



## Transfusion in Pediatric Surgical Settings: Economic Aspects and Hospitalization Costs

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### Abstract

**Background:** An observational study published in 2017 revealed transfusion as one of the predictive factor of outcome in surgical children in terms of organ dysfunction, length of intensive care unit stay, length of hospital stay and length of mechanical ventilation. Transfusion can be a necessity and life-saving intervention in patients. Balancing the benefits and risks of this therapeutic intervention is mandatory to improve patient outcome. Patient blood product management protocols reduce transfusion needs and length of hospital stay. A second analysis was undertaken to determine hospitalization costs in transfused and non-transfused patients in the observational study in children published in 2017.

**Objectives:** To determine the hospitalization costs of transfused and non-transfused patients of the observational study in 594 pediatric neurosurgery, abdominal and orthopedic surgery patients published in 2017.

**Methods:** Second analysis of the database of 594 pediatric surgical patients of the observational study published in 2017.

**Results:** Median total hospitalization costs in transfused patients were significantly twice higher {32041.97 euros [13983.82-59003.59]} than in non-transfused patients {14084.45 euros [8551.2-29124.55]},  $p < 0.0001$ .

**Keywords:** Transfusion; Pediatric Surgical Settings; Hospitalization Costs

### Introduction

An observational study was undertaken in 2017 to determine predictive factors of postoperative outcome in 594 pediatric surgical patients in neurosurgery, abdominal and orthopedic surgery [1-4]. Among other predictive factors of postoperative outcome, transfusion was identified as an independent predictive factor of morbidity in terms of organ dysfunction, infections, length of intensive care unit stay (LOSICU), length of mechanical ventilation (LMV) and length of hospital stay (LOS). Another retrospective study on 41 children with scoliosis surgery identified transfusion

as a factor correlated to postoperative complications and LOS [5]. In hemorrhagic surgery, transfusion can be a necessity and a life-saving therapeutic mean. In trauma patients, hemorrhagic shock is a leading cause of adverse outcome in terms of mortality. Anemia in children has also been related to morbi-mortality [6]. Transfusion, hemorrhage and anemia related adverse outcomes should be put into balance in patient blood product management protocols. A systematic review and meta-analysis in hemorrhagic pediatric surgery evidenced that transfusion guided protocols with point of care (POC) tests reduced fresh frozen plasma transfusion and length of

hospital length [7]. The mechanisms underlying transfusion related adverse outcomes have been studied and these include mainly immunologic reactions in critically ill immune compromised and immune competent patients receiving blood products [8]. All sorts of blood products have been implicated that is to say red blood cells, fresh frozen plasma and platelets [1]. This implies the necessity of developing transfusion protocols guided with POC tests to optimize patient blood product management with the aim to improve patient outcome.

One other aspect concerning transfusion is economic and includes hospitalization costs.

Intuitively, taking into account the results of the previous studies [1-5,7], transfused patients have high hospitalization costs which are related to the critical illness and the increased LOSICU, LMV and LOS [1].

This study undertook a second analysis of the results of the previous study [1] with the primary objective to determine the hospitalization costs among transfused and non-transfused patients in this cohort of 594 patients since this analysis was not realized then. The second objective was to demonstrate whether transfused patients had higher hospitalization costs compared to non-transfused patients in this cohort. Considering the results of the previous systematic review and meta-analysis on the impact of transfusion guided protocols with POC tests in hemorrhagic settings in children [7], hospitalization and transfusion costs could be reduced with these protocols by shaping and optimizing patient blood product management. The results of this second analysis serves as evidence to develop transfusion guided protocols with POC devices for patient blood management since these protocols have not been developed in our Hospital. These protocols have the aim to optimize outcome and hospitalization costs related to transfusion in children. The rationale is that when transfusion guided with POC devices protocols are integrated in patient blood management in hemorrhagic surgery, outcome and hospitalization costs are improved. This study is part of the Thesis entitled "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)" [9].

## Methods

The local ethic committee in 2017 approved the study [1].

The database of the previous study [1] in transfused and non-transfused patients was analyzed in terms of quantity of administered blood products, in terms of number of days spent in the intensive care unit (LOSICU) and the number of days spent in the standard hospitalization ward (LOS) and the total number of days spent during the entire hospitalization that is to say LOSICU+LOS. The costs of total blood products and the costs of hospitalization were calculated with reference to the official costs published by the Authorities [10,11]. According to the official references, costs were in euros with ICU daily hospitalization costing 2819.89 euros and daily surgical hospitalization costing 1710.24 euros considering a 100% price. A packed red blood cell unit costed 187.33 euros, a fresh frozen plasma unit costed 99.06 euros and a concentrated platelet unit costed 76.45 euros.

Statistics were analyzed with XLSTAT 2020.4.1.

Variables were compared with Mann Whitney U test. Variables were expressed in medians with interquartile ranges.

## Results

There were 302 non-transfused patients from neurosurgery (103 patients), abdominal (99 patients) and orthopedic surgery (100 patients): median ICU hospitalization cost was 7042.23 euros [704.22 - 16901.34], median conventional hospitalization cost was 6840.96 euros [3420.48 - 11971.68] and median total hospitalization cost (ICU+ conventional hospitalization ward) was 14084.45 euros [8551.2 - 29124.55].

There were 292 transfused patients from neurosurgery (103 patients), abdominal (94 patients) and orthopedic surgery (95 patients): median ICU hospitalization cost was 14084.45 euros [8450.67 - 28168.9], median conventional hospitalization cost was 17102.4 euros [5130.72 - 30784.32] and median total hospitalization cost (ICU+conventional hospitalization ward) was 32041.97 euros [13983.82 - 59003.59].

The median ICU hospitalization, median conventional hospitalization and the median total hospitalization costs (ICU+ conventional hospitalization) were significantly higher in the transfused patients ( $p < 0.0001$ ) (Table 1).

The median cost of all transfused blood products (packed red blood cells+ fresh frozen plasma+ platelets) was 187.33 euros [187.33 - 374.66].

	Non-transfused patients (n = 302)	Transfused patients (n = 292)	p-value
Median ICU hospitalization costs in euros	7042.23 [704.22 - 16901.34]	14084.45 [8450.67 - 28168.9]	< 0.0001
Median conventional hospitalization costs in euros	6840.96 [3420.48 - 11971.68]	17102.4 [5130.72 - 30784.32]	< 0.0001
Median total hospitalization costs in euros	14084.45 [8551.2 - 29124.55]	32041.97 [13983.82 - 59003.59]	< 0.0001
Median total blood product costs in euros	0	187.33 [187.33 - 374.66]	< 0.0001

**Table 1:** Hospitalization and blood product costs.

## Discussion

Patient blood management protocols are necessary to improve patient outcome in transfused patients. A meta-analysis in children revealed that POC devices to guide transfusion in hemorrhagic surgery namely cardiac surgery, trauma, liver transplantation, and craniosynostosis reduced fresh frozen plasma and LOS in transfused patients compared to those who were managed without POC tests [7]. Reducing transfusion and LOS can decrease hospitalization costs. Transfusion can be a life- saving therapeutic intervention, but it should be administered with caution in critically ill patients since it is related to adverse outcome in terms of organ dysfunction, LOSICU, LMV and LOS. Shaping patient blood management with POC tests can improve outcome and decrease hospitalization costs. This second analysis revealed that transfused patients have hospitalization costs which were more than twice higher than in non-transfused patients which was due to higher LOSICU and LOS in transfused patients. In the primary analysis of the previous study [1], packed red blood cells were the most transfused blood products, followed by fresh frozen plasma and platelet units. The systematic review and meta-analysis in pediatric hemorrhagic surgery revealed that POC tests integrated in transfusion protocols reduced FFP transfusion and LOS [7] hence this can improve outcome in transfused patients since FFP administration and increased LOS have been related to adverse outcome. Transfusion of all types of blood products has been related to adverse outcome in terms of organ dysfunction, LOSICU, LMV and LOS [1]. Transfused patients had more complications, had increased LOS and were more critically ill than non-transfused patients. Among the reported postoperative organ dysfunctions in this cohort of 594 children, the most common were respiratory (16%), re-surgery (16%), neuro-meningeal (9%), abdominal (8%), cardiocirculatory (6.6%), urinary (4%), surgical wound infections (4%), deaths (4%) and renal (1.46%) complications [1].

Patient blood management protocols with POC should be part of the general patient management in hemorrhagic surgery in order to improve postoperative outcome, LOS and hospitalization costs. These protocols need to be implemented in our Hospital to manage hemorrhagic surgery and optimize patient outcome.

## Conclusion

This secondary analysis revealed that hospitalization costs were more than twice higher in transfused than non-transfused patients. These results emphasize the importance of implementing patient blood management protocols with POC tests in hemorrhagic surgery to optimize transfusion with the aim to improve outcome and reduce hospitalization costs in patients since these protocols are not yet implemented in our Hospital.

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