Audit on neonatal exchange transfusion in the Neonatology Unit of Assiut University applying American Academy of Pediatrics 2004 guidelines

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Introduction
Exchange transfusion (ET) still has an important role in the Neonatal ICU of Assiut University Children Hospital as an emergency procedure for management of severe cases of hyperbilirubinemia. Therefore, this audit study was done on 26 patients for 1 year to detect the adherence to the American Academy of Pediatrics (AAP) 2004 guidelines, which are already implanted in the unit. The procedure involves incremental removal of the infant's blood having high bilirubin levels and/or antibody-coated red blood cells and simultaneous replacement with fresh donor blood providing fresh albumin with binding sites for bilirubin.

Patients and methods
This study included 26 infants admitted at the Neonatal ICU of Assiut University Children Hospital for whom ET was done over 12 months from first day of September 2017 to the end of August 2018. The data were collected by recording the investigations done before and after ET and observation by the Neonatal ICU of Assiut University Children Hospital staff during ET in comparison with the checklist, which is already implanted in the unit and is based on the AAP 2004 guidelines.

Results
Of the 26 studied infants, 73% had ABO incompatibility, where 19.3% had RH incompatibility and 7.7% have other diagnosed breast milk jaundice by exclusion of other causes, subgroup incompatibility, and polycythemia. Coombs test was done in 31% and not done in 69% of the studied cases. All the studied cases were given medication during ET in the form of calcium gluconate intravenously.

Conclusion
AAP 2004 guidelines have been partially followed in ET in the studied cases, but there were some shortcomings that can affect the outcome. The study recommends avoiding these shortcomings.

Keywords:
ABO incompatibility, exchange transfusion, hyperbilirubinemia, kernicterus, neonatal jaundice, Rh incompatibility

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Introduction

Exchange transfusion (ET) still has an important role in the neonatal intensive care unit of Assiut University Children Hospital as an emergency procedure for management of severe cases of hyperbilirubinemia [1]. The use of ET was subsequently expanded to hyperbilirubinemia [2], other hemolytic diseases of the newborn, neonatal sepsis [3], disseminated intravascular coagulation, metabolic disorders (such as aminoaciduria with associated hyperammonemia) [4], severe fluid or electrolyte imbalance, polycythemia, and severe anemia. Intervention for severe neonatal hyperbilirubinemia, especially hemolytic diseases, remains the most frequent indication [5]. ABO incompatibility (mother usually has blood group O, and infant has blood group 'A' or 'B') [6]. For reasons that are unclear, B-O incompatibility (mother type O and baby type B) seems to be in general more severe than A-O incompatibility [7]. The procedure involves incremental removal of the infant's blood having high bilirubin levels and/or antibody-coated red blood cells and simultaneous replacement with fresh donor blood providing fresh albumin with binding sites for bilirubin [1]. Development and widespread use of Rh-immunoglobulin, improvements in diagnostic prenatal ultrasound, intensive phototherapy, and revised American Academy of Pediatrics (AAP) guidelines for hyperbilirubinemia have resulted in a worldwide decrease in the need for ET during the past 2–3 decades [2]. Bilirubin is produced by the catabolism of red blood cells in the reticuloendothelial system [8]. Kernicterus is the pathogenic diagnosis characterized by bilirubin staining of the brain stem nuclei and cerebellum but has also come to refer to chronic bilirubin encephalopathy [9].

Type of study
This was an audit study.

Aim
The aim was to check the adherence of neonatal intensive care unit staff to the AAP 2004 guidelines for ET at neonatal intensive care unit of Assiut University Children Hospital; a guideline checklist is already implanted in the unit.

Patients and methods
This study included 26 infants admitted at Neonatal ICU of Assiut University Children Hospital for whom ET was done over 12 months from first day of September 2017 to the end of August 2018. Ethics committee approval statement 17100835.

Inclusion criteria
All neonates (from 0 day up to 28 day of age) admitted at Neonatal ICU of Assiut University Children Hospital for whom ET was done were included.

Method
The data were collected through investigations done before and after ET and observation at the Neonatal ICU of Assiut University Children Hospital staff during ET in comparison with the checklist, which is already implanted in the unit and is based on the AAP 2004 guidelines.

Statistics
Data were processed and analyzed using (IBM, Armonk, New York, USA) SPSS software version 16 and expressed as percentages.

Results
Table 1 shows that 50% of the studied patients were males and 50% were females. The ages of the studied cases revealed 62% of the cases were less than 48 h, whereas 38% of cases were more than 48 h of age.

Table 2 shows that 73% of the studied cases have ABO incompatibility, where 19.3% have Rh incompatibility and 7.7% have other diagnosed breast milk jaundice by exclusion of other causes, subgroup incompatibility, and polycythemia.

Table 3 shows that Coombs test was done in 31% and not done in 69% of the studied cases as a part of jaundice workup for diagnosis of hemolytic disease of the newborn (HDN).

Table 4 show that hematocrit and bilirubin were measured in 100% of the studied cases before and after the exchange. Serum calcium was measured in 38% before and in only 19% after exchange of the studied cases. Sodium and potassium were measured in 76% of the studied cases before and in 38% after exchange for the studied cases. Serum chloride was not done in all studied cases.

Table 5 shows that buffering and hematocrit of the blood donor were not done in 100% of the studied cases.

Table 6 shows that all the studied cases were monitored but 89% were monitored properly and 11% were monitored improperly as the body temperature and blood pressure were not monitored in these cases. The duration of the technique was proper in 77% of the studied cases and improper in 23% of the studied cases, which may be shortened or prolonged than the expected time. The amount of the blood used was proper in 88% of the studied cases, but the rest was less than calculated, as the blood bank did not supply us with the requested amount.

Table 1 Demographic data of the studied cases

Demographic data	26 (100) [*n* (%)]
Sex	
Male	13 (50)
Female	13 (50)
Age (days)	
Range	0-7
0-48 h	16 (62)
>48 h	10 (38)

Table 2 Recorded data about diagnoses of the studied cases

Cases	ABO [*n* (%)] Incompatibility	RH [*n* (%)] Incompatibility	Others [*n* (%)]
Diagnoses	19 (73)	5 (19.3)	2 (7.7)

Table 3 Recorded data about direct Coombs test

Cases	Done [*n* (%)]	Not done [*n* (%)]
Direct Coombs test	8 (31)	18 (69)

Table 4 Recoded data about investigation done for the studied cases before and after exchange transfusion

Cases	Before exchange [*n* (%)]		After exchange [*n* (%)]	
	Done	Not done	Done	Not done
Hematocrit	26 (100)	0	26 (100)	0
Bilirubin	26 (100)	0	26 (100)	0
Calcium	10 (38)	16 (62)	5 (19)	21 (81)
Potassium	20 (76)	6 (24)	10 (38)	16 (62)
Sodium	20 (76)	6 (24)	10 (38)	16 (62)
Chloride	0	26 (100)	0	26 (100)

Table 7 shows that top-up transfusion was done in 62% of the studied cases and not done in 38% of the studied cases. All the studied cases were given medication during ET in the form of calcium gluconate intravenously.

Fig. 1 show that hematocrit and bilirubin were measured in 100% of the studied cases before and after the exchange. Serum calcium was measured in 38% before and in 19% after exchange of the studied cases only. Sodium and Potassium were measured 76% of the studied cases before and in 38% after exchange for the studied cases. Serum chloride was not done in all studied cases.

Fig. 2 show that all the studied cases were monitored but 89% were monitored properly and 11% were monitored improperly as the body temperature and blood pressure were not monitored in these cases. The duration of the technique was proper in 77% of the studied cases and improper in 23% of the studied cases may be shortened or prolonged than the expected time. The amount of the blood used was proper in 88% of the studied cases but the rest was less than calculated as the blood bank did not supply us by the requested amount.

Fig. 3 show that top up transfusion was done in 62% of the studied cases and not done in 38% of the studied cases. All the studied cases were given medication during exchange transfusion in the form of calcium gluconate intravenous.

Table 5 Recorded data about the donor blood

Cases	Done [*n* (%)]	Not done [*n* (%)]
Buffering	0	26 (100)
Hematocrit	0	26 (100)

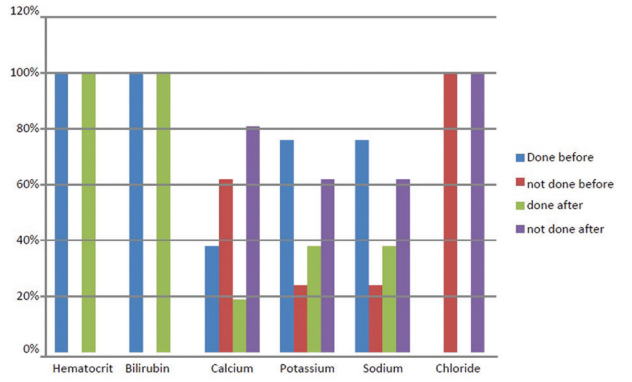
Table 6 Recoded data about the duration and monitoring of the technique and the amount of the blood

	Proper [*n* (%)]	Improper [*n* (%)]
Monitoring	23 (89)	3 (11)
Duration	20 (77)	6 (23)
Amount of the blood	23 (88)	3 (12)

Table 7 Recoded data about top-up transfusion and medications given during the exchange transfusion

Cases	Done [*n* (%)]	Not done [*n* (%)]
Top-up transfusion	16 (62)	10 (38)
Medications (calcium)	26 (100)	0

Figure 1



Percentage of patients for whom hematocrit, bilirubin, and serum electrolytes were done before and after transfusion.

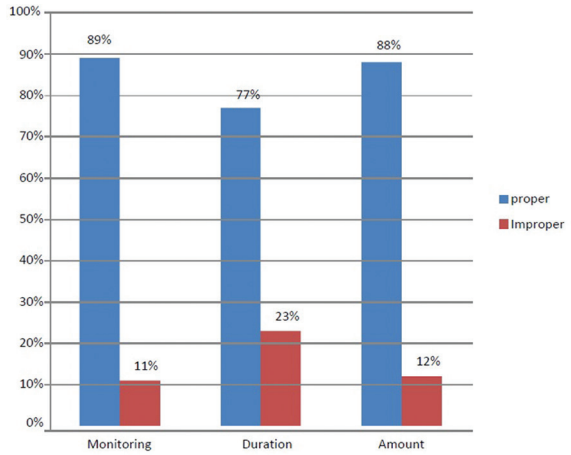
Discussion

Regarding the diagnoses of the studied cases, 62% had hemolytic disease of the newborn owing to ABO incompatibility. This is in agreement with Patel *et al.*[10] who stated that the most common cause of hyperbilirubinemia is ABO incompatibility. This is owing to wide range use of anti-D antibodies that prevent RH incompatibility. On the contrary, there is no prevention up till now for ABO incompatibility.

Regarding Coombs test, it was done for only 31% of cases. This is owing to unavailability of the test all the time in the hospital's laboratory. This is in disagreement with the AAP 2004 guidelines, which state that coombs test should be done for all cases that are candidates for ET.

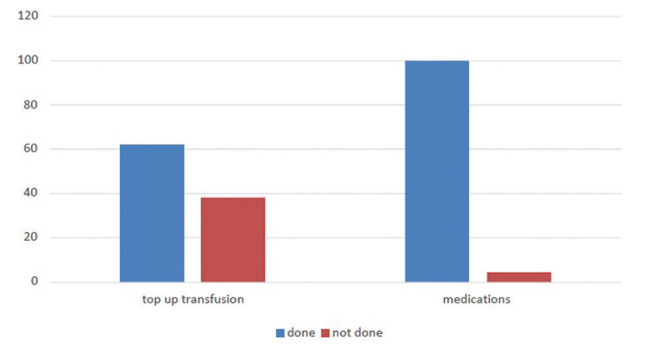
Regarding the investigations, serum bilirubin and hematocrit were done in all cases before and after the procedure. This is in agreement with AAP 2004 guidelines, which states that serum bilirubin and hematocrit should be done for all cases. Calcium level was measured in 38% before and 19% after exchange of the studied cases. This is owing to unavailability all

Figure 2



Percentage of patients that were monitored in proper, and improper way.

Figure 3



Percentage of patients receiving top-up transfusion, and medications.

the time at the laboratory and insufficient samples. Serum sodium and potassium were measured in 76% before and 38% after exchange for the studied cases. This is owing to insufficient samples at many times as it was claimed that sample was not sufficient, but they were already ordered. Serum chloride was not done at all as the test is not available all the time in the laboratory. This was not in agreement with AAP 2004 guidelines, which state that electrolyte monitoring should be done for all cases that are candidates for ET.

Regarding the donors' blood hematocrit and buffering, it was found that they were not done at all as they were not routinely done. This did not agree with AAP 2004 guidelines, which states that hematocrit and buffering of the donors' blood should be done. Regarding monitoring of the studied cases, all the studied cases were monitored but 89% were monitored properly. This is not in agreement with AAP 2004 guidelines, which state that proper monitoring should be done for all cases that are candidates for ET. Improper monitoring was claimed to be owing to unavailability of chest leads and temperature probe all the time in the unit.

Regarding the duration of the procedure, it was found that it was proper in 77% of the studied cases, as there was time delay owing to displacement of the umbilical catheter. Regarding the amount of the blood used in the procedure, it was found that it was proper in 88% of the studied cases, as sometimes the amount of the blood was insufficient from the blood bank. This is not in agreement with AAP 2004 guidelines, which state that the duration and the amount of the blood should be proper in all cases that are candidates for ET.

Regarding top-up transfusion, it was done in 62% of cases associated was hemolytic anemia, and this is in agreement with the AAP 2004 guidelines, which state that top-up transfusion should be done in cases associated with anemia.

Regarding medications given to the patients during ET, intravenous calcium gluconate was given in all cases, which is not in agreement with the AAP 2004 guidelines, which state that calcium should be given only if there is manifested hypocalcemia to avoid the hazard of arrhythmias, which may be associated with its rapid infusion. It also may be associated with chemical burn owing to extravasation.

Conclusion

We concluded that this initial audit about ET in neonates demonstrates that there is a lack of complete adherence to the AAP 2004 guidelines, which are already implemented in the unit in the form of the following: calcium was given to every patient with or without laboratory or clinical evidence of hypocalcemia, no complete workup for any case of hyperbilirubinemia especially Coombs test for accurate diagnosis of the studied cases, also the amount of the blood used in the procedure was not always accurate, proper monitoring was not always done, donor blood buffering was not routinely done to avoid acidosis, and donor blood hematocrit was not routinely done. Re-audit to demonstrate improvement is recommended.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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