RED BLOOD CELL TRANSFUSION PRACTICES IN VERY LOW BIRTH WEIGHT INFANTS IN 1990s POSTSURFACTANT ERA

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The purposes of this study are (1) to evaluate the practice of red blood cell transfusions in very low birth weight (VLBW) infants (between 501 to 1500 g) during the postsurfactant era of the 1990s; and (2) to evaluate if there is a decreasing trend in red cell transfusions in the 1990s.

Database and medical records of VLBW infants admitted to the neonatal intensive care unit (NICU) between January 1990 and December 1995 at Scott & White Clinic, Temple, Texas, were reviewed. Five hundred twenty-seven infants were admitted to the NICU, excluding 5 infants that were transferred out for possible cardiac surgery or for other reasons. Fifty one (9.7%) of these infants died prior to discharge. Hence, data from 476 survivors were reviewed for red blood cell (RBC) transfusions. Transfusions were given at the discretion of the attending neonatologist. None of the infants received erythropoietin.

Of the 476 infants, 289 (61%) received RBC transfusions during the hospital stay, with 2.7 ± 3.6 transfusions per infant with a volume of 40.5 ± 50.4 mL/kg. Smaller infants required significantly more transfusions compared to larger infants when divided into 250-g subgroups. No statistically significant difference was noted in the number of RBC transfusions per infant or number of infants transfused during the 6-year period from year to year.

We conclude that VLBW infants in the 1990s postsurfactant era required 2.7 RBC transfusions per infant, on average, with the smallest infants requiring the most transfusions. These data will be helpful to counsel mothers in preterm labor regarding the need of transfusions for each birth weight category. Red cell transfusion practice has not changed over this 6-year period in the 1990s. Additional measures such as erythropoietin or even stricter transfusion criteria may be necessary to decrease transfusions further. However, safety of such measures should be carefully evaluated. (*J Natl Med Assoc.* 2001;93:405–409.)

Key words: transfusion ♦ red blood cell ♦ infant

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Red blood cell (RBC) transfusion practice in neonates is a subject for debate. Preterm infants routinely require frequent small transfusions.[1,2] Efforts are being made to decrease the number of transfusions infants receive and donor exposure to avoid infectious complications by utilizing strict transfusion criteria, older blood, and erythropoietin ther-

apy.[1–5] In our practice, parents of preterm infants frequently ask questions near the time of birth regarding the need for blood transfusions and the possible number of transfusions these sick preterm infants would need during their hospital stay. There is limited information in the literature regarding birth weight- and gestational age-specific red cell transfusion practice. Hence, the purpose of this retrospective study is twofold: (1) to evaluate the practice of RBC transfusions in very low birth weight infants (VLBW), infants that require transfusions often, during the 1990s since the introduction of surfactant therapy; and (2) to evaluate whether there is a decreasing trend of red cell transfusions in the postsurfactant 1990s.

METHODS

This retrospective study was performed at Scott & White Clinic in Temple, Texas, which has a level III neonatal intensive care unit (NICU) with annual admissions of approximately 350 to 400 infants. A detailed database, locally developed and personally managed by a neonatologist (D.R.K.), is maintained regarding NICU admissions, morbidity, and mortality, for the purpose of quality improvement over the years. Data were initially prospectively collected on a database sheet by a neonatologist during the course of the infant's hospital stay. At discharge, the neonatologist reviewed the data collection sheet along with the chart for accuracy and completeness. Data were then entered directly into the computer. Packed red cell transfusions are part of the database. Utilizing this database and, when in question, by reviewing medical records, relevant data were retrieved for the study purpose. A 6-year review from January 1990 to December 1995 of the data were undertaken with a focus on VLBW infants with birth weight between 501 to 1500 g who survived to discharge.

Transfusion Criteria

Transfusion decisions were made by the attending neonatologist. The infant's hematocrit, reticulocyte count, gestational age (GA), age, respiratory status, and other signs and symptoms were primary issues in this decision. At no time were infants transfused to raise the hematocrit level above 35% or to replace phlebotomy losses. None of the infants received erythropoietin therapy. Iron supplements were provided for enterally fed infants starting approximately from 2 weeks of age with iron-fortified preterm infant formulas. Direct elemental iron supplements were provided for infants who were fed with expressed breast milk. The goal of the neonatologists was to provide at least 2 mg/kg/day of elemental iron by the time feedings are well established. Transfusion criteria of erythropoietin studies[4] during this period had a major influence on the practice of blood transfusions in the NICU at this institution. Knowledge of strict transfusion criteria was based on weekly journal clubs and national meetings such as "Hot Topics in Neonatology" and "Society of Pediatric Research." Each transfusion was 15 mL/kg as per our practice protocol. Hematocrit of transfused packed red cells ranged from 60 to 70% stored with additive solution containing dextrose, adenine, monobasic sodium phosphate, and sodium chloride. In anticipation of further transfusion needs, attempts were made to use single-donor blood by utilizing component aliquot bags attached to the main bag and blood as old as 42 days was used for transfusion.

Data Collection

Data collection included birth weight, gestational age, and volume and number of red cell transfusions infants received during the study period. None of the infants received exchange transfusion. Morbidity data such as duration of oxygen therapy, necrotizing enterocolitis, patent ductus arteriosus, intraventricular hemorrhage, and retinopathy of prematurity were collected. Morbidity data were reviewed to compare this study population with other populations reported in the literature.

Statistical Analysis

Mean and standard deviations were calculated where appropriate. To compare transfusion practices from the earlier 1990s to later years, analysis of variance for continuous data and χ^2 for categorical data were utilized, and a p value < 0.05 was considered significant.

RESULTS

During the 6-year study period, between January 1990 and December 1995, 532 infants with birth weight (BW) between 501 and 1500 g were admitted to the NICU at Scott & White Clinic. Five infants were transported out to other hospitals for reasons such as a requirement for specialized cardiovascular

Table 1. Morbidity Data of 476 Study Infants (Survivors)

Characteristic	No. of infants	%
Patent ductus arteriosus	154	32
Necrotizing enterocolitis	14	3
CLD* with O_2 needs at 28 days	165	35
CLD with O_2 needs at 36 weeks	83	17
Home on oxygen	39	8
Intraventricular hemorrhage (all grades)	99	21
Intraventricular hemorrhage (grade III/IV)	47	10
Retinopathy of prematurity (all stages)	175	37
Retinopathy of prematurity (stage III/IV)	60	13

*CLD, chronic lung disease; O_2 = oxygen.

surgery, leaving 527 infants. Of these 527 infants, 51 (9.7%) infants died prior to discharge. Hence, 476 survivors formed the basis of this report. Morbidity data of the 476 study infants are shown in Table 1. Of these 476 infants, 289 (61%) were transfused with RBCs with 2.7 ± 3.6 (mean ± SD) transfusions per infant with a volume of 40.5 ± 50.4 (mean ± SD) mL/kg/infant during their hospital stay. Number of transfusions, volume of blood, and number of infants transfused in each birth weight category are shown in Table 2. The number of transfusions between each birth weight category were statistically significant with a p value as expected. The number of transfusions subgrouped as 0, 1 to 5, 6 to 10, or >10 in each birth weight category are shown in Figure 1. The percent of infants transfused each year is shown in Figure 2. The average number of transfusions per infant by year are shown in Figure 3. The number of transfusions per infant in each year by birth weight category are shown in Figure 4. No statistically significant differences were identified in terms of number of RBC transfusions per infant or the number of infants transfused from year to year during the study period from 1990 to 1995.

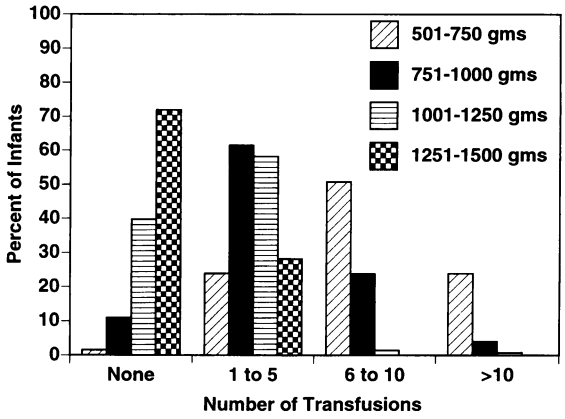

Figure 1. Red blood cell transfusions in 476 VLBW infants.

DISCUSSION

This is the largest study of VLBW (476) infants to date from a single institution evaluating current transfusion practices in the 1990s since surfactant therapy has become routine practice for respiratory distress syndrome. This is also the first study with significant numbers in each subgroup of birth weights. These results are comparable to the data

Table 2. Red Blood Cell Transfusions in Very Low Birth Weight Infants Between 1990–1995

BW group (gm)	N	GA (wk)	BW (gm)	# Infants transfused (%)	#RBCT*/infant	Volume mL/kg
501–750	67	24.6 ± 1.6	645 ± 60	66 (99)	8.2 ± 4.0	123 ± 60
751–1000	101	26.5 ± 1.7	873 ± 73	90 (89)	4.4 ± 3.4	66 ± 51
1001–1250	141	28.9 ± 1.8	1136 ± 74	85 (60)	1.4 ± 1.8	21 ± 27
1251–1500	167	30.7 ± 2.1	1389 ± 71	47 (28)	0.4 ± 0.8	6 ± 12
501–1500	476	28.4 ± 2.9	1100 ± 274	288 (61)	2.7 ± 3.6	40.5 ± 50.4

*RBCT, red blood cell transfusion; BW, birth weight; GA, gestational age; SD, standard deviation.
± values represent mean ± SD.

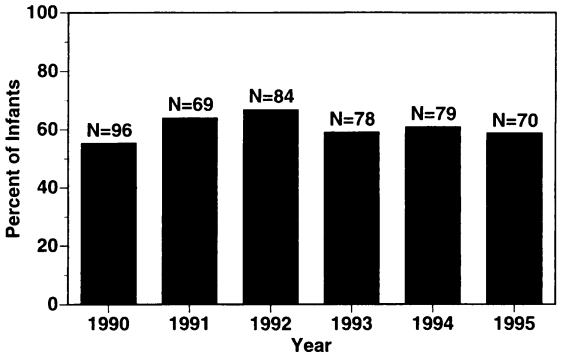

Figure 2. Percent of infants receiving transfusions, by year.

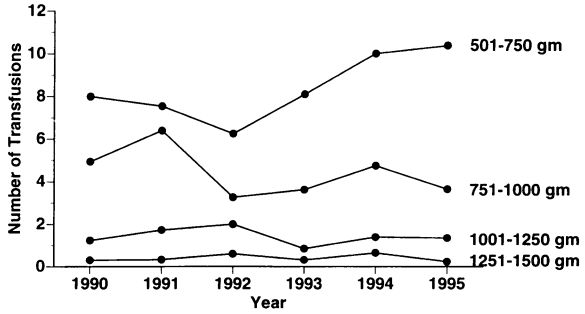

Figure 4. Average number of transfusions per infant per year, by birth weight groups.

provided by Widness et al.,[6] but better than those reported by Alagappan et al.[7] and Ringer et al.[8]

Alagappan et al.[7] evaluated transfusion needs in infants <1250 g and <32 weeks' gestation before and after implementation of strict transfusion guidelines (39 infants before and 41 infants after). The number of transfusions decreased from 10.5 to 8 compared to before and after implementation of guidelines and in volume of 156 to 119 mL, with a trend toward decrease but not with statistically significant results. Transfusion needs are lower in our population compared to this study.

In 1990, Ringer et al.[8] compared 270 infants with BW <1500 g in two nurseries. NICU A had 98 infants with a mean BW of 1073 g and a mean GA of 28.5 weeks. Approximately 65% of infants were transfused, with an average of 4.8 transfusions/infant. NICU B had 172 infants with mean BW of 978 g and GA of 27.6 weeks. Nearly 87% of these infants were transfused, with a mean of 4.9 transfusions per infant, with a volume of 54.8 mL/kg. Phlebotomy losses, lower gestational age, and higher SNAP score correlated with transfusion needs. Infants in our institution received a significantly lower number of transfusions compared to these study infants.

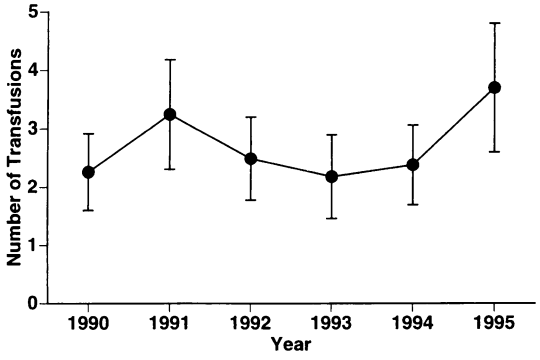

Figure 3. Average number of transfusions per infant by year, with 95% confidence intervals.

Wildness et al.[6] reported trends of RBC transfusions in 1982, 1989, and 1993. Transfusion needs in 50 VLBW infants were found to be 2.3 transfusions per infant with a volume of 49.6 mL per infant in 1993 compared to 2.7 transfusions per infant with 40.5 mL of volume per infant in our study. Wildness et al. also reported increased use of transfusions in 1982 (7 per infant) and 1989 (5 per infant) compared to 2.3 per infant in 1993 by utilizing strict transfusion criteria of erythropoietin study.

Even though we did not participate in erythropoietin studies that have set the strict transfusion guidelines,[4] the information has spread through guest lectures, annual scientific meetings, and journals. Hence, transfusion criteria are similar in our population. Compared to Wildness et al., the mean number of transfusions in our study population is 0.4/infant higher but volume of blood transfused is lower at 40.5 mL/infant vs. 49.6 mL/infant in the Wildness et al. study. Morbidity in our study population was similar to that in their patient population. The study also reflects that the message of researchers in this area is getting across and is helping to decrease the number of transfusions. In 1996, there were 3,914,953 births in the United States[9] and 1.4% of those were VLBW infants with birth weight <1500 g (approximately 54,809 infants). By extrapolation, at 2.7 transfusions per VLBW infant, approximately 148,000 transfusions are given in this subgroup across the country.

We are surprised to find that there was no significant difference in terms of number of RBC trans-

fusions per infant or the number of infants transfused from year to year during the 6-year study period from 1990 to 1995. This means that to achieve further reduction in transfusions, additional measures will be necessary. The strength of the study is its 476 VLBW infants and accurately kept database regarding transfusion information over a 6-year period. However, limitations of this study are (1) its retrospective nature; (2) the database did not provide a time frame of these transfusions (transfusions during first 2 weeks vs. later weeks); and (3) no stringent transfusion criteria existed even though neonatologists made transfusion decisions with the background of transfusion criteria from erythropoietin studies. Our clinical practice of all four neonatologists participating in clinical rounds and discussion about nearly each transfusion might have contributed to this lower number of transfusions. On the other hand, our practice of obtaining weekly hematocrit levels on VLBW infants on each Monday probably contributed to a number of transfusions. More infants were transfused on Mondays compared to any other day of the week. Now, we are debating whether it is a necessary practice to check hematocrit on a weekly basis or whether it should be checked as clinically indicated.

We conclude that VLBW infants in the 1990s postsurfactant era received 2.7 red blood cell transfusions per infant on average, with the smallest infants requiring more transfusions. These data will be helpful to counsel mothers in preterm labor regarding the need for transfusions and approximate number of transfusions VLBW preterm infants in each birth weight category would need. These data can also be used as comparative data for future interventional measures such as erythropoietin, because this study includes the largest number of infants during postsurfactant time. It appears that with current transfusion guidelines, we have reached the lowest limits. The number of transfusions may be decreased further by high-volume blood transfusions (20 mL/kg vs. 15 mL/kg), or measures such as erythropoietin, or by utilizing stricter transfusion guidelines. The safety of such measures needs to be carefully evaluated with appropriate studies prior to implementation. Utilizing stricter guidelines for transfusions without evaluating physiologic effects on tissue oxygenation and long-term neurological outcome may not be warranted.

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