

Characterization and outcome of packed red blood cells transfusion in critically ill children in PICU in Sohag University hospital

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Abstract

Red blood cell transfusions are a common therapy in critically ill anemic children, a packed cell product is the component of choice for replacement therapy during RBC loss and sporadic transfusion therapy.

The decision to transfuse must be based on an assessment of the risks of anemia versus the risks of transfusion. In addition to the individual assessment of any symptomatic anemic child, the duration of anemia must be taken into consideration as well as the extent of trauma or surgery and the probability of blood loss and coexisting conditions such as impaired pulmonary function and inadequate cardiac output. ⁽¹⁻³⁾

This study was a prospective observational study conducted for one year in Pediatric Intensive Care Unit (PICU) of Sohag University Hospital, a tertiary health center which provide specialized care to critically ill infants and children with about 400 admissions yearly. Patients was divided to two groups according to arterial blood pressure.

Stable critically ill: not hypotensive (mean arterial pressure not less than 2 standard deviations below the mean for age), or no cardiovascular support for at least two hours prior to enrollment.

Unstable critically ill: hypotensive (mean arterial pressure less than 2 standard deviations below the mean for age), or there is cardiovascular support for at least two hours prior to enrollment, this includes patients with heart failure.

Packed RBCS transfusion following a restrictive blood transfusion strategy was used.

Stable critically ill patients: received blood transfusion only if hemoglobin concentration falls below 7 gm/dl.

Unstable critically ill patients: received blood transfusion according to clinical judgment. ^(1,4)

Short term outcome till discharge including (mortality or improvement) and duration of ICU stay was observed and recorded.

Our study showed that respiratory diseases were the main risk factor that increase the duration of PICU stay (p value **0.001**), while suffering from hemodynamic instability was the main risk factor for death in our PICU (P value **0.02**). a restrictive blood transfusion strategy was safe in pediatric patients whose condition was stable in PICU, with no effect on mortality or duration of admission in PICU and the study was not able to highlight a cause-effect relationship between RBC transfusions and outcomes in critically ill children.

Key words: Packed RBCs, Transfusion, Critically ill, Pediatric ICU

Introduction

Red blood cell transfusions are a common therapy in critically ill anemic children, a packed cell product, which comprises the sedimented or centrifuged RBCs from one unit of single-donor whole blood, is the component of choice for replacement therapy during RBC loss (e.g., owing to surgery or trauma) and sporadic transfusion therapy.

The decision to transfuse must be based on an assessment of the risks of anemia versus the risks of transfusion. In addition to the individual assessment of any symptomatic anemic child, the duration of anemia must be taken into consideration as well as the extent of trauma or surgery and the probability of blood loss and coexisting conditions such as impaired pulmonary function and inadequate cardiac output.⁽¹⁻³⁾

The transfusion strategy in critically ill children remains controversial and has generated much research and debate.

Aim of the work

To study the epidemiology and short term outcome of packed RBCS transfusion in critically ill children admitted to PICU and to determine the incidence, indications and a strategy to use for pRBCs transfusion in critically ill children admitted to PICU.

Patients and Methods

This study was a prospective observational study conducted for one year in Pediatric Intensive Care Unit (PICU) of Sohag University Hospital, a tertiary health center which provides specialized care to critically ill infants and children with about 400 admissions yearly. Patients were divided into two groups according to arterial blood pressure.

Stable critically ill: Patients were considered stable if they were not

hypotensive (mean arterial pressure not less than 2 standard deviations below the mean for age), or no cardiovascular support for at least two hours prior to enrollment.

Unstable critically ill: Patients were considered unstable if they were hypotensive (mean arterial pressure less than 2 standard deviations below the mean for age), or there is cardiovascular support for at least two hours prior to enrollment, this includes patients with heart failure.

Packed RBCS transfusion following a restrictive blood transfusion strategy was used

Stable critically ill patients: received blood transfusion only if hemoglobin concentration falls below 7 gm/dl.

Unstable critically ill patients: received blood transfusion according to clinical judgment (Hemoglobin level and other determinants of RBC transfusion may play a role, like acute blood loss and ScvO₂ (<70%), but the usefulness of these markers to drive goal-directed transfusion therapy remains to be determined)^(1,4)

Packed red blood cells was⁽⁵⁾ given in dose of 10 ml/kg of body weight

2. Study size and sampling

2.1 Study population

Our study was conducted on 190 critically ill children of total 392 critically ill child admitted to PICU (48.46% of admissions).

2.2 Patient selection

Inclusion criteria: any critically ill child received pRBCs transfusion aged from one month to 18 years admitted to PICU and pediatric Emergency unit during the study period.

Exclusion criteria:

Patients with cyanotic congenital heart diseases, acute blood loss, platelet dysfunction, hemolytic anemia, survival for less than 24 hours.

3. Ethical consideration

Approval of Sohag faculty of medicine research ethics committee was obtained and verbal consent was obtained from guardians.

4. Patient

handling and data collection during the study

Patient stabilization and monitoring according to PICU Protocols. After patient stabilization medical history was collected from patient relatives. These include demographic data; severity of illness parameters. Diagnosis on admission was taken from patient sheet as defined by caring medical attendant.

Complete clinical examination was conducted. Importantly hemodynamic stability, vital signs and cardiovascular system examination. Hemodynamic stability was frequently checked by pulse rate and volume evaluation (rates for age were judged with specific centile tables), capillary refill time determination and regular systematized blood pressure measurement, blood pressure measurements were compared with normal values.

Short term outcome till discharge including (mortality or improvement) and duration of ICU stay was observed and recorded.

Investigators did not intervene in patient management, which was provided by attending physician using standard protocols.

5. Statistical analysis:

A. descriptive statistics which included:

Demographic characteristics, indications for admission to PICU, clinical features of studied critically ill patients in PICU, duration of admission and outcome of studied critically ill patients in PICU, prevalence, frequency and indications of PRBCs transfusion of studied critically ill patients in PICU.

Comparison between transfused cases with non-transfused cases as regards age, diagnosis, hemoglobin level, hemodynamic stability and use of inotropic support and comparison between dead and improved cases as regards age, diagnosis, hemoglobin level, hemodynamic stability and use of inotropic support and need for blood transfusion. Mortality among critically ill children.

B. Overall incidence: Incidence of pRBCs transfusion in critically ill children.

C. Regression :

A multivariate logistic regression model was used to identify independent risk factors affecting duration of admission and mortality in our PICU among these risk factors: diabetic ketoacidosis, age of studied patients in months, cardiac diseases, neurological diseases, respiratory diseases, post-operative admission, sepsis, hemoglobin level, hemodynamic un-stability, use of inotropic support, frequency of pRBCs transfusion and indications of pRBCs transfusion including (Anemia, Shock, Shock and anemia).

D. Significance level: P value was considered significant if it was less than **(0.05).**

E. Programs used and versions

Data was analyzed using STATA intercooled version **12.1.** Quantitative

data was represented as mean, standard deviation, median and range. Data was analyzed using student t-test to compare means of two groups. When the data was not normally distributed Mann-Whitney test was used. Qualitative data was presented as number and percentage and compared using either Chi square test or fisher exact test. Univariate and multivariate linear regression analyses were used to determine factors that affect the length of admission. Univariate and multivariate logistic regression analyses were used to determine factors that affect the mortality. Graphs were produced by using Excel or STATA program.

STUDY RESULTS

The study was conducted on **190** critically ill children of total **392** critically ill children admitted to PICU during one year. The mean age of studied critically ill children admitted to PICU was **19** month with SD ± 29 months , about **52%** was males. most of patients was diagnosed with respiratory and neurological diseases (about **25%** for each). the mean hemoglobin level on admission was **10** gm /dl with SD ± 2 and median **10** mg/dl. about two thirds (**71%**) of studied patients was hemodynamically unstable and vasopressor support was used in treatment of **74%** of patients.

About half (**47%**) of the studied patients received pRBCs transfusion during their stay in PICU at least once. the mean duration of admission in PICU was **10** days with SD ± 7 and median **8** days , and the mortality among studied cases was **39%**. **30%** of patients received pRBCs for management of shock and **12%** of patients received pRBCs for

management of shock and anemia , while **4%** of patients received pRBCs for management of anemia. non transfused cases was diagnosed mainly with cardiac and respiratory diseases (**28%**) for each , while transfused cases was diagnosed mainly with neurological diseases (**26%**) . about half (**52%**) of non-transfused cases was unstable , while most of transfused cases (**92%**) was unstable . (P value < 0.0001). in non-transfused cases **74%** of cases improved , while in transfused cases about **46%** of cases were improved , with a statistically significant difference between the two groups . (P value < 0.0001).

Most of cases who died washemodynamically unstable (**97%**). About two thirds (**74%**) of the patients who don't receive pRBCs improved and discharged from PICU, while more than half (**54%**) of the patients who received pRBCs died . (P value < 0.0001). Correction of shock was the main indication of pRBCs transfusion as **42%** of cases who died received PRBCs transfusion for correction of shock while **23%** of cases who improved received PRBCs transfusion for correction of shock. (P value < 0.0001).

There was increased mortality with increasing frequency of transfusion as **75%** of patients who received pRBCs transfusion twice died , **80%** of patients received pRBCs transfusion **3** times and all the patients who received pRBCs transfusion four times also died.

Respiratory diseases were the main risk factor that increase the duration of PICU stay (p value **0.001**), while suffering from hemodynamic unstability was the main risk factor for death in our PICU. (P value **0.02**)

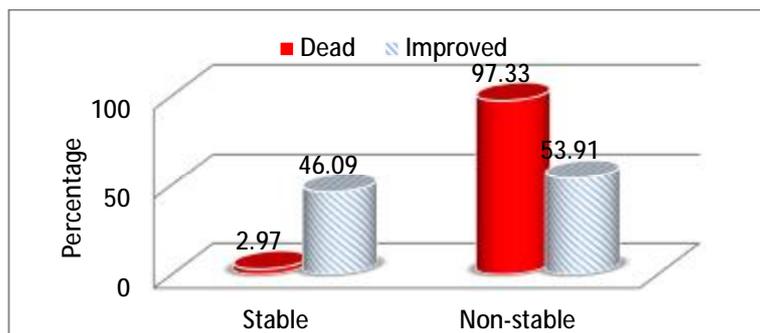


Figure (1): Comparison between dead and improved cases as regards hemodynamic stability

Table (II) Multivariate logistic analysis of factors affecting mortality in PICU

Variable	Adjusted Odds ratio (95% confidence interval)	P value
Age/months	0.99 (0.97:1.00)	0.06
Cardiac	0.36 (0.15:0.87)	0.02
Non-stable	25.15 (1.86:341.04)	0.02
Support	1.24 (0.09:17.72)	0.87
Frequency		
1	0.92 (0.28:2.97)	0.89
2	3.16 (0.70:14.19)	0.13
3	4.17 (0.36:48.28)	0.25
4	Omitted	
Indication		
Anemia	0.65 (0.02:19.82)	0.81
Shock	0.92 (0.30:2.80)	0.89
Shock + anemia	1.63 (0.57:4.72)	0.36

Table (I) Multivariate regression analysis of factors affecting duration of admission (include significant variable in univariate analysis)

Variable	Regression co-efficient (95% confidence interval)	P value
Respiratory	3.76 (1.48:6.04)	0.001
Non-stable	2.30 (-2.10:6.69)	0.30
Support	-5.19 (-9.58:-0.79)	0.02
Frequency		
1	-9.16 (-19.02:0.70)	0.07
2	-2.71 (-12.94:7.53)	0.60
3	-5.18 (-16.56:7.53)	0.37
4	6.88 (-2.86:16.62)	0.17
Indication		
Anemia	8.05 (-3.11:19.21)	0.16
Shock	7.24 (-2.73:17.21)	0.15
Shock + anemia	6.51 (-3.40:16.43)	0.20

mortality among studied cases.

Discussion

The mean age of studied cases was about 19 month, so younger children admitted to PICU are more than older children, a higher mean for age was found in study of *Lacroix., et al 2007* and *Pierre., et al ,2015* that difference could be explained by the vulnerability of small children for complications of infections as sepsis, congenital heart diseases and rapid deterioration of these cases especially in low socioeconomic locality.^(2,6)

The main indication for admission in PICU was respiratory and neurological diseases mainly CNS infections and the mean Hemoglobin level on admission was 10 gm/dl, this agreed with *Pierre., et al ,2015*

study, who found that male and female distribution nearly has the same percentage that in our study, and the main indication for PICU admission was respiratory diseases followed by bacterial infections, viral infections.

In our study we found that almost half of the studied patients received PRBC transfusion during their stay in PICU at least once this disagree with in *Pierre., et al ,2015* who documented that 17% of the patients only received PRBC transfusion.

About 30 % of patients received PRBCs for management of shock while 4% of patients received PRBCs for management of anemia while in *Pierre., et al ,2015* study only 16% of patients received pRBCs for correction of shock and the main indication for transfusion was correction of anemia.⁽⁶⁾

The mean duration for admission in PICU was about 10 days with about 40%

The study conducted by *Bateman., et al, 2008* was the first large, multicenter, prospective study of anemia, blood loss, and transfusion practices in critically ill children. anemia was a common problem, affecting 74% of these children during or immediately before PICU admission, and about 50% of patients received pRBCs during PICU admission, that's agreed with results of our study, also this study documented that Low Hb was the most common reason for transfusion (42% of total transfusions) and this disagree with our study.

Transfused cases was statistically compared with non-transfused cases. and we find that transfused critically ill children are younger than non-transfused cases this agree with findings in *Bateman., et al, 2008* who found that the children who received a transfusion in the PICU were younger (mean age, 4.5 vs. 6.6 years for non-transfused cases (P value 0.001).⁽⁷⁾

In our study we found that the mean hemoglobin level was 11 gm/dl in non-transfused cases and 9 gm/dl in transfused cases. Non transfused cases were diagnosed mainly with cardiac diseases and respiratory diseases (28%) for each while transfused cases was diagnosed mainly with neurological diseases mainly CNS infections (26%). about half (52%) of non-transfused cases was unstable, while most of transfused cases (92%) was unstable. these previous findings agreed with *Armano., et al 2005*, study that showed that a significant proportion of critically ill children receive at least one

red blood cell transfusion during their PICU stay. presence of anemia, cardiac

disease, severe critical illness, and multiple organ dysfunction syndrome (MODS) are the most significant determinants of red blood cell transfusions in PICU. ⁽⁸⁾

Transfused cases had shorter admission period than non-transfused cases which could be explained by increased mortality in transfused cases as unstability was the main indication for pRBCs transfusion. Previous results disagree with *Pierre., et al ,2015* who documented that transfused cases have longer admission periods and found that much lower percentage of un stable cases are found in both transfused and non-transfused groups than that of our study . The same study agree with results of our study that non-transfused cases was diagnosed mainly with respiratory diseases. also, transfused cases was diagnosed mainly with bacterial infection and the mean hemoglobin level was about 11 gm/dl in non-transfused cases and 9 gm/dl in transfused cases which was nearly the same result found in our study. ⁽⁶⁾

Our study showed that Respiratory diseases were the main risk factor that increase the duration of PICU stay (p value 0.001), while suffering from hemodynamic unstablity was the main risk factor for death in our PICU. (P value 0.02)

- pRBCs transfusion following a restrictive blood transfusion strategy was safe in pediatric patients whose condition was stable in PICU, with no effect on mortality or duration of admission in PICU

Our study results agreed with *Lacroix., et al, 2007* study who found that a

restrictive strategy with a hemoglobin threshold of 7 g per deciliter resulted in a 96% reduction in the number of patients who had any transfusion exposure and a 44% decrease in the number of red-cell transfusions administered, without increasing the rates of new or progressive MODS, in stable, critically ill children There were also no clinically important differences between the two groups in any secondary outcomes.

(2) Our study has limitations:

It was conducted in a single center, which limits its external validity , the findings from one center may not apply to other centers with different patient populations . Selection of cases admitted to PICU strongly affected by limited resources ,pediatric trauma patients not included , so most of study cases suffer from medical diseases .Our study was not able to highlight a cause-effect relationship between pRBC transfusions and outcomes in critically ill children only a randomized-controlled trial could establish such a causal link.

Our study also has strengths :

It's a prospective study with better data collection than retrospective studies and the study included all consecutive PICU admissions over a 1-year period, which resulted in a case-mix with a limited risk of selection bias and no influence due to seasonal variation.

Conclusion:

Our study showed that respiratory diseases were the main risk factor that increase the duration of PICU stay (p value 0.001), while suffering from hemodynamic unstablity was the main risk factor for death in our PICU (P value 0.02) .a restrictive blood transfusion strategy was safe in pediatric patients whose condition was stable in

PICU, with no effect on mortality or duration of admission in PICU and the study was not able to highlight a cause in critically ill children.

Recommendations:

Good care should be provided to smaller children and infants as this group is vulnerable, while careful assessment and early correction of shock is the key point for improving mortality in PICU. be adopted in guidelines for management of critically ill children in PICU.

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effect relationship between RBC transfusions and outcomes

neurological cases should receive good attention regarding nutritional status, management of anemia, and early detection and management of sepsis.

A restrictive blood transfusion strategy was safe in pediatric patients whose condition was stable in PICU, so it should

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