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Transfusion and morbi-mortality factors: an observational descriptive retrospective pediatric cohort study

Abstract

Background: Intraoperative and postoperative morbi-mortality factors are multiple in pediatric patients. Studies in pediatric cardiac surgery and intensive care patients have identified transfusion as one independent factor among others. There is not a lot of data concerning transfusion related morbi-mortality in other pediatric patients fields like neurosurgery, abdominal and orthopedic surgery. These were investigated.

Objectives: To identify morbi-mortality risk factors in intraoperatively transfused and not transfused pediatric patients in neurosurgery, abdominal and orthopedic surgery.

Design: Retrospective observational descriptive pediatric cohort study.

Setting: Monocentric pediatric tertiary center, Necker Enfants Malades University Hospital Paris, from 1 January 2014 to 17 Mai 2017.

Patients: 594 patients with mean age of 90.86±71.80 months were included. Inclusion criteria were the presence or the absence of transfusion in the intraoperative period in neurosurgery, abdominal and orthopedic surgery patients. Exclusion criterion was transfusion in the postoperative period until discharge from hospital.

Main outcome measures: Primary outcome was mortality and secondary outcome was morbidity in transfused and non-transfused patients. Mortality was assessed by deaths occuring intraoperatively or postoperatively during the entire hospitalisation. Morbidity was assessed by intraoperative, postoperative complications, repeat surgery, length of stay in the intensive care unit, in the hospitalisation ward, total length of stay in hospital and length of mechanical ventilation.

Results: Multivariate analysis revealed that ASA score was the independent risk factor for mortality. Transfusion, emergency surgery, type of surgery, age and prematurity were independent risk factors for morbidity.

Conclusion: Patient outcome can be improved by applying specific preventive measures on each risk factor.

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Introduction

In pediatric patients admitted for surgery under anesthesia, morbi-mortality is related to mutiple factors. Several morbi-mortality risk factors have been identified of which transfusion is one of the independent risk factors in studies concerning pediatric cardiac surgery and critical care patients.[1-3] This study was undertaken to determine whether transfusion is an independant morbi-mortality risk factor in three different pediatric surgical populations: neurosurgery, orthopedics and abdominal surgery. The primary endpoint was to identify factors related to mortality and the secondary endpoint was to identify factors related to morbidity in this pediatric population. Mortality (primary outcome) was assessed by deaths occurring intraoperatively or postoperatively until discharge from hospital. Morbidity (secondary outcome) was assessed by intraoperative and postoperative complications, repeat surgery, length of stay in the intensive care unit (LOSICU), length of stay in hospital (LOSHOSP), total length of stay in hospital (intensive care and standard hospitalisation ward, TLOSHOSP) and length of mechanical ventilation (LMV).

Methods

After approval from the Ethics Committee of Necker Enfants Malades University Hospital, Paris, France, under the registration number 2017-CK-5-R1 on 21 March 2017 (Chairperson Professor Mariane de Montalembert) and after declaration of this study to the National Commission of Liberties and Computer Science, Paris, France (CNIL, Commission Nationale des Libertés et de l'Informatique) under the registration number 2028257 v0 on 21 February 2017 (Chairperson Mrs Isabelle Falque Pierrotin), 594 patients with mean age of 90.86±71.80 (± standard deviation) months where included in this study from our Hospital, Necker Enfants Malades, Paris. Inclusion criteria consisted of patients admitted for neurosurgery, orthopedic and abdominal surgery and who received blood products [packed red blood cells (PRBC) and/or fresh frozen plasma (FFP) and /or concentrated platelet units (CPU)] in the intraoperative period (transfusion group,) and patients admitted for the same surgical specialities and who did not receive any blood transfusion during surgery or in the postoperative period.

We first included the transfused patients and then patients who did not receive blood components, in order to include patients with same surgical operations whenever possible. The local Transfusion Department (EFS, Establishment Français de Sang, HôpitalUniversitaire Necker Enfants Malades) provided a list of patients who had been transfused in the operation theater from 1 January 2014 until 31 December 2016. There were 1500 transfused

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patients identified of which only 292 were finaly retained for the study because of complete data and also in order to have the same number of patients with equivalent surgical operations as in the no transfusion group. We used the operation theater programmation system (IPOP) to identifiy patients who did not receive blood products intraoperatively and postoperatively. We included 302 patients from 1 January 2014 until 17 Mai 2017 in the no transfusion group. Whenever possible, patients scheduled for similar interventions as in the transfusedgroup where included.

Medical records were analyzed using the computer medical report system (Orbis, Mediweb and Cristalnet). Data collected consisted of intraoperative and postoperative mortality occuring during hospitalisation regardless of TLOSHOSP (to assess primary outcome), intraoperative and postoperative complications which included organe failure and infections, repeat surgery, number of days spent in the intensive care unit and in the hospitalisation ward, total number of days spent in hospital, number of days spent under mechanical ventilation (to assess secondary outcome). Factors that could influence primary and secondary outcomes were collected: age, prematurity, type of surgery, comorbidities, ASA score (American Society of Anesthesiologists Score), emergency surgery, number of units of blood products administered [packed red blood cell units (PRBC), fresh frozen plasma units (FFP), concentrated platelet units (CPU], preoperative and postoperative hemoglobin and platelet concentration. The ASA score (I-V) is a scale used in anesthesia to assess patient severity physical status: ASA I: normal healty patient, ASA II: patient with mild systemic disease, ASA III: patient with severe systemic disease, ASA IV: patient with severe systemic disease which is constantly threatening life, ASA V: moribund patient who is not expected to survive without surgery. Missing data concerning patient weight, intraoperative blood loss and fluid therapy with cristalloids and colloids, coagulation analysis like international normalized ratio, activated partial thromboplastine time, fibrinogen blood levels which could influence blood transfusion were not taken into account since they were not always available.

XLSTAT 2017.4 software was used for statistics. Statistical tests included Student's test for parametrical variables, Chi square or Fischer's exact test to compare category variables; propensity score matching analysis to assess for cofounding morbi-mortality factors, logistic, log-linear regressions and multiple factor analysis (MFA) for multivariate analysis. We considered significant a p-value equals to or less than 0.05. We firstly identified risk factors with univariate analysis in each subgroup (neurosurgery, orthopedic and abdominal surgery) and then we included the three groups subgroups in one single group. Secondly we proceeded with multivariate measures: logistic, log-linear regressions and to confirm the results obtained by these, MFA was finaly realized.[4] Mean values were expressed with standard deviation (±SD) and category values are expressed as proportions.

Six risk factors were identified (ASA score, emergency surgery transfusion (units of blood products administered PRBC+FFP+CUP), age, prematurity and type of surgery) and correlated to the number deaths (mortality) during hospitalisation, number of patients with intraoperative and postoperative complications (complications), repeat surgery, number of days spent in the intensive care unit (LOSICU), in the hospitalisation ward (LOSHOSP), total number of days spent in hospital (ICU plus hospitalisation ward, TLOSHOSP), and the number of days spent under mechanical ventilation (LMV). Hemoglobin and platelet concentration were not taken into account for analysis since some of the data was not available.

Results

We included 594 patients, 292 transfused patients and 302 patients without transfusion. Table 1 illustrates some characteristics in the transfused and non-transfused patients in univariate analysis. The number of patients with complications, of repeat surgery, deaths, emergency surgery, LOSHOSP, TLOSHOSP, LMV were higher in the transfused group (T). The proportion of patients with higher ASA scores (³ IV) was bigger in the T group. Non premature patients were younger in the T group but the premature patients were concentrated in the non transfused group (NT). Table 2 illustrates, different surgical interventions. 60 different types of interventions were identified. The most frequent surgical intervention in the T group was scoliosis 63/292) followed by craniosynostosis (48/292), liver transplantation (19/292), intracerebral tumor exeresis (16/292), intestinal exeresis (14/292), neuroblastoma (13/292) and limb tumor exeresis (11/292). In the NT group, the most frequent surgery was scoliosis (61/302) followed by intracerebral tumor exeresis (38/302), intestinal exeresis (23/302), limb tumor exeresis (22/302), craniosynostosis (21/302), kidney transplantation (11/302), esophageal atresia (14/302) pelvic tumor (10/302),Chiari's Malformation (10/302).

Table 1 Characteristics in transfused and non-transfused patients

	Transfusion Group (T)	No Transfusion Group (NT)	p-value
Number of patients with complications	108	34	<0.001
Number of repeat surgery	32	11	<0.001
Number of deaths	9	2	0.03
Mean length of stay in the intensive care unit in days±SD	9.5±13.29	7.15±16.17	0.052
Mean length of stay in hospital in days±SD	15.98±23.25	6.56±9.49	<0.001
Total mean length of stay in hospital in days±SD	25.51±32.50	12.02±16.90	<0.001
Mechanical ventilation mean length in days±SD	2.78±7.2	1.12±4.20	<0.001
Number of ASA I patients	39	17	<0.01
Number of ASA II patients	58	122	<0.001
Number of ASA III patients	138	142	0.95
Number of ASA IV patients	51	20	<0.001
Number of ASA V patients	6	1	0.055
Mean number of blood component units per patient±SD	2.67±4.24	0±0	<0.001
Mean age in months±SD	82.30±72.01	99.14±70.54	<0.01
Number of premature patients	0	25	<0.001
Number of neurosurgical patients	103	103	0.77
Number of orthopedic patients	95	100	0.88
Number of abdominal surgery patients	92	99	0.74
Number of emergency operations	83	53	<0.01
Total number of patients	292	302	0.98

Citation: Kumba C, Cresci F, Picard C, et al. Transfusion and morbi-mortality factors: an observational descriptive retrospective pediatric cohort study. *J Anesth Crit Care Open Access.* 2017;8(4):11–12. DOI: 10.15406/jaccoa.2017.08.00315

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Table 2 Type of surgery

Type of surgery	Number of patients in transfusion group (T)	Number of patients in No transfusion group (NT)
Peritoneal ventriculostomy/ External Ventriculostomy	4	5
Craniosynostosis	48	21
Intracerebral genetical therapy	2	0
Aneurysm/arterio-venous malformation embolisation	2	0
Vertebral arthrodesis, spinal decompression,laminectomy	7	1
Craniotomy	2	5
Central venous catheter placement	2	0
Attached Spinal cord	1	0
Moya-Moya	1	0
Intracerebral tumor exeresis	16	38
Lefort III	1	0
Epileptogen lesion exeresis	2	6
Extradural hematoma	5	0
Subdural hematoma	0	1
Spinal cord Tumor Exeresis	2	1
Brainstem tumor exeresis	2	0
Posterior Fossa Decompression	1	0
Intracerebral lesion biopsy	1	3
Chiari's Malformation	2	10
Orbital tumor exeresis	1	1
Cerebral Cavernoma	1	2
Basal Skull Schwannoma	1	3
Trauma (exploration laparotomy)	3	0
Arachnoid cyst	0	1
Cranioplasty	0	2
Intraventricular stenting	0	2
Subdural empyema	0	1
Scoliosis	63	61
Limb amputation	2	0
Pelvic osteotomy	5	3
Femoral osteotomy	5	6
Limb Tumor exeresis	11	22
Knee prothesis	1	1
Femoral Prothesis	2	0
Interscapular thoracic desarticulation	3	3
Corset	0	4
Ano-rectal Malformation	3	1
Neuroblastoma	13	3
Liver Transplantation	19	0
Pelvic Tumor	4	10
Splenectomy	3	0
Intestinal exeresis	14	23
Pancreatectomy	1	0
Hepatic Tumor	5	1
Revascularisation/by-pass	5	0
Kidney Transplantation	6	11
Gastric Fibroscopy	3	0
Lung Lobectomy	2	0
Gastroplasty	2	3

Table Continued...

Type of surgery	Number of patients in transfusion group (T)	Number of patients in No transfusion group (NT)
Siamese Tween Separation	3	0
Cryopreservation	1	0
Kasai Operation	3	0
Exploration Laparotomy for Volvulus	2	6
Exploration Laparotomy	1	8
Ganglioneuroma	1	1
Laparoschisis	0	8
Gastrectomy	0	1
Omphalocele	0	9
Esophageal Atresia	1	14
Cysto-Ureterectomy	1	0
Total	292	302

p-value<0.0001

Table 3 illustrates the type of blood components in the transfusion group. There were 780 units of blood components (PRBC+ FFP+ CPU) administered amoung 292 patients. The most administered blood products were PRBC units (481/780), followed by FFP units (226/780 and CPU (73/780). Table 4 illustrates patients' comorbidities. 79 comorbidities were identified. In the T group, the most frequent comorbidities were hepatic failure (25/292), cerebral anoxic lesions (19/292), intracerebral tumor (14/292), Ewing sarcoma (14/292) and cancer (12/292). In the NT group, the most frequent comorbidities were intracerebral tumor (36/302), cancer (15/302), prematurity (13/302), epilepsia (13/302), Chiari's malformation type I (12/302) and hemorrhagic diathesis (10/302). Table 5 illustrates intraoperative and postoperative complications. 25 different complications were identified. In the T group there were 220 complications and 53 in NT group. In the T group the most frequent intraoperative complication was hemorrhagic shock (22/220); the most frequent postoperative organe failure complications were neurologic (20/220), cardiocirculatory (17/220) and respiratory (13/220); the most frequent postoperative infectious complications were pulmonary (33/220), abdominal (23/220), urinary (12/220); there were 34 (34/220) repeat surgeries and 9 (9/220) deaths. In the NT group the most frequent intraoperative complication was cardiac arrest (2/53), the most frequent postoperative organe failures were respiratory (8/53), neurologic (5/53); the most frequent postoperative infectious complications were pulmonary (5/53) and surgical wound sepsis (4/53); there were 11 repeat surgeries (11/53) and 2 deaths (2/53).

Table 3 Blood component units in transfusion group

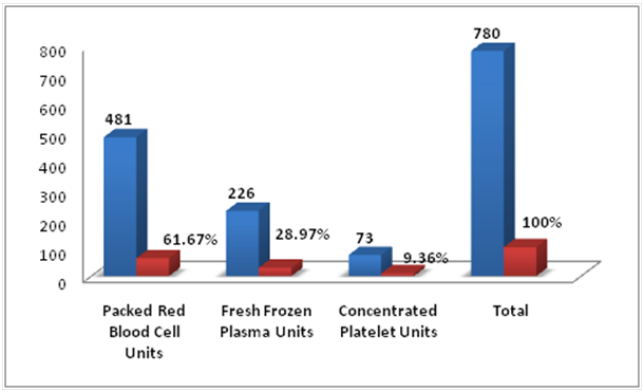

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Table 4 Comorbidities

Comorbidities	Number of Patients in Transfusion Group	Number of Patients in No Transfusion Group
Intracerebral Tumor	14	36
San Filippo Syndrome	1	0
Cerebral Aneurysm/Arterio-Venous Malformation	3	1
Crouzon Syndrome	3	3
Loeys-Dietz Syndrome	2	0
Trauma	3	4
Sickle Cell Disease	2	0
Obstructive Chronic Apneic Syndrome	1	1
Stroke	2	0
Psychomotor deficiency	8	1
Apert Syndrome	2	1
Hemorrhagic Diathesis	2	10
Bilateral Subdural Hematoma	1	1
Rachitisme	1	1
Epilespisa	6	13
Larsen Syndrome	1	0
Congenital Heart Disease	5	9
Carcinomateous Meningitis	1	0
Asthma	1	1
Neurofibromatosis	9	5
Bourneville's Sclerosis	1	0
Head Trauma	1	1
Endocarditis	1	0
Tracheomalacia	1	0
Brainstem lesion	1	0
Achondroplasia	1	0
Cyphosis/Scoliosis/Vertebrae Hypoplasia	2	0
Klippel-Feil Syndrome	1	0
Metachromic Leucodystrophy	1	0
Spinal Cord Tumor	1	0
Chiari Malformation Type 1	1	12
Intracerebral Hypertension	0	2
Saerthre-Chotzen Syndrome	0	1
Arachnoid Cyst	0	1
Morquio Syndrome	0	1
Complexe polymalformation Syndrome with metabolic and heart disease	0	1
Extradural Hematoma	0	1
History of prematurity	2	2
Cerebral anoxic lesions	19	11
Osteogenesis Imperfecta	3	2
Ewing Sarcoma	14	5
Myelomeningocele	4	0
Hurler Syndrome	2	0
Epileptic Encephalopathy	3	0
Arcadi Syndrome	1	0
Arthritis	0	9
Severe Sepsis	1	0
Lowe Syndrome	1	0
Spinal Muscular Amyotrophy	2	0
Spina Bifida	1	1
Di George Syndrome	2	0
Central Core Myopathy	1	0
Goldenhar Syndrome	1	0
Williams Syndrome	1	0
Pierre-Robin Syndrome	1	1
Muscular Dystrophy	0	2
Rett Syndrome	1	0

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Table Continued...

Comorbidities	Number of Patients in Transfusion Group	Number of Patients in No Transfusion Group
Sarcoïdosis	0	1
Scoliosis	1	0
Xeroderma Pigmentosum	0	1
Gorlin Syndrome	4	0
Hepatic Failure	25	0
Immune Deficiency	1	0
Metabolic Disease	1	0
Chronic Kidney Failure	7	10
Transplantation	2	0
Necrotizing Enterocolitis	2	4
Cancer	12	15
Cystic Fibrosis Disease	1	0
Crohn Disease	0	1
Duodenal Atresia	0	1
Mediastinal Tumor	0	1
Prematurity	0	13
Chronic intestinal Pseudo-occlusion	0	3
Broncho-Pulmonary Dysplasia	0	1
Intraauricular Thrombus	0	1
Hepatoblastoma	0	1
Hirschprung	1	2
Polymalformative syndrome	4	8
Prader Willi Syndrome	0	2
None	91	97
Total	292	302

p-value <0.0001

Table 5 Number of complications in Transfusion/No Tranfusion Group

Complications	Number of Complications Transfusion Group (T)	Number of Complications No Transfusion Group (NT)	p-value
Intraoperative complications			
Hemorrhagic Shock	22	1	
Anaphylaxis	2	0	
Cardiac Arrest	0	2	
Broncho-Laryngospasm	2	1	
Difficult Intubation	1	0	
Respiratory Distress Syndrome	1	0	
Postoperative organe failure			
Neurologic	20	5	
Cardiocirculatory	17	1	
Respiratory	13	8	
Kidney	3	1	
Hepatic	2	0	
Endocrinal	0	2	
Multisystemic	7	2	
Miscellaneous	3	0	
Hemorrhagic Shock	2	0	
Anaphylaxis	1	0	
Postoperative infections			
Pulmonary sepsis	33	5	
Abdominal sepsis	23	1	
Urinary Tract sepsis	12	0	
Mediastinal sepsis	0	0	
Neuro-meningeal sepsis	2	0	
Septic Choc	0	0	
Surgical Wound Sepsis	8	4	
Septicemia	3	5	
Generalized Sepsis	0	2	
Repeat Surgery	34	11	
Deaths	9	2	
Total	220	53	<0.01

After multivariate analysis with logistic regression for complications, repeat surgery and mortality, results are shown in tables 6 to 8 and ROC curves are illustrated in Figures 1-3. Figures 4-6 illustrate the contributions of each risk factor to mortality, complications and to repeat surgery. ASA score is the independent risk factor for mortality in this cohort study (Table 6). ASA score, transfusion, emergency surgery and abdominal surgery are independent risk factors for complications (Table 7). Emergency surgery, transfusion and orthopedic surgery are independent risk factors for repeat surgery (Table 8). The ROC curves show that the area under the curve (AUC) equals 1 for mortality (Figure 1), 0.8 for complications and repeat surgery (Figures 2 & 3). The contribution of each risk factor is illustrated in Figure 4 (mortality), Figure 5 (complications) and Figure 6 (repeat surgery).

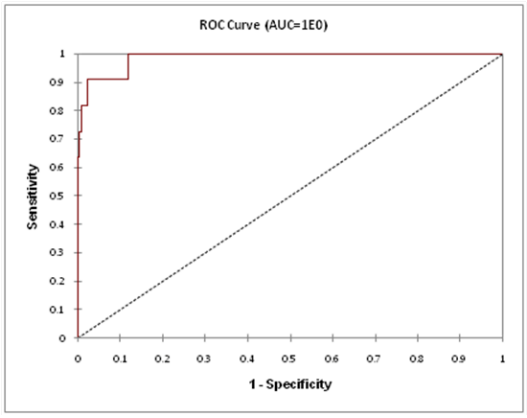

Figure 1 Mortality ROC curve.

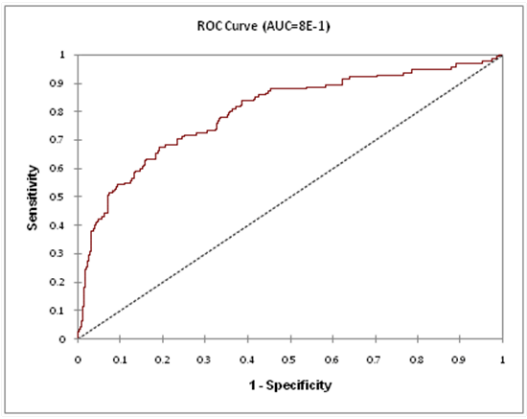

Figure 2 Complications ROC curve.

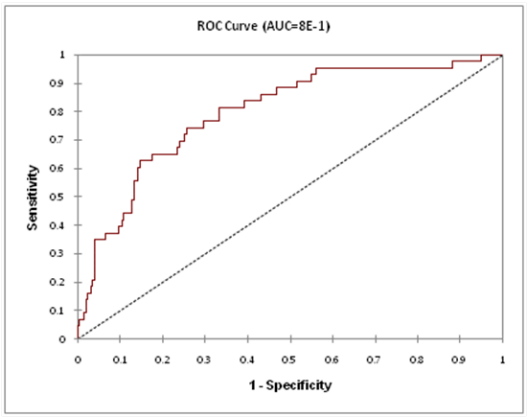

Figure 3 Repeat surgery ROC curve.

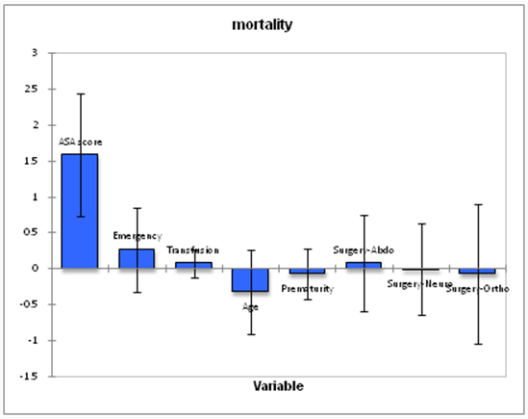

Figure 4 Contribution of each risk factor to mortality.

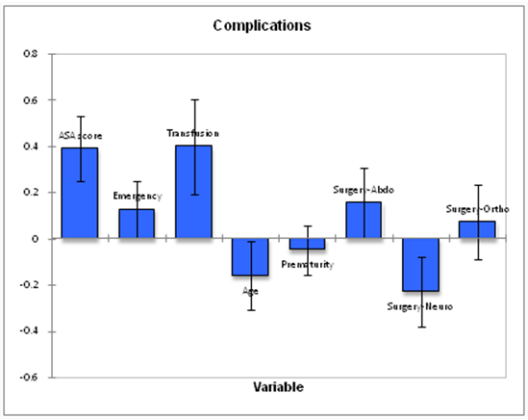

Figure 5 Contribution of each risk factor to complications.

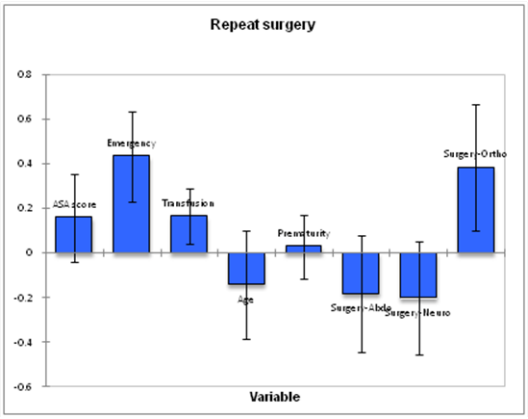

Figure 6 Contribution of each risk factor to complications.

Log linear regression was realised for LOSICU, LOSHOSP, TLOSHOSP and LMV (length of mechanical ventilation) and the results are shown in tables 9-12. ASA score, emergency surgery, transfusion, age, prematurity and abdominal surgery are independent risk factors for length of stay in the intensive care unit (Table 9). ASA score, transfusion, age and abdominal surgery are independent risk factors for LOSHOSP (Table 10). ASA score, emergency surgery, transfusion, age and abdominal surgery are independent risk factors for TLOSHOSP (Table 11). ASA score, emergency surgery, transfusion, age and prematurity are independent risk factors for length of mechanical ventilation (Table 12). Propensity score

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matching (PMS) analysis revealed that 100% of transfused patients 97% of non-transfused patients (Table 13), 100% of patients who died, 100% of those who presented with repeat surgery and 99% of patients with complications were matched in this cohort study. Multiple factor analysis (MFA) (Table 14) confirmed the results obtained with logistic and log linear regressions.

Table 6 Logistic regression for mortality

Independent Variable	Odds Ratio	Confidence Interval 95% Odds Ratio	p-value
ASA score	28.73	4.65-177.47	<0.001
Emergency	3.11	0.25-38.48	0.38
Transfusion	1.04	0.93-1.16	0.47
Age	0.992	0.977-1.07	0.28
Prematurity	0.511	0.020-12.94	0.68
Abdominal Surgery	1.18	0.26-4.08	0.83
Neurosurgery	0.996	0.24-4.08	0.99
Orthopedic Surgery	0.85	0.097-7.35	0.88

Table 7 Logistic regression for complications

Independent Variable	Odds Ratio	Confidence Interval 95% Odds Ratio	p-value
ASA score	2.3	1.71-3.09	<0.0001
Emergency	1.73	1.01-2.97	0.045
Transfusion	1.25	1.11-1.40	<0.0001
Age	0.99	0.992-0.997	0.033
Prematurity	0.65	0.25-1.69	0.38
Abdominal Surgery	1.42	1.01-1.99	0.043
Neurosurgery	0.6	0.43-0.84	<0.01
Orthopedic Surgery	1.17	0.82-1.67	0.39

Table 8 Logistic regession for repeat surgery

Independent Variable	Odds Ratio	Confidence Interval 95% Odds Ratio	p-value
ASA score	1.4	0.92-2.13	0.11
Emergency	6.49	2.72-15.48	<0.0001
Transfusion	1.09	1.02-1.17	<0.01
Age	0.996	0.990-1.002	0.26
Prematurity	1.3	0.36-4.79	0.69
Abdominal Surgery	0.66	0.37-1.19	0.17
Neurosurgery	0.64	0.36-1.12	0.12
Orthopedic Surgery	2.35	1.25-4.43	<0.01

Table 9 Log linear regression for LOSICU (length of stay in the intensive care unit)

Independent Variable	Wald Value	Confidence Interval 95% Wald Value	p-value
ASA score	0.45	0.41-0.49	<0.0001
Emergency	0.48	0.41-0.55	<0.0001
Transfusion	0.02	0.019-0.030	<0.0001
Age	-0.003	0.004-(-0.003)	<0.0001
Prematurity	0.593	0.508-0.748	<0.0001
Abdominal Surgery	0.65	0.551-0.748	<0.0001
Neurosurgery	-0.123	0.225-(-0.002)	0.018
Orthopedic Surgery	0	NA	NA

Table 10 Log linear regression for LOSHOSP (length of stay in hospitalisation wardl)

Independent Variable	Wald Value	Confidence Interval 95% Wald Value	p-value
ASA score	0.25	0.23-0.29	<0.0001
Emergency	0.058	-0.1224	0.064
Transfusion	0.03	0.026-0.035	<0.0001
Age	-0.0013	-0.0026	<0.0001
Prematurity	-0.442	-0.217	<0.0001
Abdominal Surgery	0.589	0.521-0.656	<0.0001
Neurosurgery	-1.27	-0.19	<0.0001
Orthopedic Surgery	0	NA	NA

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Table 11 Log linear regression for TLOSHOSP (Total length of stay in hospital = ICU + Hospitalisation ward)

Independent Variable	Wald Value	Confidence Interval 95% Wald Value	p-value
ASA score	0.31	0.29-0.34	<0.0001
Emergency	0.35	0.31-0.40	<0.0001
Transfusion	0.03	0.02-0.032	<0.0001
Age	-0.0019	-0.0007	<0.0001
Prematurity	-0.0997	-0.1431	<0.01
Abdominal Surgery	0.545	0.49-0.60	<0.0001
Neurosurgery	-0.73	-1.457	<0.0001
Orthopedic Surgery	0	NA	NA

Table 12 Log linear regression for LMV (length of mechanical ventilation)

Independent Variable	Wald Value	Confidence Interval 95% Wald Value	p-value
ASA score	0.733	0.652-0.814	<0.0001
Emergency	0.83	0.67-0.986	<0.0001
Transfusion	0.043	0.033-0.052	<0.0001
Age	-0.007	-0.0023	<0.0001
Prematurity	0.37	0.18-0.56	<0.001
Abdominal Surgery	0.0039	-0.445	0.73
Neurosurgery	-0.172	-0.4342	0.12
Orthopedic Surgery	0	NA	NA

Table 13 Propensity score matching

Summary of the matched observations					
Categories	Number	Matched	Percentages	Unmatched	Percentages
Transfusion	292	292	100%	0	0%
No Transfusion	302	292	97%	10	3%

Table 14 Multiple factor analysis: contribution of each variable in different axes (or factors), F1, F2…F13

Contribution of the variables (%):													
	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13
Complications	8	2	1	0	1	1	0	5	3	46	34	0	0
Repeat surgery	6	1	0	1	2	5	8	1	55	1	20	0	0
Deaths	3	0	9	11	1	7	3	22	1	33	8	3	0
LOSICU	14	0	3	1	2	4	0	2	2	0	0	56	16
LOSHOSP	7	3	1	15	1	2	20	1	1	8	1	15	25
TLOSHOSP	14	1	1	11	0	0	9	0	0	3	0	2	59
Mechanical ventilation	17	0	0	0	32	6	14	1	11	1	0	19	0
ASA score	7	7	0	43	0	1	20	2	1	3	16	0	0
Emergency	12	4	0	7	16	23	2	30	3	0	2	1	0
Transfusion	6	6	22	2	34	22	6	1	0	0	1	0	0
Age	3	36	1	5	1	5	0	26	5	5	14	0	0
Prematurity	4	12	35	5	7	15	1	2	11	2	4	3	0
Surgery	0	27	28	1	3	8	17	7	8	0	2	0	0

Disscussion

Our study has shown that in this pediatric retrospective cohort study, perioperative and postoperative mortality and morbidity were determined by multiple factors. We focused on some of these factors: transfusion, ASA score, emergency surgery, type of surgery, age and prematurity. Studies in pediatric cardiac surgery and critically ill pediatric patients have reported the role of transfusion as an independent morbi-mortality factor. This survey concerned critically ill pediatric patients from the intraoperative and the postoperative period to discharge from hospital. Transfusion was not found in our study to be an independent risk factor for mortality but as an independent risk factor for morbidity as assessed by intra and postoperative complications, repeat surgery, LOSICU, LOSHSOP, TLOSHOSP and LMV. ASA score (^{3}III) was the independent risk factor for mortality. Univariate analysis showed that in the transfusion group there were more complications, more repeat surgery; mortality, LOSICU, LOSHOSP, TLOSHOSP LMV and ASA score were higher than in the no transfusion group. This could be explained in part by the selection bias of our study but still the same results were obtained when analyzing the three subgroups separately (neurosurgery, orthopedics and abdominal surgery) (data was not shown here to simplify the results) and propensity score matching analysis showed that 100% of the transfused and 97% non transfused patients were matched.

Nevertheless, patients who needed transfusion had more comorbidities, higher ASA scores thus were more critically ill and were much more exposed to hemorrhagic surgery (liver transplantation, craniosynostosis, scoliosis, trauma…). Multivariate analysis when considering all patients in the same group revealed other multiple

independent morbidity factors: emergency surgery, type of surgery, age, and prematurity. Our study highlightened some factors which were only the visible part of the iceberg since perioperative and postoperative morbi-mortality is multifactorial. Other factors that could influence patient outcome like hemoglobin concentration, weight, fluid therapy with colloids and cristalloids, blood loss, type of anesthesia (all patients had general anesthesia in this study) and organisational aspects were not analysed here. LOSICU, LOSHOSP, TLOSHOSP and LMV depend upon several factors and those analysed in our study are far from being exhaustive but they can help to understand some aspects implicated in morbidity.

Patient outcome can be improved by reducing morbi-mortality risk factors. Since ASA score is the independent mortality risk factor in this study, perioperative management of high ASA score patients should be adapted to patient status and surgery. Optimizing transfusion strategies could improve patient outcome, studies have reported the physiopathology underlying some transfusion related complications.[5,6] Exposure to blood products can be reduced by applying restrictive transfusion strategies,[7] using transfusion protocols based on bedside viscoelastic methods to guide blood components administration during hemorrhagic surgery like liver transplantation, craniosynostosis, scoliosis and trauma.[8-13] Emergency surgery is an independent risk factor for morbidity, only urgent interventions should be realised during emergency periods and non urgent operations realised electively.

Age is also an independent factor for morbidity. A recent prospective multicenter study reported the importance for management of pediatric patients under a certain age in specialiazed centers, the importance of a good training and supervision environment.[14] Our survey enlarged the analysis on transfusion and morbi- mortality factors to critically ill pediatric patients in neurosurgery, abdominal and orthopedic surgery. Our survey enlarged the analysis on transfusion and morbi-mortality factors to critically ill pediatric patients in neurosurgery, abdominal and orthopedic surgery. We focused on these three groups since we did not find a lot of data concerning this subject in these particular fields.

We deliberately included the three subspecialities in one group because univariate analysis of each subgroup revealed the same results as the all in one group. We do not pretend to have analysed all morbi-mortality risk factors in our study but only some of those factors which were accessible and thus analysable. Identifying morbi-mortality factor is one of the first steps towards patient outcome improvement. Once these factors are identified, preventive measures can be applied. Our study had limits: it was retrospective, monocenter, some data concerning factors which could influence outcome was missing. More prospective multicenter studies are needed to analyse the invisible part of the iceberg which contains the multiple morbi-mortality factors.

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Conflicts of interest

None.

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