoglobin levels ± standard deviation g/dL	12.07 ± 3.09
Mean postoperative hemoglobin levels ± standard deviation g/dL	12.40 ± 2.54
ASA I n (%)	31 (31.96)
ASA II n (%)	23 (23.71)
ASA III n (%)	26 (26.80)
ASA IV n (%)	15 (15.46)
ASA V n (%)	2 (2.06)
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 1: General characteristics.

tra-operative and or postoperative complications (organ failure or sepsis) (30.93%). 5 patients had intra-operative hemorrhagic shock (5.16%), 1 patient had an intra-operative cardiac arrest (1.03%) and 1 patient had an intra-operative bronchospasm/laryngospasm (1.03%). 2 patients had postoperative neurologic failure (2.06%), 5 patients had postoperative cardio-circulatory failure (5.16%), 6 patients had postoperative respiratory failure (6.19%), 1 patient had postoperative renal failure (1.03%), 5 patients had postoperative multi-organ failure (5.15%), and 1 patient had postoperative hemorrhagic shock (1.03%). 6 patients had postoperative pulmonary sepsis (6.19%), 6 patients had postoperative abdominal sepsis (6.19%), 2 patients had postoperative neuro-meningeal sepsis (2.6%), 7 patients had postoperative septicemia (7.22%) and 1 patient had postoperative multi-organ sepsis (1.03%). 67 patients received transfusion intra-operatively (69.07%). There were 5 in-hospital deaths (5.16%) and all were ASA III 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).

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

Table 2: Patients with fatal outcome.

There were 31 ASA I (31.96%), 23 ASA II (23.71%), 26 ASA III (26.80%), 15 ASA IV (15.46%) and 2 ASA V patients (2.06%) (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].

The majority of the patients (69.07%) were transfused intra-operatively.

Mean preoperative hemoglobin levels were 12.07 ± 3.09 g/dL and mean postoperative hemoglobin levels were 12.40 ± 2.54 g/dL.

Surgery	Number of patients
Ano-rectal malformation	3
Neuroblastoma	2
Hepatic transplantation	7
Intestinal exeresis	11
Hepatic tumor	1
Nissen Gastrostomy	1
Conjoined twin separation	2
Kasai	3
Mediastinal ganglioneuroma	1
Esophageal atresia	5
Pelvic tumor	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 exeresis	1
Extra-dural hematoma drainage	2
Limb Tumor exeresis	1
Total	97

Table 3: Surgery.

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 and table 5 illustrates p-values for complications per surgery.

Discussion

The most common intra-operative complication was hemorrhagic shock (5.16%), followed by broncho-laryngo spasm (1.03%) and cardiac arrest (1.03%). 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 69.07% in this study. A previous study in craniosynostosis has reported a transfusion rate of 100% which was reduced to 22.7% after an implementation program with 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 the cardiovascular instability and hypoxemia [5]. In our study the rate of intra-operative critical events was 7.22% 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 30.93%. The respiratory system was the most affected in the postoperative period with overall complication rate of 12.38% which included respiratory failure (6.19%) and pulmonary sepsis (6.19%). According to 2 previous studies, postoperative pneumonia rate varied between < 1% to 1.2% [3,6,7]. Re-surgery was present in 11.34% of the patients in our study. Previous studies have reported a re-operation rate between 2 and 5% [3,8]. Postoperative cardio-circulatory failure (5.16%) and multi-organ failure (5.16%) were the second most frequent postoperative systemic failures followed by neurologic dysfunction which included neurologic failure (2.06%) and neuromeningeal sepsis (2.06%). According to a previous narrative review, the incidence multiple organ dysfunction in pediatric intensive care unit (PICU) varies from 6 to 57% according to the studies [9]. Mortality rates from multi-organ dysfunction varies from < 5% to > 80% depending on the number of organ failure [9]. The most

Conjoined twin separation	Gastro-plasty	Hepatic tumor	Intestinal exeresis	Hepatic trans-plantation	Neuroblas-toma	Ano-rectal malformation	
2	1	1	11	7	2	3	**Surgery**
0	0	0	1	2	1	0	**Intraoperative hemorrhagic shock**
0	0	0	0	0	0	0	**Intra-operative cardiac arrest**
0	0	0	0	0	0	0	**Intra-operative bronchospasm/ laryngospasm**
0	0	0	0	1	0	0	**Postoperative neurologic failure**
0	0	0	1	1	2	0	**Postoperative cardio-circulatory failure**
0	1	0	2	0	0	0	**Postoperative respiratory failure**
0	0	0	0	0	0	0	**Postoperative renal failure**
1	0	0	0	0	0	0	**Postoperative miscellaneous**
0	0	0	1	1	0	0	**Postoperative multi-organ failure**
0	0	0	0	0	0	0	**Postoperative hemorrhagic shock**
1	1	0	1	0	0	0	**Postoperative pulmonary sepsis**
1	0	0	1	2	0	0	**Postoperative abdominal sepsis**
0	0	0	1	0	0	0	**Postoperative neuro-meningeal sepsis**
0	0	0	1	3	0	0	**Postoperative septicemia**
0	0	0	0	0	0	0	**Postoperative multi-organ sepsis**
0	0	0	1	1	0	0	**Mortality**
1	1	0	2	2	0	0	**Re-surgery**
2	1	1	9	7	2	2	**Transfusion**

Citation: Claudine Kumba, *et al.* "Postoperative Outcome in Non-Preterm Infants Under One Year Old in Non-Cardiac Surgery". *Acta Scientific Paediatrics* 4.8 (2021): 11-23.

Craniosynostosis	Peritoneal or external ventriculostomy	Omphalocele	Exploratory laparotomy	Laparotomy for volvulus	Pelvic tumor	Esophageal atresia	Mediastinal ganglioneuroma	Kasai
39	3	5	1	4	2	5	1	3
1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1	0
1	0	0	0	0	0	1	0	0
0	0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	0	0
1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	1	0	1
1	0	0	0	0	0	0	0	0
0	0	1	0	1	0	0	1	0
0	0	0	0	1	0	0	0	0
0	0	0	0	1	0	0	0	0
1	1	0	0	1	0	0	1	0
31	1	0	0	0	0	1	1	3

Total	Tumor exeresis (orthopedic)	Extra-dural hematoma drainage	Intra-cerebral tumor exeresis	Attached/Fixed spinal cord	Central venous catheter	Cerebral aneurysm or arterio-venous malformation embolization
97	1	2	1	1	1	1
5	0	0	0	0	0	0
1	0	0	0	0	1	0
1	0	0	0	0	0	0
2	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	1	0
1	0	0	0	0	0	0
1	0	0	0	0	0	0
5	0	1	0	0	0	1
1	0	0	0	0	0	0
6	0	1	0	0	1	0
6	0	0	0	0	0	0
2	0	0	0	0	0	0
7	0	0	0	0	0	0
1	0	0	0	0	0	0
5	0	1	0	0	0	1
11	0	0	0	0	0	1
67	0	2	1	1	1	1

Table 4: Outcome per surgery.

Nissen Gastroplasty	Hepatic tumor	Intestinal exeresis	Hepatic transplantation	Neuroblastoma	Ano-rectal malformation	
0.4	1	0.44	0.09	0.70	0.65	**Surgery**
1	1	0.53	0.106	0.14	1	**Intraoperative hemorrhagic shock**
1	1	1	1	1	1	**Intra-operative cardiac arrest**
1	1	1	1	1	1	**Intra-operative bronchospasm/la-ryngospasm**
1	1	1	0.21	1	1	**Postoperative neurologic failure**
1	1	0.53	0.47	0.01	1	**Postoperative cardio-circulatory failure**
0.12	1	0.19	1	1	1	**Postoperative respiratory failure**
1	1	1	1	1	1	**Postoperative renal failure**
1	1	1	1	1	1	**Postoperative miscellaneous**
1	1	0.53	0.47	1	1	**Postoperative multi-organ failure**
1	1	1	1	1	1	**Postoperative hemorrhagic shock**
0.12	1	0.6	1	1	1	**Postoperative pulmonary sepsis**
1	1	0.6	0.15	1	1	**Postoperative abdominal sepsis**
1	1	0.3	1	1	1	**Postoperative neuro-meningeal sepsis**
1	1	1	0.04	1	1	**Postoperative septicemia**
1	1	1	1	1	1	**Postoperative multi-organ sepsis**
1	1	0.5	0.5	1	1	**Mortality**
0.2	1	0.7	0.62	1	1	**Re-surgery**
1	0,499	1	0.82	1	0.63	**Transfusion**

Omphalocele	Exploratory laparotomy	Laparotomy for volvulus	Pelvic tumor	Esophageal atresia	Mediastinal ganglio-neuroma	Kasai	Conjoined twin separation
0.1	0.4	0.7	0.2	0.7	0.4	1	0.47
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	0.1	1	1
1	1	1	1	0.2	1	1	1
0.03	1	1	1	1	1	1	1
1	1	1	1	1	1	1	0.04
1	1	1	1	0.2	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	0.2	1	1	0.2
1	1	1	1	0.2	1	0.2	0.2
1	1	1	1	1	1	1	1
0.2	1	0	1	1	0.1	1	1
1	1	0.04	1	1	1	1	1
1	1	0.2	1	1	1	1	1
1	1	0.3	1	1	0.2	1	0.3
0.1	1	0.1	1	0.3	1	0.4	1

Intra-cerebral tumor exeresis	Attached/Fixed spinal cord	Central venous catheter	Cerebral aneurysm or arterio-venous malformation embolization	Craniosynostosis	Peritoneal or external ventriculostomy
1	1	.04	0.4	0.06	0.7
1	1	1	1	0.6	1
1	1	0.02	1	1	1
1	1	1	1	0.3	1
1	1	1	1	1	1
1	1	1	1	0.1	1
1	1	0.1	1	0.6	1
1	1	1	1	1	1
1	1	1	1	1	1
1	1	1	0.1	0.1	1
1	1	1	1	0.3	1
1	1	0.1	1	0.2	1
1	1	1	1	0.2	1
1	1	1	1	1	1
1	1	1	1	0.1	1
1	1	1	1	1	1
1	1	1	0.1	0.2	1
1	1	1	0.2	0.1	0.2
0.5	0.5	1	1	0.01	1

Extra-dural hematoma drainage	0.7	1	1	1	1	1	1	1	1	0.1	1	0	1	1	1	1	0.1	1	1
Tumor exeresis (orthopedic)	0.42	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 5: p-values Fischer exact test outcomes per surgery.

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 (7.22%), followed by pulmonary (6.19%) and abdominal sepsis (6.19%). Postoperative septicemia rates has 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 was 6.9% [11]. In this study same, 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 5.16% in our study. All patients had a 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 non cardiac surgery, 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 consider the integration of these protocols in major hemorrhagic surgery to reduce transfusion and improve outcome [23].

One third of 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 [24-31].

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.

Conclusion

This secondary analysis of 97 non pre-term infants aged less than one year old, 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 5.16%. 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 intraoperative patient management to improve postoperative outcome.

Conflicts of Interest

The author declared no conflicts of interest.

Bibliography

1. Kumba C., *et al*. "Transfusion and Morbi-Mortality Factors: An Observational Descriptive Retrospective Pediatric Cohort Study". *Journal of Anesthesia and Critical Care: Open Access* 8.4 (2017): 00315.

2. Beethe AB., *et al*. "The Road to Transfusion-Free Craniosynostosis Repair in Children Less Than 24 Months Old: A Quality Improvement Initiative". *Pediatrics Quality Safety* 4 (2020): e331.

3. Bartz-Kurycki M., *et al*. "Impact of Cardiac Risk Factors on Complications following Cranial Valut Remodeling: Analysis of the 2012-2016 NSQIP-P database". *The Journal of Craniofacial Surgery* 30.2 (2019): 442-447.

4. Jin SJ., *et al*. "Risk Factor For Intra-operative massive transfusion in pediatric liver transplantation: a multivariate analysis". *International Journal of Medical Sciences* 14.2 (2017) :173-180.

5. Disma N., *et al*. "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)". *British Journal of Anaesthesia* (2021).

6. Bruce WJ., *et al*. "Age at Time of Craniosynostosis Repair Predicts Increased Complication Rate". *The Cleft Palate-Craniofacial Journal* 55.5 (2018): 649-654.

7. Shoji K., *et al*. "Risk Factors For Bloodstream Infection After Living-donor Liver Transplantation in Children". *The Pediatric Infectious Disease Journal* 34.10 (2015): 1063-1068.

8. Sinha CK., *et al*. "The need for Paediatric Emergency Laparotomy Audit (PELA) in the UK". *Annals of the Royal College of Surgeons of England* 102 (2020): 209-213.

9. Watson RS., *et al*. "Epidemiology and Outcomes of Pediatric Multiple Organ Dyfunction Sydrome (MODS)". *Pediatric Critical Care Medicine* 18.3-1 (2017): S4-S16.

10. Kim JE., *et al*. "Infections after Donor Liver Transplantation in Children". *Journal of Korean Medical Science* 25 (2010): 527-531.

11. Kessler U., *et al*. "Postoperative Sepsis in Infants Below 6 months of age". *World Journal of Pediatrics* 5.2 (2009): 113-117.

12. Hetts SW., *et al*. "Intracranial Aneurysms in Childhood: 27-Year Single-Institution Experience". *American Journal of Neuroradiology* 30.7 (2009): 1315-1324.

13. Amelot A., *et al*. "Long-term Outcomes of Cerebral Aneurysms in Children". *Pediatrics* 143.6 (2019): e20183836.

14. Binder H., *et al*. "Management and outcome of traumatic epidural hematoma in 41 infants and children from a single center". *Orthopedics and Traumatology: Surgery and Research* 102 (2016): 769-774.

15. Nath PC., *et al*. "Supratentorial extradural hematoma in children: An Institutional Clinical Experience of 65 cases". *Journal of Pediatric Neurosciences* 10.2 (2015): 114-118.

16. Copeland AE., *et al*. "Clinical Significance of Venous Anomalies in Syndromic Craniosynostosis". *Plastic and Reconstructive Surgery-Global Open* 6 (2018): e1613.

17. Haberal M., *et al*. "Liver Transplantation in Children Weighing Less Than 10 Kilograms". *Transplantation Proceeding* 38 (2006): 3585-3587.

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

19. Jain A., *et al*. "Pediatric Liver Transplantation: A single Center Experience Spanning 20 Years". *Transplantation* 73.6 (2002): 941-947.

20. Beath SV., *et al*. "Successful Liver Transplantation in Babies Under 1 year". *British Medical Journal* 307 (1993): 825-828.

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

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

23. Kumba C., *et al*. "A Systematic Review and Meta-analysis of Goal Directed Intra-Operative Transfusion Protocols Guided by Viscoelastic Methods and Perioperative Outcomes in Children". *International Journal of Recent Scientific Research* 10.03 (2019): 31466-31471.

24. Kumba C. "Physiology Principles Underlying Goal Directed Therapies in Children". *Research Pediatrics and Neonatology* 4.4 ().

25. Kumba C. "Rationale of Goal Directed Therapies in Children". *Advances in Pediatric Research* 7 (2020): 42.

26. Kumba C. "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 (2019): 17-19.

27. Kumba C. "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". *Advances in Pediatric Research* 7 (2020): 35.

28. Kumba C. "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 (2020): 90-95.

29. Kumba C., *et al*. "A Systematic Review and Meta- Analysis of Intraoperative Goal Directed Fluid and Haemodynamic Therapy in Children and Postoperative Outcome". *Journal of Emergency and Critical Care Medicine* 5.1 (2019): 1-9.

30. Kumba C., *et al*. "Rapid Recovery Pathways after Surgery in Children: A Systematic Review and Meta-Analysis". *Medical Journal of Clinical trials and Case Studies* 3.3 (2019): 000211.

31. Kumba C and Melot C. "The Era of Goal Directed Therapies in Paediatric Anaesthesia and Critical Care". *EC Emergency Medicine and Critical Care* 3.5 (2019): 306-309.

Volume 4 Issue 8 August 2021