

Exchange Blood Transfusion as an Emergency Tool for Children beyond the Neonatal Age Group

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ABSTRACT

Beyond the use of Exchange Blood Transfusion (EBT) in neonatal hyperbilirubinemia and sickle cell anemia, other applications are yet to be fully explored in clinical practice. The present study sought to expose the benefits of EBT in older children with severe sepsis (unresponsive to antibiotics, blood transfusion nor vasoactive medications) which progressed to be complicated by life threatening conditions including multiple organ dysfunction syndrome, shock or coagulopathy. It is a prospective observational study carried out over a period of 5 months following the introduction of EBT as a treatment modality for sepsis in the Children's Emergency Room (CHER) ISTH. All the patients who had EBT during the period were recruited. The indications for and response to the procedure as well as the final outcomes are documented. A total of 7 patients had EBT during the period with indications being severe sepsis with: multiple organ dysfunction syndrome, disseminated intravascular coagulopathy, fulminant hepatic failure and septic shock. The average time (\pm SD; R) spent in the emergency unit/ state after the EBT was 3.29 (\pm 1.98; 1 - 6) days. There is no acute blood transfusion reaction recorded. There is a direct relationship between the duration of illness prior to the EBT and the total length of hospital admission. The average duration of hospital admission following the EBT was 19.12 (\pm 20.83; 3 - 60) days. The mortality rate was 0%. EBT may be a life saving medical intervention in critically ill children with severe sepsis unresponsive to conventional therapy. Timely intervention with EBT in such severe conditions is imperative to curtail the untoward outcome of the disease process.

Keywords: exchange blood transfusion, severe sepsis, septic shock, older children

INTRODUCTION

Exchange blood transfusion (EBT) or substitution transfusion is defined as the removal of a patient's blood followed by introduction of an equal amount of blood from donors (The American Heritage Medical Dictionary, 2007). The use of EBT in contemporary clinical practice is largely limited due to the advent of highly specialized facilities for extracorporeal apheresis permitting the separation and removal of specific undesired blood components as well as hemodialysis permitting removal of toxic substances from the circulation. Further restricting its use is the risk of transmission of infectious diseases with transfusion of blood products. Currently, its use is almost exclusively restricted to developing countries for neonates with hyperbilirubinemia to reduce the risk of kernicterus (Owa and Ogunlesi, 2009; Badie, 2007) and in specific cases of sickle cell crisis (Wun and Hassell, 2009). However, EBT may have an important role in the management of critically ill children with

severe sepsis and septic shocks. This is against the backdrop of very high mortality rates associated with these conditions. Rates as high as 50% to 80% are documented (Jawad, Luksic and Rafnsson, 2012) and the persistently high mortality rates globally account for continuous research and therapeutic innovations devoted to the management of severe sepsis. According to Levinson and Casserly (2011), these new techniques including Early Goal Directed Therapy (EGDT) and Protein C therapy are highly specialized and beyond the reach of most developing countries. Hence the need arises to explore other treatment modalities with a view to containing the morbidity and mortality associated with severe sepsis and septic shocks in resource poor settings and even globally. The current study exposes the usefulness of EBT in the management of severe sepsis and septic shocks in children.

METHOD

The study was a prospective observational one carried out over a period of 5 months in CHER ISTH. All the patients who had EBT during the period were recruited. The criteria for carrying out EBT were a background of progressive deterioration of clinical status despite broad spectrum intravenous antibiotics in patients with: (i) septic shock unresponsive to vasoactive drugs and repeated blood transfusions (ii) severe sepsis with coagulopathy and (iii) severe sepsis with multiple organ dysfunction syndrome including fulminant hepatic failure. Isovolumetric EBT technique was used whereby blood was let from a peripheral vein while blood transfusion was going on concurrently through another peripheral vein. Freshly donated blood was preferably used for the procedure except when unavailable. The target was double volume exchange. The vital signs and Oxygen saturation were monitored regularly during the procedure. Pre and post EBT biochemical profile were obtained. Antibiotics were continued throughout the procedure up until discharge.

RESULTS AND DISCUSSION

A total of seven patients aged 13 - 70 months had exchange blood transfusions within the period under study. Six (85.7%) of the patients were male while one was female (14.3%). Their mean age was 25.14 ± 20.47 months. Table 1 shows the age and gender distribution of the study population. Figure 1 shows the clinical manifestation of sepsis in the patients. All the patients (100.0%) were diagnosed of severe sepsis with multiple organ dysfunction syndrome and all of them had symptoms affecting the central nervous system (CNS) and the respiratory systems. In addition, 2 (28.6%) of the patients also had septic shock, 2 (28.6%) had disseminated intravascular coagulopathy, 2 (28.6%) had severe anemia, 2 (28.6%) had abnormal liver function tests and 1 (14.3%) had acute renal failure (ARF). Six patients (85.7%) had retinal hemorrhages and a similar proportion (6, 85.7%) had elevated age specific shock index (SIPA). One (14.3%) of the patients had sickle cell anemia and one (14.3%) developed fulminant hepatic failure prior to the EBT. Table 2 shows that all (100%) of the patients had broad spectrum antibiotics, glucose containing infusions and Oxygen therapy prior to EBT. Six (85.7%) had antimalarials, 5 (71.4%) had anticonvulsants, 5 (71.4%) had initial blood transfusions while 4 (57.1%) of the patients

had diuretics for heart failure. The indications for the initial blood transfusions were septic shock (2, 50%), severe anemia (2, 50%) and sickle cell crisis (1, 25%). All the patients had Exchange Blood Transfusion (EBT) within an average of 3.9 ± 3.1 days (R = 6hrs - 9 days) following presentation at ISTH. The mean volume (\pm SD; R) of blood exchanged was 668 (\pm 371; 350 – 1260) mls. The average time (\pm SD; R) spent in the emergency unit/state after the EBT was $3.5 (\pm 2.1; 1 - 6)$ days. Table 3 shows that there was a direct relationship between the duration of illness prior to the EBT and the total length of hospital admission, $F = 64.5, df = 5, p = 0.0001$.

Conversely, the clinical response following EBT (assessed by the length of hospital admission following EBT) was not dependent on the age of the patients ($F = 0.01, df = 4, p = 0.99$) but was rather dependent on the duration of illness prior to presentation at ISTH ($F = 17.3, df = 4, p = 0.01$). This is shown on table 4. There were no (0%) acute blood transfusion reactions nor was there any mortality and all of the patients were subsequently discharged home. The average duration of hospital admission following the EBT was 21.5 ($\pm 21.7; 3 - 60$) days. On follow up for 6 - 12 weeks, none (0%) had complications attributable to EBT. One (14.3%) patient developed cerebral palsy with cognitive impairment while another (14.3%) had segmental lung collapse. The remaining 5 (71.4%) had no sequelae.

The study shows that EBT is a potentially useful medical intervention in critically ill children even beyond the neonatal age group especially for the management of severe sepsis. In addition to acting as a substitute for apheresis and hemodialysis in resource poor settings lacking in these complex machinery, it also provides useful blood components including immunologic agents and clotting factors in sufficient amounts required to restore normal immunologic functioning and homeostasis of the different organ systems in the body in cases of severe sepsis. This study shows that response to treatment was not dependent on the age of the patients but on the promptness of the EBT. The severity of the illness of the patients in the study was illustrated by the lengthy recovery period which took an average of three weeks following EBT. However, all of the children who had the procedure survived the illness and the only long term complications recorded (cerebral palsy and lung collapse) were complications of the primary disease and not of the EBT.

Table 1: Age and gender distribution of the study population

Gender	Age (months)
Male	13
Male	15
Male	15
Female	16
Male	18
Male	29
Male	70
Mean	25.14 ± 20.47

Source: Empirical Analysis, 2014

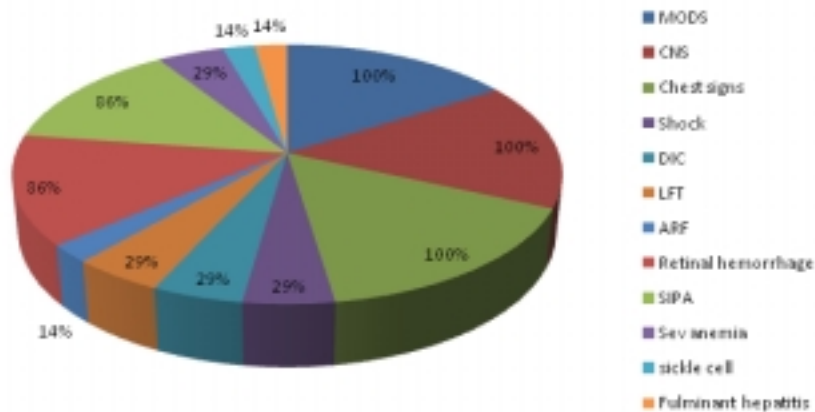


Figure 1: Clinical manifestations of the study population

Table 2: Initial treatment prior to EBT

Pre-EBT treatment	Frequency (%)
Diuretics	4 (57.1)
Blood transfusion	5 (71.4)
Anticonvulsants	5 (71.4)
Antimalarials	6 (85.7)
Oxygen therapy	7 (100.0)
Glucose infusion	7 (100.0)
Antibiotics	7 (100.0)

Source: Empirical Analysis, 2014

Table 3: Relationship between the duration of illness prior to the EBT and the total length of hospital admission

Duration of illness prior to EBT (days)	Total hospital admission (days)	F	Df	P value
4	4	64.5	5	0.0001
4	3			
16	26			
47	60			
11	28			
4	6			
4	5			

Source: Empirical Analysis, 2014

Table 4: Relating age of patients and duration of illness before presentation to the response to EBT

Hospital admission post EBT (days)	Age (months)	P value	Hospital admission post EBT (days)	Duration of illness before presentation	P value
2	29	0.87	2	2	0.001
1	15		1	2	
25	15		25	21	
55	13		55	42	
19	70		19	2	
8	16		8	4	
5	14		5	4	
F = 0.029	df = 5		F = 41.94	df = 5	

Source: Empirical Analysis, 2014

CONCLUSION

Exchange blood transfusion is readily accessible and may be the only life saving technique available in resource poor settings in older critically ill children with severe sepsis complications that has failed to respond to routine management. In such conditions, it should be instituted promptly to prevent rapid deterioration and death. In addition, prompt EBT may forestall the need for repeated blood transfusions in cases of disseminated intravascular coagulopathy and also reduces morbidities arising from prolonged hospitalization. Nevertheless, The small sample size of the study increases the risk of bias. Further large scale studies are thus required.

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