Impact of restrictive platelet transfusion strategies on transfusion rates: a cohort study in very preterm infants

Heeger, L.E.; Houben, N.A.M.; Caram-Deelder, C.; Fustolo-Gunnink, S.F.; Bom, J.G. van der; Lopriore, E.

Received: 21 November 2023 | Revised: 18 March 2024 | Accepted: 1 April 2024

DOI: 10.1111/trf.17844

TRANSFUSION PRACTICE

TRANSFUSION

Impact of restrictive platelet transfusion strategies on transfusion rates: A cohort study in very preterm infants

L. E. Heeger[1,2] | N. A. M. Houben[1,2] | C. Caram-Deelder[3] | S. F. Fustolo-Gunnink[2] | J. G. van der Bom[3] | E. Lopriore[1]

[1]Willem-Alexander Children's Hospital, Department of Pediatrics, Division of Neonatology, Leiden University Medical Center, Leiden, The Netherlands

[2]Sanquin Blood Supply Foundation, Clinical Center for Transfusion Research, Amsterdam, The Netherlands

[3]Department of Clinical Epidemiology, Leiden University Medical Center, Leiden, The Netherlands

Correspondence
E. Lopriore, Willem Alexander Children's Hospital, Department of Pediatrics, Division of Neonatology, Leiden University Medical Center, 2333ZA Leiden, The Netherlands.
Email: e.lopriore@lumc.nl

Abstract

Background: Evidence supports a restrictive platelet transfusion threshold in preterm neonates. We aimed to describe the effect of implementing this threshold on transfusion rates.

Study Design and Methods: This retrospective observational cohort study included all very preterm infants (born <32 weeks' gestation) admitted to a neonatal intensive care unit between 2004 and 2022, divided into three epochs. Platelet transfusion thresholds changed from 30×10^9/L for stable neonates and 50×10^9/L for unstable neonates (January 2004 to December 2009) to 20×10^9/L for stable neonates and 50×10^9/L for unstable neonates (January 2010 to June 2019) to 25×10^9/L for non-bleeding neonates and 50×10^9/L for neonates with major bleeding (July 2019 to July 2022). The primary outcome was the percentage of transfused neonates in each epoch. Secondary outcomes included the median number of transfusions per neonate, the percentage of transfusions given above 25 or 50×10^9/L, and major bleeding and mortality rates.

Results: The percentage of neonates transfused was 12.2% (115/939), 5.8% (96/1660), and 4.8% (25/525) in Epoch I, II, and III, respectively ($p < .001$), a relative reduction of 61%. The median number of transfusions per transfused neonate was 2.0 (interquartile range [IQR]: 1.0–3.0) in Epoch I, and 1.0 (IQR: 1.0–2.0) in subsequent Epochs ($p = .04$). The percentage of infants receiving at least one transfusion above 50×10^9/L in Epoch I, II, and III was 51.3% (59/115), 17.7% (17/96), and 20.0% (5/25; $p < .001$). Mortality and bleeding rates did not significantly differ between epochs.

Abbreviations: CBO, Centraal Begeleidings Orgaan; GA, gestational age; IQR, interquartile range; IUGR, intrauterine growth restriction; IVH, intraventricular hemorrhage; LUMC, Leiden University Medical Center; NEC, necrotizing enterocolitis; NICU, neonatal intensive care unit.

Discussion: Implementation of restrictive platelet guidelines led to reduction of the rate and number of platelet transfusions.

KEYWORDS
neonatology, platelet transfusion, restrictive platelet threshold

1 | INTRODUCTION

Platelet transfusions are administered to 5.8%–53.0% of neonates with a gestational age (GA) at birth below 32 weeks.[1–3] Most of these transfusions are given prophylactically, aiming at preventing bleeding when platelet counts drop below the set transfusion threshold.[4] Evidence supporting these thresholds has only recently become available. In 2019, the PlaNeT-2/MATISSE trial, a large multicenter randomized controlled trial, compared a liberal transfusion threshold (50×10^9/L) to a restrictive transfusion threshold (25×10^9/L) in non-bleeding neonates with a GA at birth below 34 weeks.[2] In this trial, major bleeding or death occurred in 26% of the neonates in the high threshold group and 19% in the low threshold group, supporting the benefit of a restrictive threshold. A secondary analysis of the trial demonstrated that the benefit of a lower threshold is consistent for all neonates, irrespective of their baseline risk of major bleeding and/or death.[5] A follow-up study showed mortality and neurodevelopmental impairment at 2 years of corrected age were also lower in the low-threshold group.[6] The findings of the trial resulted in a national guideline change for neonatal platelet transfusions in the Netherlands in 2019, which recommended a platelet transfusion threshold of 25×10^9/L in all non-bleeding preterm neonates.[7] Before 2019, two guideline changes for platelet transfusions were implemented in the study hospital. Internationally, after the publication of the PlaNeT-2/MATISSE trial, similar implementation of more restrictive strategies led to a reduction of platelet transfusions in some, but not in all reported studies.[8–11]

The aim of this study was to assess the effects of the guideline changes on the proportion of neonates receiving transfusions, the number of transfusions per neonate, and the percentage transfusions given at a platelet count above the threshold of 25 and 50×10^9/L in each epoch.

2 | MATERIALS AND METHODS

2.1 | Setting, study design, and population

We performed a retrospective single-center observational cohort study in the neonatal intensive care unit (NICU) at the Leiden University Medical Center (LUMC), a tertiary care center in the Netherlands. The institutional review board of the LUMC approved the study and waived the need for informed consent (G17-045). All neonates born with a GA below 32 weeks and admitted between January 2004 and July 2022 were included in the study. Based on the implementation of two separate guideline changes for platelet transfusion in 2010 and 2019, three consecutive time epochs were defined, and we allocated all neonates to the corresponding epoch based on their date of birth: Epoch I from January 1, 2004 to December 31, 2009; Epoch II from January 1, 2010 to June 30, 2019; and Epoch III from July 1, 2019 to July 16, 2022.

2.2 | Transfusion guideline changes

The guideline changes during the study period are described in Table 1. In Epoch I, platelet transfusion thresholds were 30×10^9/L for stable neonates and 50×10^9/L for sick or unstable neonates. "Sick" was not further defined in the transfusion guideline.[12,13] In 2010, the Dutch national blood transfusion guidelines were revised following a request from the national blood bank (Sanquin Blood Supply Foundation) council of users, to incorporate new evidence and unaddressed topics.[7] Based on this revision, the prophylactic transfusion threshold for stable neonates was lowered from 30×10^9/L to 20×10^9/L (Epoch II). However, the threshold of 50×10^9/L for sick neonates remained in the transfusion guideline. In July 2019, the transfusion guideline was adapted again, following the publication of the PlaNeT-2/MATISSE trial.[2] The prophylactic transfusion threshold changed from 20×10^9/L to 25×10^9/L in non-bleeding neonates to match the restrictive threshold used in the trial and 50×10^9/L for neonates with major bleeding.

2.3 | Outcome measures

All data were collected from the electronic medical records. The primary outcome measure was the percentage of neonates receiving at least one platelet transfusion per epoch. The secondary outcomes were the number of transfusions per transfused neonate, major bleeding and mortality, the percentage of babies given at least one

TABLE 1 Recommendations for transfusion thresholds for platelet transfusions in the three epochs.

	Epoch I January 2004–December 2009	Epoch II January 2010–June 2019	Epoch III July 2019–July 2022
Transfuse all	$<30 \times 10^9$/L	$<20 \times 10^9$/L	$<25 \times 10^9$/L
Weight < 1500 g, and gestational age at birth <32 weeks and sick/instable[a]	$<50 \times 10^9$/L	$<50 \times 10^9$/L	
Prior to intervention (surgery, lumbar puncture), after exchange transfusion, or experiencing a major bleed	$<50 \times 10^9$/L		
Prior to exchange transfusion (administer platelet transfusions halfway during exchange transfusion)	$<100 \times 10^9$/L		

[a]The protocol did not include a definition of being sick/instable. This indication was removed in the 2019 revision.

transfusion above the thresholds of 25×10^9/L and 50×10^9/L in each epoch, and the percentage of transfusions given above the thresholds of 25×10^9/L and 50×10^9/L in each epoch. Major bleeding was defined as severe gastrointestinal bleeding (frank rectal bleeding, except for mild bleeding caused by necrotizing enterocolitis [NEC]),[14] any acute fresh bleed through an endotracheal tube with ventilatory changes,[2] and/or a severe intraventricular bleed (IVH; defined as Grade III or Grade IV according to Papile),[15] and/or intracranial bleed with midline shift or compression. Premature neonates routinely undergo serial cranial ultrasonography to screen for possible bleeds in the first 2 weeks of life. Hereafter, cranial ultrasounds are performed less often, except when needed to monitor existing bleeds. As bleeding is an important clinical outcome and an important indication for receiving a therapeutic transfusion, we presented bleeding rates per epoch. We did not collect data on transfusion indications such as major bleeding or surgery, so we could not distinguish between prophylactic and therapeutic transfusions.

Before 2010, infants with a GA at birth below 25 weeks were not actively resuscitated according to the national guideline. In 2010, the national guideline was revised,[16] and the limit for active care measures in the NICU was lowered to a GA of 24 weeks. Therefore, no extremely preterm infants born below 24 weeks of gestation were included in Epoch I, in contrast to Epoch II and Epoch III.

2.4 | Platelet transfusion component specifications

The recommendations for transfusion dosage, the velocity of infusion, and irradiation remained unchanged during the entire study period. The default platelet transfusion product used was an apheresis hyperconcentrate platelet component, given in approximately 30 min at a dose of 20×10^9/L. Hyperconcentrate platelet transfusion is platelet component in which the amount of plasma is reduced to below 30%. This corresponds to around 4 mL for a 1 kg infant, depending on the concentration of platelets in the transfusion product. The choice for hyperconcentrate platelet components is based on potential prevention of volume overload.[17,18] In less than approximately 10% of transfusions, a non-hyperconcentrate transfusion is administered, usually in an emergency setting. Once a hyperconcentrate platelet transfusion is ordered, the Dutch national blood bank will prepare the hyperconcentrate component and immediately ship it to the hospital, where it is administered within 6 h after hyper concentration. The product is stored at 20–24°C.[19] Platelet transfusions for infants born below 32 weeks' gestation during the study period were routinely irradiated, leukocyte reduced,[20] ABO compatible, and Parvovirus B19 negative.

2.5 | Statistical analysis

Normally distributed values were presented as means and standard deviation (SD), and non-normal distributed values were presented as medians and interquartile range (IQR). We used the Kruskal–Wallis test to compare the use of platelet transfusions in the study epochs and the Chi-square test or Fisher exact test for comparing the morbidity and mortality rates. All statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) version 29.0 (IBM, Chicago, IL, USA) and STATA Statistical Software version 16.1 (TX, USA).

3 | RESULTS

During the study period, a total of 3124 neonates born at a GA below 32 weeks were admitted to the NICU. In total, 624 transfusions were given to 236 neonates.

3.1 | Baseline characteristics

Baseline characteristics are presented in Table 2. There are several differences between the epochs. As expected, the GA was higher in Epoch I compared to Epoch II and III. There was also an increase in cesarean section rates over time. The incidence of sepsis was lower in Epoch II and III compared to Epoch I. The incidence of NEC ≥ Stage 2[14] was lower in the first epoch compared to the latter two epochs. Lastly, the duration of mechanical ventilation was longer in Epoch I.

3.2 | Primary outcome

During the whole study period, 236 (7.6%) very preterm infants received at least one platelet transfusion. Over time transfusion rates decreased from 12.2% (115/939) to 5.8% (96/1660) to 4.8% (25/525) in Epoch I, II, and III, respectively ($p < .001$; Figure 1). This is an absolute reduction of 7.5% and a relative reduction of 61%.

3.3 | Secondary outcomes

The median number of transfusions for each transfused neonate decreased from 2 (1–3) in Epoch I to 1 (1–2) in Epochs II and III, respectively ($p = .04$). We stratified the transfusion rates by GA at birth, which shows a lower transfusion rate among neonates with a higher GA at birth (Figure 2).

The percentage of infants receiving at least one transfusion given at a platelet count of 25×10^9/L or higher decreased from 90.4% (104/115) in Epoch I, to 74.0% (71/96) in Epoch II, and 56.0% (1425) in Epoch III ($p < .001$). The percentage of infants receiving at least one transfusion at a platelet count of 50×10^9/L or higher was 51.3% (59/115) in Epoch I, 17.7% (17/96) in

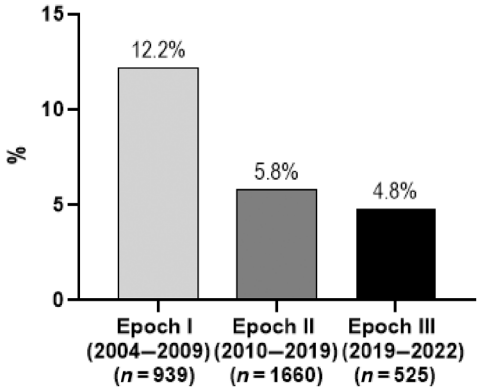

FIGURE 1 The percentage of neonates who received at least one platelet transfusion stratified by epoch.

TABLE 2 Baseline characteristics.

Characteristics	Epoch I January 2004–December 2009 ($n = 939$)	Epoch II January 2010–June 2019 ($n = 1660$)	Epoch III July 2019–July 2022 ($n = 525$)	p-Value[a]	Total ($n = 3124$)
Male sex, % (n)	53.0 (498)	53.6 (889)	54.7 (287)	.84	53.6 (1674)
GA at birth (median, IQR)	29.0 (28.0–30.0)	29.0 (27.0–31.0)	29.0 (27.0–30.0)	.001	29 (27–30)
Multiple birth, % (n)	38.7 (363)	39.5 (655)	36.8 (193)	.54	38.8 (1211)
Cesarean section, % (n)	44.6 (419)	50.5 (838)	56.8 (298)	<.001	49.8 (1555)
Birth weight in grams (mean, SD)	1262.0 (363)	1249.6 (378)	1213.3 (366)	.35	1247 (371.6)
IUGR,[23] % (n)	34.8 (327)	30.7 (510)	30.7 (161)	.08	32 (998)
Sepsis, % (n)	31.4 (296)	23.8 (395)	22.5 (118)	<.001	25.9 (808)
NEC (≥ stage 2), % (n)	2.8 (26)	4.8 (80)	4.4 (23)	.04	4.1 (129)
Days of mechanical ventilation (median, IQR)	1.0 (0–6)	0.0 (0–3)	0.0 (0–3)	.0001	0 (0–4)
Mortality, % (n)	8.0 (75)	6.9 (115)	9.0 (47)	.27	7.6 (237)
Length of stay, days (median, IQR)	13.0 (6–27)	12.0 (6–29)[b]	13.0 (6–32)[b]	.39	13 (6–29)[c]
Days of life until first platelet transfusion (median, IQR)	3.0 (1–7)	3.0 (1.5–6)	2.0 (2–9)	.941	3.0 (1–7)

Abbreviations: GA, gestational age; IQR, interquartile range; IUGR, intrauterine growth restriction; NEC, necrotizing enterocolitis.
[a]χ^2 test, analysis of variance, or Kruskal–Wallis test when appropriate.
[b]Two missing values for length of stay.
[c]Four missing values for length of stay.

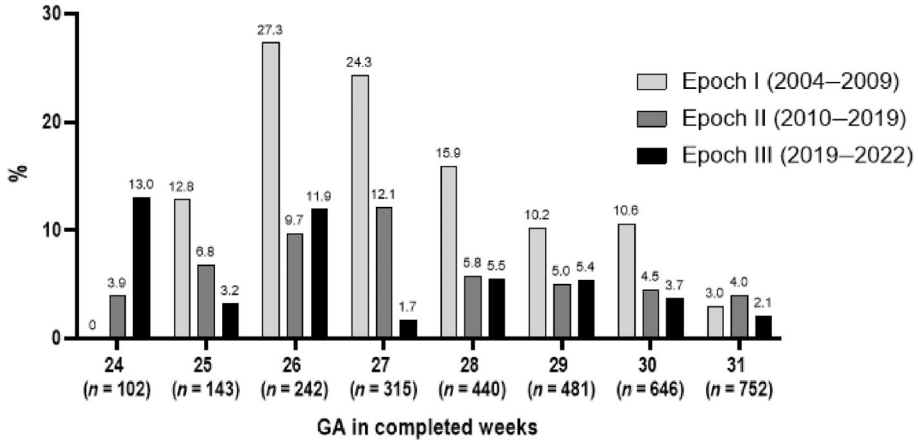

FIGURE 2 Percentage of neonates receiving at least one platelet transfusion stratified by gestational age (GA) at birth and epoch.

TABLE 3 Incidence of major bleeding and mortality in each epoch.

Morbidity % (*n*)	Epoch I Jan 2004–Dec 2009 (*n* = 939)	Epoch II Jan 2010–June 2019 (*n* = 1660)	Epoch III July 2019–July 2022 (*n* = 525)	*p*-Value[a]
Gastrointestinal bleeding	0.0 (0)	0.4 (7)	0.4 (2)	.14
Pulmonary bleeding	1.0 (9)	1.7 (28)	2.5 (13)	.08
Severe IVH (Grade III or IV)	7.2 (68)	6.9 (115)	9.5 (50)	.14
Intracranial bleed, non IVH	0.3 (3)	0.3 (5)	0.2 (1)	.90
Major bleeding (overall)	8.4 (79)	8.5 (141)	11.2 (59)	.13
Mortality (overall)	8.0 (75)	6.9 (115)	9.0 (47)	.27

Abbreviation: IVH, intraventricular hemorrhage.
[a]χ^2 test or fisher exact test when appropriate.

Epoch II, and 20.0% (5/25) in Epoch III ($p < .001$). The percentage of transfusions given at a platelet count of 25×10^9/L or higher decreased from 60.1% (211/351) in Epoch I to 50.5% (111/220) in Epoch II and 37.7% (20/53) in Epoch III ($p = .003$). The percentage of transfusions given at a platelet count of 50×10^9/L or higher decreased from 23.4% (83/351) in Epoch I to 10.0% (22/220) in Epoch II and 9.4% (5/53) in Epoch III ($p < .001$).

The percentage of major bleeding was 8.4% (79/939) in Epoch I, 8.5% (141/1660) in Epoch II, and 11.2% (59/525) in Epoch III ($p = .13$). Overall mortality was 8.0% (75/939) in Epoch I, 6.9% (115/1660) in Epoch II, and 9.0% (47/525) in Epoch III ($p = .27$). Severe IVH was detected in 7.2% (68/939), 6.9% (115/1660), and 9.5% (50/525) of infants in Epoch I, II, and III, respectively ($p = .14$; Table 3).

4 | DISCUSSION

This study shows that the implementation of successive restrictive platelet transfusion guidelines at the study hospital in the past two decades resulted in an absolute reduction of 7.5% in the proportion of neonates who received one or more transfusions and a relative reduction of 61%. In addition, we found a 50% reduction in the median number of transfusions per neonate.

In all epochs, transfusion rates decreased with increasing GA. The group of extreme preterm neonates with a GA of 24–25 weeks of gestation had however a lower transfusion rate compared to neonates of 26–27 weeks. This is potentially a chance finding. An alternative explanation is that many of these infants may have passed away before receiving a transfusion. Within the neonates born at 24 weeks gestation, an increase in the proportion transfused is visible between epochs II and III. This might be a chance finding, due to a lower number of included infants in epoch III. Another explanation might be that survival has increased due to advances in neonatal care, and therefore more infants remain at risk for receiving a transfusion.

Besides transfusion rates, we also reported clinical outcomes for each epoch. We observed a slight increase in the incidences of severe IVH, overall major bleeding,

and mortality in epoch III. Importantly, epochs II and III include infants born at 24 weeks gestation, which may contribute to the higher incidences of severe IVH, overall bleeding, and mortality (since the population of infants born <25 weeks is at very high risk for each of these outcomes). Given the non-significant *p*-values, these observed incidences may also be chance findings. One should be careful interpreting these results as our study did not allow further evaluation of other possible causes.

Proving the safety of restrictive platelet transfusion guidelines was not the intention of our study, as this has been shown previously in the PlaNeT-2/MATISSE study. The focus of our study was on evaluating the implementation of these findings.

4.1 | Comparison with the literature

A few other studies have previously described successful implementation of restrictive platelet transfusion guidelines, of which four studies used the thresholds from the PlaNeT-2/MATISSE study.[8–11] The percentages of neonates receiving a transfusion after implementation vary between 5.0% and 11.9% in these studies. Three of these studies show relative reductions varying from 40% to 51% in the number of neonates receiving a platelet transfusion over the years following guideline changes.[8–10] Our findings corroborate these findings. One study did not show a significant reduction in the number of neonates receiving a transfusion.[11] This contradicts our study results but might be due to the selection of transfused neonates in the second period of this study. As these recipients have a lower GA, a lower birth weight, and consist of a higher proportion of intrauterine growth restricted (IUGR) neonates than in the first period, they are likely more at risk of morbidity and therefore transfusions.

4.2 | Strengths and limitations

Strengths of our study encompass the large number of included preterm neonates, complete data of high quality, and the long time period. We described the direct implementation of the PlaNeT-2/MATISSE study with restrictive thresholds for preterm neonates, irrespective of postnatal age or clinical status.

We acknowledge the limitations to our study. We did not have information on clinical characteristics that may have been considered by the prescribing physicians for transfusion indications. This is particularly relevant in Epochs I and II, where being deemed "sick" was a reason for prescribing a transfusion at the higher platelet count threshold.

Second, this is a single-center study. The study hospital may differ from others with respect to guidelines, platelet component specifications, transfusion dose and velocity, and patient characteristics, hampering the generalizability of our results.

Third, the characteristics of our study population changed over time. The observed decreased transfusion rates may, in part, be influenced by these changes. However, the changes we observed were an increase in the proportions of neonates with NEC in Epochs II and III compared to Epoch I and a lower GA in the later epochs. These are usually associated with higher or similar risks of transfusion, which is the opposite of what we observed. Our results therefore suggest that the reduction in transfusion rates is most likely a result of the implementation of new guidelines.

To compare rates of infants receiving at least one transfusion given above the restrictive thresholds of 25 and 50×10^9/L, we categorized all platelet transfusions based on the pre-transfusion platelet counts. This is a crude assessment, dictated by data availability, as it does not consider whether these transfusions were given while actively bleeding or during a clinical setting where the transfusion was deemed necessary. Nonetheless, this approach does allow us to observe a trend in the number of non-indicated transfusions. Additionally, we know from previous studies that the majority of platelet transfusions are given prophylactically.[3,4,21]

4.3 | Clinical relevance

We provide information on the current proportion of transfused neonates in a single center, after implementing increasingly restrictive platelet transfusion thresholds. While the rates of transfusions have gone down, still 20% of transfused infants received at least one transfusion above 50×10^9/L and 56% above 25×10^9/L. An international survey showed 57% of European NICUs transfuse non-bleeding neonates at platelet counts above 25×10^9/L,[22] indicating the importance of information on implementation. Future studies regarding the optimal platelet transfusion threshold will require an increasingly larger sample size given the current low transfusion prevalence.

5 | CONCLUSION

We found that the successive implementation of increasingly restrictive prophylactic platelet transfusions in the past two decades in very preterm neonates reduced by more than half the relative need of transfusion rates and number of transfusions per neonate. Implementation of

the Planet-2/MATISSE study results is feasible and urgently needed, given the increased risk of mortality and major bleeding associated with higher transfusion thresholds.

ACKNOWLEDGMENTS

S.D.L. Broer for her assistance in the data collection.

CONFLICT OF INTEREST STATEMENT

The authors have disclosed no conflicts of interest.

ORCID

L. E. Heeger https://orcid.org/0000-0002-3944-8991

REFERENCES

1. Patel RM, Hendrickson JE, Nellis ME, Birch R, Goel R, Karam O, et al. Variation in neonatal transfusion practice. J Pediatr. 2021;235:92–9.e4.
2. Curley A, Stanworth SJ, Willoughby K, Fustolo-Gunnink SF, Venkatesh V, Hudson C, et al. Randomized trial of platelet-transfusion thresholds in neonates. N Engl J Med. 2019;380(3):242–51.
3. Sola-Visner M, Bercovitz RS. Neonatal platelet transfusions and future areas of research. Transfus Med Rev. 2016;30(4):183–8.
4. Sparger KA, Assmann SF, Granger S, Winston A, Christensen RD, Widness JA, et al. Platelet transfusion practices among very-low-birth-weight infants. JAMA Pediatr. 2016;170(7):687–94.
5. Fustolo-Gunnink SF, Fijnvandraat K, van Klaveren D, Stanworth SJ, Curley A, Onland W, et al. Preterm neonates benefit from low prophylactic platelet transfusion threshold despite varying risk of bleeding or death. Blood. 2019;134(26):2354–60.
6. Moore CM, D'Amore A, Fustolo-Gunnink S, Hudson C, Newton A, Santamaria BL, et al. Two-year outcomes following a randomised platelet transfusion trial in preterm infants. Arch Dis Child Fetal Neonatal Ed. 2023;108(5):452–7.
7. CBO. Richtlijn bloedtransfusie. Centraal begeleidingsorgaan, Netherlands; 2011. p. 1–557. https://www.nvog.nl/wp-content/uploads/2018/02/Bloedtransfusie-2.0-11-11-2011.pdf
8. Davenport PE, Chan Yuen J, Briere J, Feldman HA, Sola-Visner MC, Leeman KT. Implementation of a neonatal platelet transfusion guideline to reduce non-indicated transfusions using a quality improvement framework. J Perinatol. 2021;41(6):1487–94.
9. Borges JP, dos Santos AMN, da Cunha DHF, Mimica AFMA, Guinsburg R, Kopelman BI. Restrictive guideline reduces platelet count thresholds for transfusions in very low birth weight preterm infants. Vox Sang. 2013;104(3):207–13.
10. Zabeida A, Chartrand L, Lacroix J, Villeneuve A. Platelet transfusion practice pattern before and after implementation of a local restrictive transfusion protocol in a neonatal intensive care unit. Transfusion. 2023;63(1):134–42.
11. Bahr TM, Christensen TR, Henry E, Astin M, Ilstrup SJ, Ohls RK, et al. Platelet transfusions in a multi-neonatal intensive care unit health care organization before and after publication of the PlaNeT-2 clinical trial. J Pediatr. 2023;257:113388.
12. New HV, Berryman J, Bolton-Maggs PHB, Cantwell C, Chalmers EA, Davies T, et al. Guidelines on transfusion for fetuses, neonates and older children. Br J Haematol. 2016;175(5):784–828.
13. NBA. National Blood Authority Australia guideline: Patient Blood Management guidelines: module 6 neonatal and paediatrics. https://blood.gov.au/system/files/14523_NBA-Module-6-Neonat_Paediatrics_internals_5_updated_14_May_2020.pdf
14. Bell MJ. Neonatal necrotizing enterocolitis. N Engl J Med. 1978;298(5):281–2.
15. Papile LA, Burstein J, Burstein R, Koffler H. Incidence and evolution of subependymal and intraventricular hemorrhage: a study of infants with birth weights less than 1,500 gm. J Pediatr. 1978;92(4):529–34.
16. de Laat MWM, Wiegerinck MM, Walther FJ, Boluyt N, Mol BWJ, van der Post JAM, et al. Richtlijn Perinataal beleid bij extreme vroeggeboorte. Ned Tijdschr Geneeskd. 2010;154(A2701):1–5.
17. Honohan A, van't Ende E, Hulzebos C, Lopriore E, van't Verlaat E, Govaert P, et al. Posttransfusion platelet increments after different platelet products in neonates: a retrospective cohort study. Transfusion. 2013;53(12):3100–9.
18. Specialisten FM. Transfusieproduct trombocytentransfusies neonaten trombocytopenie. Federatie medische specialisten, Netherlands; 2019. p. 258–61.
19. S.B.S. Foundation. Sanquin Bloedwijzer-Informatie voor gebruikers van korthoudbare bloedproducten en Omniplasma. Stichting Sanquin, Netherlands; 2021.
20. van der Meer PF, Reesink HW, de Korte D, Loos JA, Klei TRL. The history of buffy coat platelet concentrates: the Dutch story. Vox Sang. 2022;117(7):913–9.
21. Gunnink SF, Vlug R, Fijnvandraat K, van der Bom JG, Stanworth SJ, Lopriore E. Neonatal thrombocytopenia: etiology, management and outcome. Expert Rev Hematol. 2014;7(3):387–95.
22. Scrivens A, Reibel NJ, Heeger L, Stanworth S, Lopriore E, New HV, et al. Survey of transfusion practices in preterm infants in Europe. Arch Dis Child Fetal Neonatal Ed. 2023;108(4):360–6.
23. Kloosterman GJ. Intrauterine growth and intrauterine growth curves. Maandschr Kindergeneeskd. 1969;37(7):209–25.

How to cite this article: Heeger LE, Houben NAM, Caram-Deelder C, Fustolo-Gunnink SF, JG van der Bom, Lopriore E. Impact of restrictive platelet transfusion strategies on transfusion rates: A cohort study in very preterm infants. Transfusion. 2024;64(8):1421–7. https://doi.org/10.1111/trf.17844