Original Article

Blood Transfusion and Lung Surgeries in Pediatric Age Group: A Single Center Retrospective Study

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Abstract

Background: Blood transfusion is not without harm, and recent studies suggest association between transfusion and poor outcome in critically ill patients. Although it is prescribed for many reasons based on the firm belief that blood transfusion improves oxygen carrying capacity, it carries notable adverse hazards. Importantly, lung surgeries are counted as moderate to high-risk operations and take a significant risk of blood loss. **Aim:** This study aims to reveal the association between blood transfusion and poor clinical outcomes and characterize the epidemiology of blood transfusion after pediatric chest surgery. **Settings and Design:** Retrospective cohort study, done throughout 3 years. **Materials and Methods:** A total of 248 patients who underwent open thoracotomy and lung surgery and aged ≤18 years were classified according to the need of intraoperative or postoperative blood transfusion into two groups: Group I (non-transfused = 130) and Group II (transfused = 118). **Statistical Analysis:** SPSS v25 was used for analysis. **Results:** Transfusion probability ranged between 42.8% and 50% according to type of surgery. As regard to postoperative variables, there was no significant difference between both groups regarding the duration of analgesia, allergic reactions, need of re-operation and in-hospital mortality. However, transfused group showed significant increase in duration of antibiotic, persistent postoperative fever, time to remove chest drains, ICU stays, hospital stay and pneumonia. Incidence of pneumonia had a relative risk 1.82 with transfused compared to non-transfused group. **Conclusion:** Transfusion group in pediatrics undergoing lung surgeries in our study was more prone to adverse outcomes such as pneumonia, delayed time to remove chest drains, prolonged ICU stay, and hospital stay.

Keywords: *Blood transfusion, lung surgeries, pediatrics, retrospective study*

Introduction

Blood transfusion is a mainstay and standard therapeutic option for blood loss and severely anemic patients if maximum medical strategies fail. Blood transfusion is not without harm, recent studies suggest a correlation between transfusion and poor outcome in critically ill patients.[1,2] Although blood is prescribed for many reasons based on the firm belief that it improves oxygen carrying capacity, it carries many adverse hazards.[3]

Importantly, lung surgeries are counted as moderate to high-risk operations and take a significant risk of blood loss. The amount of blood loss can significantly vary depending on the pathology of the disease and nature of the surgery.[4] Evidence from many studies indicated that the incidence of patient's re-exploration in thoracic surgery for bleeding ranges from 1% to 3.7% and the rate of blood transfusion ranges from 20% to 52%.[5,6]

Little published works are identifying the requirements of blood transfusion during different types of lung surgeries and mostly comes from western world experiences.[7,8] Transfusion probability (%T) is defined as the number of patients transfused divided by some patients cross-matched and multiplied by 100, according to Mead's criteria; a value of 30% or more is indicative of efficient blood usage.[9] Apart from the risk of infection transmission (includes both existing and emerging pathogens), the outcome data of blood transfusion therapy hasn't always been favorable, particularly in the issues of postoperative infection, systemic inflammatory response syndrome (SIRS), multi-organ failure and mortality.[10]

This study aims to reveal the association between blood transfusion and poor clinical

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outcomes and characterize the epidemiology of blood transfusion after pediatric chest surgery.

Materials and Methods

It is a retrospective cohort study over 3 years from January 2015 to December 2017 at Cardio-thoracic Surgery Department, Tanta University Hospitals. The medical records of all patients were reviewed for the 3-year period and 248 patients who underwent open thoracotomy and major lung surgery and aged 18 years or younger were included. Patients undergoing emergency surgery, redo surgery, minor procedures like biopsy or thoracotomy for non-pulmonary operations were excluded.

Patient charts were identified by screening of a database into which data were entered prospectively. Demographic variables (e.g., age, sex, weight), comorbid conditions, diagnosis, and nature of the disease (tuberculosis or not), surgery done, baseline hemoglobin (Hb), final Hb at the end of the operation and number of blood units cross-matched and transfused were recorded in the study.

Information concerning blood products included the use of allogenic whole blood, red cells, platelets, and plasma either intraoperative or postoperative. Three units of whole blood or red cells concentrate (PRBCs) are routinely cross-matched, reserved and ordered in addition to two units of fresh frozen plasma (FFP) and two units of platelets are reserved for each patient. Intraoperative transfusion was at the carefulness of the anesthetist in charge of the case.

Transfusion probability (%T) and the need for postoperative blood transfusion (determined by the intercostal drainage and when postoperative Hb was <8 g/dl) were reviewed and analyzed.

The postoperative variables such as duration of analgesic, duration of antibiotic, persistent postoperative fever, allergic reactions, need of re-operation, in-hospital mortality, and time to remove chest drains, intensive care unit (ICU) stay, hospital stay and rate of infection were reviewed and analyzed.

Technique

Under general anesthesia, the standard surgical approach was lateral thoracotomy (anterior, mid and posterior). Types of surgical procedure were as shown in [Table 1]. At the end of the procedure, routine hemostasis was performed, and all bleeding points were secured. Thoracotomy was closed in layers, and two chest tubes were inserted for drainage and connected to underwater seal system. Chest tubes were removed sequentially if no bleeding, no effusion, no fever, no air leakage, totally expanded lung by serial chest X-ray and pleural drainage were <100 cc/day.

Statistical analysis

Our primary outcome is the incidence of pneumonia and the secondary outcomes are time to remove chest drains, ICU stay, and hospital stay. The sample size was calculated to be at least 114 in each group at a power of 95%, α error 0.05 with relative risk 3.7 in transfused patients and expected incidence in non-transfused patients 0.06 derived from a previous study.[11]

The data was analyzed using SPSS v25 (IBM, Armonk, NY, USA). Parametric variables were expressed as mean ± SD and compared by Student's T-test. Non-parametric variables were expressed as median, interquartile range and compared by Mann-Whitney U test. Categorical variables were expressed as frequency of occurrence and percentage and compared by Chi-square. P value ≤ 0.05 was considered significant.

Results

A total of 248 patients were included for final analysis. Those patients are classified into two main groups according to the need of blood transfusion, Group I (non-transfused group = 130 patients) and Group II (transfused group = 118 patients).

%T ranged between 42.8% and 50% according to type of surgery. The demographic details, comorbid conditions, tuberculosis and Hb were comparable in both groups [Table 1]. Surgical categories in both groups and %T are tabulated in Table 2.

Sixty-six out of 118 patients (55.9%) in group II received blood or blood products intraoperative. Less than 5% of the patients received platelets only, 11% received FFP only, and almost one-third of the patients received more than one component [Table 3].

As regard to postoperative variables, there were no significant differences between group I and group II in the duration of analgesia, allergic reactions, need of re-operation and in-hospital mortality. However, transfused group showed significant increase in duration of antibiotic, persistent postoperative fever, time to remove chest drains, ICU stay, hospital stay and infection (pneumonia) [Table 4]. Incidence of pneumonia had a relative risk 1.82 with transfused

Table 1: Patient demographics, comorbid conditions, tuberculosis and hemoglobin

Variables	Group I: Non-transfused (*n*=130)	Group II: Transfused (*n*=118)	*P*
Age (years)	7.2±3.4	6.9±4.2	0.535†
Sex (female)	35 (26.9%)	31 (26.3%)	0.908‡
Weight (Kg)	28.6±10.2	27.8±9.1	0.904†
Comorbid conditions			
Type 1 Diabetes	2 (1.5%)	1 (0.85%)	1§
COPD	5 (3.8%)	4 (3.4%)	1§
Tuberculosis	7 (5.3%)	4 (3.4%)	0.545§
Baseline hemoglobin	12.5±1.77	11.9±1.8	0.919†
Final hemoglobin	9.8±1.3	10.1±1.4	0.081

†By Student's *t*-test, ‡By Chi-square §By Fisher's Exact. Data expressed as mean±SD or frequency and percentage

compared to non-transfused group with 95% confidence interval: 1.364-2.43. Most of infection (9 cases, 75%) occurred with transfusion of more than one component.

Discussion

Although postoperative blood transfusion is not supported by high level of evidence, the Society of Thoracic Surgeons recommends transfusion in all patients with postoperative HB <7 gm/dL; a valid recommendation to adult and pediatric patients.[12] It may frequently lead to immune and non-immune mediated reactions such as febrile non-hemolytic transfusion reaction, hemolytic reaction, allergies, microcirculatory changes, transfusion-associated circulatory overload and infections.[13-15]

Lung surgeries are technically demanding procedures that are positively associated with a higher volume of intraoperative blood loss due to either accidental venous, arterial or oozing-type bleeding related to dense adhesion among lung lobes, mediastinum and chest wall.[8]

In the present study, 47.6% of our patients required blood product transfusion. Several studies were in agreement with our results and reported that the incidence of blood transfusion was between 20% and 52%.[5,7] Others found that 58.6% of patients of lung surgeries required blood.

In our work, we found that the %T varies between 42.8% and 50% according to type of surgery (a value equal to 30% or more point out the convenience of the number of units cross-matched).[9] Our findings are not entirely in line with some of the results published by other authors,[7] who showed a %T of 47.7% for lobectomy and pneumonectomy and 15.9% for local or segmental resection. Moreover, only 20% of patients undergoing lobectomy were transfused in another study.[8] This could be explained by the fact that blood transfusion can vary entirely across various surgical procedures within the same specialty.

Growing evidence underlines that blood transfusion causes adverse effects and is associated with poor outcome risk

Table 2: Surgical categories in both groups and transfusion probability (%T)

Surgery type	Group I: Non-transfused	Group II: Transfused	%T†
Upper lobectomy	25	21	45.6%
Middle lobectomy	6	5	45.4%
Lower lobectomy	27	24	47%
Bi-lobectomy	5	5	50%
Pneumonectomy	4	3	42.8%
Decortication	40	38	48.7%
Others‡	23	22	48.8%
Total	130	118	47.6%

†Transfusion probability (T %) = number of patients transfused ÷ total number of patients cross-matched × 100. ‡Others=Bullectomy, lingulectomy, lung abscess drainage, Hydatid cyst excision, and wedge resection

Table 3: Type and timing of blood transfusion in group II according to type of surgery

Timing and type of transfusion	Upper lobectomy (*n*=21)	Middle lobectomy (*n*=5)	Lower lobectomy (*n*=24)	Bi-lobectomy (*n*=5)	Pneumonectomy (*n*=3)	Decortication (*n*=38)	Others (*n*=22)	Total number (*n*=118)
Peri-operative	15	2	14	5	3	20	7	66 (56%)
Postoperative	6	3	10	0	0	18	15	52 (44%)
Whole blood	8	0	10	0	0	7	2	27 (22.8%)
Packed RBCs	5	5	6	5	0	11	8	40 (33.8%)
FFP†	4	0	2	0	0	5	2	13 (11%)
Platelet	3	0	0	0	0	2	0	5 (4.2%)
More than one component‡	1	0	6	0	3	13	10	33 (27.9%)

†FFP: Fresh frozen plasma, ‡More than one component: whole blood or packed RBCs in addition to FFP and platelet

Table 4: Postoperative variables in group I and group II

Variables	Group I: Non-transfused (*n*=130)	Group II: Transfused (*n*=118)	*P*
Duration of analgesic (days)	5.4±2.3	5.8±2.5	0.191†
Duration of antibiotics (days)	6.3±3.3	7.9±3.7	<0.001†*
Persistent fever (days)	3.3±1.2	4.6±2.1	<0.001†*
Allergic reaction	0	1 (0.8%)	0.51‡
Time to remove CD (days)	3.1 (2-6)	6.3 (3-8)	<0.001*
ICU stay (days)	1.5 (1-3)	3 (1-5)	<0.001*
Hospital stay (days)	5 (4-7)	8 (5-10)	<0.001*
Infection (pneumonia)	2 (1.5%)	10 (8.5%)	0.015‡*
Re-operation	1 (0.8%)	3 (2.5%)	0.09‡
In-hospital mortality	0	2 (1.7%)	1‡

†By Student's *t*-test, ‡By Fisher's Exact, *Significant as *P*<0.05. Data expressed as (mean±SD), (median and interquartile range) or (frequency and percentage). CD: Chest drain, ICU: Intensive care unit

factor especially in critically ill children.[16] Our study demonstrated that time to remove the chest drain, ICU stay, hospital stay and incidence of pneumonia after surgery all are significantly higher in transfused compared to non-transfused patients.

Recent data[17] support RBC transfusion association with morbidity and adverse outcomes in children undergoing cardiac surgery. In a series done by Costello and colleagues[18] elucidated that postoperative exposure to three or more RBC transfusions was associated with an eightfold increase in the risk of infection. Salvin *et al*.[19] studied 802 postoperative admissions to cardiac ICU and they found that RBC transfusion in younger and acutely ill was associated with a prolonged hospital stay.

Also, many studies have documented the risk factors associated with blood transfusion in lung surgery patients. Harpole Jr *et al*.[20] reported that intraoperative blood loss and intraoperative RBC transfusion are independent predictors of 30 days mortality and morbidity after lung resection procedures. Also, Weber *et al*.[21] concluded that blood transfusions are acknowledged to prolong hospital stay and increase mortality after lung transplantation. Moreover, some studies[21] have confirmed postoperative complications such as the initiation of pneumonia, wound infections, sepsis, systemic inflammatory response, renal complications, and operative mortality; turn into more periodic in transfused patients than non-transfused.

Some mechanisms[22] have been proposed to explain these controversial findings. The blood transfusion effect may have been in part related to low dose of bacterial contamination from the phlebotomy site, blood handling procedures and its storage. Indeed, infections itself explain the direct relationship between blood transfusion and prolonged hospital stay, hence other adverse outcomes. However, this association between blood transfusion and undesired results was not observed in several studies. Ali and colleagues,[23] for instance, did not find such relation and proposed that clinicians should re-asses banning blood transfusion after cardiac surgery owing to worries of liability to infection.

Furthermore, Vamvakas and Moore[22] re-evaluated the clue stated, up to 1994 and declared that an incidental path was not determined and multiple confounders could grant blood transfusion just a representative sign for infection and other adverse outcomes. Monitoring other variables, we noticed that, the figures are higher in group II (transfused patients) compared to group I. Although, no statistically significant differences between both groups, we recognized there would be some correlation between blood transfusion and outcomes in terms of duration of analgesia, duration of antibiotics, persistent fever, allergic reaction, re-operation, and hospital mortality.

Blood transfusion harm in pediatric age group patients is ultimately the same as the risk for adults; even, it might be costlier over the long term because infant and young patients are critically ill and may live longer with persistent sickness originating from a blood transfusion.

The main limitations of this study are its retrospective nature and being a single-center experience. Hence, there are unknown factors that may affect the study outcomes and were not captured in our data collection. Also, the lack of more detailed data on the exact type, amount and frequency of blood transfusion requirement concerning blood loss in various lung surgery procedures, and the absence of control between the numbers of transfused units related to ordered and cross-matched units were other limitations. The absence of control between the numbers of transfused units related to ordered and cross-matched units. Such details may influence the efficiency of our overall transfusion strategy and to avoid overburden on the blood bank in the future.

A prospective large-scale study is commanded with particular emphasis on pre-operative serum creatinine, duration of surgery and period of blood storage and other postoperative variables like renal complications and respiratory diseases after blood transfusion in those young age patients. Blood and blood components given in our center are typically non-leukoreduced hence further work should emphasize outcomes of leuko-depleted blood transfusion patients in comparison to non-transfused patients.

Conclusion

Transfusion group in pediatrics undergoing lung surgeries in our study was more prone to adverse outcomes such as pneumonia, delayed time to remove chest drains, prolonged ICU stay, and hospital stay.

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Conflicts of interest

There are no conflicts of interest.

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