

# Pedipacks in the transfusion of pediatric patients to reduce wastage of blood components: an observational study from a tertiary center

Nihat Atahan Kanbur<sup>®</sup>, Sema Aylan Gelen<sup>®</sup>, Emine Zengin<sup>®</sup>, Nazan Sarper<sup>®</sup>

*Department of Pediatric Hematology, Kocaeli University Faculty of Medicine, Kocaeli, Türkiye.*

## ABSTRACT

**Background.** Pedipacks prevent wastage of blood components but they are not used efficiently in pediatric clinics.

**Methods.** Red cell concentrate (RCC) and platelet concentrate volumes transfused in the last eight months in the pediatric clinics were screened. To calculate the wastage of blood components, the number of transfused pedipacks, whole unit RCC, and platelet units were screened from transfusion laboratory digital records to show the number of whole RCC units or platelets units used instead of pedipacks. The study results were shared with physicians and transfusion laboratory staff and they were trained on the subject in meetings. Two years later, the transfusion laboratory records were assessed again to evaluate pedipack usage. A google questionnaire was also submitted to the transfusion laboratories of other hospitals to assess the use of pedipacks.

**Results.** RCC and platelets were used in 82.9% of the transfusions, and 31.2% of RCC and 18.4 % of platelets were transfused to patients  $\leq 12$  months. During the study period, 569 pedipacks and 117 random donor or apheresis platelets separated into satellite packs would be required. But only 48 pedipacks of RCCs and 24 units of random donor platelets/apheresis platelets separated into satellite packs were used. After two years, in RCC transfusions of 0-12 month-old patients, the transfusion laboratory release of pedipacks increased to 67.9% from 13.5%. Other centers were not also using pedipacks efficiently. The main reasons were unawareness of the subject, the blood bank delivering two units of pedipacks even when only one unit was ordered and the risk of not using the second pedipack before the expiry date, and the short expiry date of irradiated pedipacks.

**Conclusions.** By increasing awareness of the subject, the collaboration of the clinic and laboratory and solving bureaucratic problems, rational use of blood components can be achieved.

**Key words:** transfusion, pediatric, pedipack, platelet, red cell concentrate.

The transfusion of blood and its components is frequently a life-saving procedure. Blood components are valuable and they should not be wasted. They are ready for use after many procedural steps including donor selection, donation, screening tests to detect the presence of transfusion-transmissible infection agents, blood grouping, and separation into components. Maintaining optimal storage and

transport conditions is also essential. Platelets are also collected by apheresis which is a more expensive procedure and laborious for donors. It is not easy to find healthy volunteer donors; throughout the world, blood services are trying to develop strategies for donor acquisition and retention to prevent the shortage of blood components. It is reported that in our country with a population of 83,614,000, the annual blood donation requirement is about 3,000,000 units.<sup>1</sup> The COVID-19 (Coronavirus disease 2019) pandemic also affected blood services; donations decreased and concerns regarding the safety of blood products have emerged.<sup>2</sup>

✉ Nazan Sarper  
nazan\_sarper@hotmail.com

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In the 21st century, neonatal and pediatric intensive care facilities increased and in these units, patients require frequent blood transfusions. In the top-up transfusion practice of newborns, 10-20 ml/kg red cell concentrates (RCC) are used.<sup>3</sup> If pedipacks are not used, blood components are wasted. Pedipack use may also reduce exposure to multiple donors. Exposure of a patient to multiple donors increases the risk of transmission of blood-borne infections and immunization with foreign antigens.

In newborns, 10 ml/kg platelet concentrate is transfused targeting a platelet count of at least  $20 \times 10^9/l$  for stable term infants,  $30 \times 10^9/l$  to  $50 \times 10^9/l$  for preterm infants. For infants who are bleeding or who have a consumptive coagulopathy, or undergoing invasive procedures, the target platelet count is even more than  $50 \times 10^9/l$ .<sup>4</sup> Random donor platelets derived from one unit of fresh whole blood are enough for non-bleeding newborns and infants. Apheresis platelets also may be divided into two or three satellite bags and may be given to newborns and infants.

RCCs derived from one unit of whole blood are generally separated into four pedipacks each with a volume of 80 ml. One pedipack is enough for all neonatal transfusions and the majority of infant transfusions. Even 30 ml packs were prepared and their transfusion was found cost-effective for some preterm babies.<sup>5</sup> Preterm neonates become frequently anemic partly due to diagnostic phlebotomy losses and require top-up transfusions. When pedipacks prepared from a single donation are used in repeated transfusions, this may result in the use of older blood. The age of red blood cells in the Premature Infants trial reported no effect on clinical outcomes for preterm neonates using red cells of different storage ages.<sup>6</sup> Although studies showed the impact of single blood donor exposure programs for infants, pediatric hematologists presumed that pedipacks were rarely used in hospitals.<sup>7,8</sup> Due to similar observations, this study was planned by pediatric hematologists at a single center to increase pedipacks usage. All the blood and

blood components transfused in the last eight months in the pediatric clinic of the center were recorded retrospectively; the results were shared with neonatologists, pediatricians, and the transfusion laboratory staff to attract their attention to the subject. They were trained on the subject and after two years, the transfusion laboratory pedipacks released were screened again to show the outcome of the study. A google questionnaire was also submitted to some centers to investigate the pedipack usage in the country and to show reasons for limited pedipack usage.

## Material and Methods

Ethical approval was obtained from Ethics Committee of Kocaeli University (No.2018/28).

The study was planned in five steps:

Step 1: This step of the study was conducted in the pediatric clinic. Transfused blood components in the last eight months (February 2018 -September 2018) were screened from patient files and electronic records. The age of the patient, transfused volume, transfused blood component and blood groups of the components were recorded. Transfused RCC and platelet concentrate volumes were classified as  $\leq 80$  ml, 81-160, and  $>160$  ml because one pedipack contains 80 ml. The number of consumed RCC (whole units and pedipacks) and platelets were recorded from transfusion laboratory records to evaluate the wastage of blood components. Data collection by the research assistant was completed in three months.

Step 2: In 2019, the results of the study were shared with the physicians of the department of pediatrics. Contents of the pedipacks and volume wasted when whole unit RCC are used in newborn and infant transfusion, risks of multiple donor exposure, and increasing expenses when pedipacks are not used were explained. The difficulty of finding blood donors, blood component producing process, storage and logistic conditions, and expiry dates of components were emphasized. In

meetings with the transfusion laboratory staff of the center, volume transfused to newborns and infants and transfusion volume per kg in children were explained. Release of the components to the clinic considering the age and weight of the patient was recommended. Blood laboratory staff were encouraged to store enough pedipacks and always send pedipacks for the transfusion of patients younger than 12 months. In these face-to-face conversations, their awareness of the subject was increased and reasons for inefficient use were determined. They reported that there was no pedipack alternative in the software program of the hospital when physicians ordered blood components and the price of pedipacks was missing in the national health insurance system. These bureaucratic problems (adding the pedipack to hospital software, pricing the pedipacks) were solved. The training was completed in two months.

Step 3: After two years, the digital records of the transfusion laboratory were screened again (February 2020 -September 2020) to evaluate the pedipack use in patients ≤12 months.

Step 4: In 2021, a google questionnaire was submitted to transfusion laboratories of other hospitals to assess the usage of pedipacks. In addition to multiple-choice questions containing home-center problems, there were open-ended questions about the reasons for limited pedipack usage.

Step 5: Google questionnaire results were shared with directors of Red Crescent Blood Service and some recommendations were given to decrease the waste of blood components.

Statistics: Descriptive statistics (percentage) were used. (IBM SPSS 20.0- IBM Corp., Armonk, NY, USA). Frequencies were calculated as a percentage.

### Results

In the pediatric clinic, 2169 transfusions were performed on 301 patients ≤18 years in the eight-month study period. Blood components were RCC (1134 units, 52.2%), platelets (668, 30.7%) fresh frozen plasma (FFP) (366 units, 16.8%), and one unit of whole blood which was used for exchange transfusion. Predominant blood groups of transfused RCC were ARh + (40.1%) and 0Rh+ (25.7%); similarly, predominant transfused platelet blood groups were A Rh + (50.6 %) and 0 Rh +(20.2%). The numbers and volumes of transfused RCCs and platelet concentrate in different age groups are shown in Tables I and II. When patients' age was evaluated, 31.2% (354/1134) of RCC and 18.4% (123/668) of platelets were transfused to patients ≤12 months.

All newborn transfusions were ≤ 80 ml. In 77% of infants, only one and in 14% two pedipacks of RCCs were required. Random donor platelets prepared from one unit of whole blood (40-80 ml) or apheresis platelets separated into three or two satellite packs (50 and 100 ml) would be enough for newborns and infants. During the study period, 347 pedipacks with a volume of 80 ml RCC and 111 two pedipacks RCC (a total of 569 pedipacks) would be required whereas 117 random donor or apheresis platelets separated into satellite packs would be enough.

**Table I.** The numbers and volume of transfused red cells concentrate in different age groups.

Age	Transfused red cell concentrate volume		
	≤80 ml	81-160 ml	>160ml
0-1 month	219 (100%)	0	0
>1 -12 month	104 (77.0%)	19(14.0%)	12(8.8%)
>12 month - 18 year	24(3.0%)	92(11.7%)	664(85.1%)
Total	347 (30.9%)	111 (9.9%)	666 (59.2%)

**Table II.** The numbers and volume of transfused platelet concentrate in different age groups.

Age	Transfused platelet concentrate volume		
	≤80 ml	81-160 ml	>160ml
0-1 month	91(100%)	0	0
>1 -12 month	18(56.2%)	14(43.7%)	0
>12 month - 18 year	8(1.4%)	154(28.2%)	383(70.2%)
Total n (%)	117 (17.5%)	168 (25.1%)	383 (57.3%)

But generally whole unit RCCs were used; only 48 pedipacks of RCCs and 24 units of random donor platelets/apheresis platelets separated into satellite packs were used. For children >12 months, two pedipacks from a single donation would be enough in 92 RCC transfusions. Apheresis platelets separated into satellite packs would be enough in some > 12-month-old stable patients especially if they were not undergoing invasive procedures. FFP transfused to infants and newborns were not evaluated because no pedipacks were available for FFP in the country and due to limited indications and long half-life, there was always excess FFP in blood banks.

During the study period, the cost of one pedipack RCC was 100TRY whereas one whole RCC unit was 217 TRY. If 569 units of pedipack RCC were used instead of 48 units, the hospital budget will save 36.870 TRY. The cost of apheresis platelets was 329 TRY and one pooled random donor platelet was 379 TRY. If the apheresis platelet was split into two satellite bags each will cost about 165 TRY. If satellite bags were used in all 117 platelet transfusions <80 ml instead of only 24 random donor platelets/ half unit of apheresis platelets, about 19.500 TRY would be saved. (1Euro=10 TRY during the study period). Pooled random donor platelets were derived from 3-4 units of whole blood but for transfusion of newborns and infants 1-2 units of random donor platelet would be enough and at least 190 TRY will be saved for each transfusion.

The reasons for inefficient use of pedipacks in the center were: a) absence of pedipack alternative in hospital software program when ordering blood components b) absence of pricing of pedipacks in the national health insurance system c) Residents' and physicians'

unawareness about pedipacks and waste of resources d) Lack of repeated transfusion training for rotating residents d)Unawareness of the local transfusion laboratory staff about the volume transfused to neonates and infants and waste of the components. e) Lack of communication between clinic and transfusion laboratory staff.

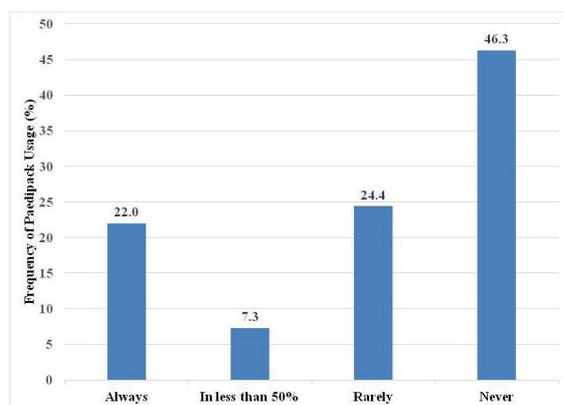
Study results determined the quantity of pedipack requirement of the clinic; whether the laboratory stored enough pedipacks according to these numbers and then clinicians guaranteed that they will order pedipacks. These communications eliminated the anxiety of the transfusion laboratory staff about the wastage of pedipacks due to expiry. After two years of the study, to evaluate the pedipacks usage, digital records of the transfusion laboratory were screened again. Comparison of pedipacks usage in RCC transfusions before and after training is shown in Table III. In RCC transfusions of 0-12 month-old patients, transfusion laboratory release of pedipacks was 13.5% before training whereas this increased to 67.9% after training. Due to the blood laboratory staff's awareness and organization, blood products in pedipacks were not wasted due to expiry date problems.

A Google questionnaire was submitted to the directors of transfusion laboratories of other hospitals with newborn intensive care units and pediatric inpatient units that could be reached by mobile phone or e-mail. Out of 43 directors, 41 answered the questionnaire; 46.3% (n=19) of these hospitals were Education and Research Hospitals of the Ministry of Health, 24.3% (n=10) were University Hospitals of Government, 24.3% (n=10) were Government Hospitals of the Ministry of Health and 4.8%

**Table III.** Comparison of pedipack usage in red cell concentrate transfusions before and after training in an eight-month period.

Age	Before Training (year 2018)		After Training (year 2020)	
	Pedipacks	Whole RCC Unit	Pedipacks	Whole RCC Unit
0-1 month n	48	171	59	13
>1 -12 months n	0	135	121	72
Total n (%)	48(13.5%)	306(86.4%)	180 (67.9%)	85(32.0%)

(n=2) were Private Hospitals. The frequency of pedipack usage in newborn units of 41 centers is shown in Figure 1: 19 (46.3%) centers never used, 10 (24.4%) rarely used, 9 (22%) always used, and 3 (7.3%) used in less than 50% of the newborn transfusions. Centers' answers for reasons of limited use of pedipacks: a) 16 centers (50%) stated "We do not order pedipacks from blood service because we may not transfuse it until the expiry date." b) 10 centers (31.3%) stated "Pediatricians and neonatologists are not aware of the pedipacks and they do not order this component." c) 9 centers (28.1%) stated "We are not used to transfusing pedipacks." d) 7 centers (21.9%) stated "This questionnaire increased our awareness about pedipacks and we will discuss this subject with neonatologists and pediatricians. Some directors also explained that blood services always sent a pair of irradiated pedipacks even when they ordered one for transfusion of a premature baby and the second irradiated pedipack would expire if they could not transfuse it within three days. Transfusion centers reported that they had no blood irradiator and they had to order irradiated products for premature babies.



**Fig. 1.** Frequency of pedipack usage in newborn units of 41 centers.

## Discussion

The present study showed that nearly one-third of the blood components were administered to newborns and infants in the pediatric clinic where <18-year-old patients were hospitalized.

RCC in pedipacks was used in only 14.0% and random donor platelets or apheresis platelets split into satellite packs were used in only 22.0% of <80 ml transfusions of  $\leq 12$  month-old patients. In this center, about 42 units of RCC and 15 units of platelets were transfused to newborns and infants monthly. A multicenter study showed that 51.6 % of preterms had transfusions at the intensive care units.<sup>9</sup> Although there was controversy about the threshold of transfusion in stable premature infants, they require multiple top-up transfusions.<sup>10</sup> In neonatal wards and neonatal intensive care units 47.3% received one, 18.6% received two and the remaining infants received three or more RCC transfusions. Infants with a birth weight below 1500 g were the group that required the highest RCC transfusions.<sup>7</sup>

One unit of RCC from one donation contains about 250-300 ml. Triple or double pedipacks from one donor with a storage period of 35 days would reduce wasted RCC volume and the number of donor exposure. A study showed that in a single-bag system  $118.5 \pm 12.5$  ml was the mean volume wasted per transfusion and the number of donor exposure was  $4.4 \pm 3.5$  in neonatal units. When double or triple bags were used, patients were exposed to about two donors.<sup>7</sup> Another study also showed that after implementing the pedipack system, red cell wastage per transfusion decreased to  $24.5 \pm 10$  mL.<sup>11</sup> During the study period, even in patients older than 12 months, 2 pedipacks RCC 80 ml each would be sufficient in 92 pediatric transfusions. In the study center, a blood irradiator was present in the transfusion laboratory and irradiation was performed just before transfusion if indicated. Indications for whole blood and cellular blood components were intrauterine transfusions, transfusions of premature infants (birth weight <1300 g), exchange transfusions, patients with leukemia and lymphoma, patients with solid tumors receiving chemotherapy, transplant patients and patients with aplastic anemia on immunosuppressive treatment.

Resource-saving is important in transfusion practice. In addition to difficulty in gaining volunteer donors, it is a subject of respect to donation. Physicians' training and awareness about transfusion practice are not always satisfying. Transfusion camps organized in Canada and United Kingdom for post-graduate training were a good solution to this problem.<sup>12</sup> A good collaboration between the clinical team and blood transfusion laboratory is essential for organizing transfusion practice rationally and for preventing waste of products without impairing the safety of patients.

Severe thrombocytopenia is a frequent finding in neonatal intensive care units and especially preterm neonates require prophylactic platelet transfusions to prevent intraventricular and other hemorrhages. Due to the short half-life of platelets, the prevention of waste of this blood component and reducing donor exposure will not be as easy as RCCs. The close interaction of physicians with transfusion laboratories is required to reduce wasted volume and donor exposure. In Turkey, there are regional blood banks of the Turkish Red Crescent Organization and due to logistic reasons ordered platelets arrive at the hospitals once a day. Transfusion laboratories prefer to store pooled or standard apheresis units of platelets to supply any patient, either newborn or adult. If apheresis procedures, donation, and blood component production were performed also in some hospitals as in previous years, preparing pedipacks from dedicated apheresis donors or random donor platelet production for infants would be possible. Splitting platelet units into two doses was among efforts to overcome platelet shortage during the COVID-19 pandemic in some countries.<sup>13</sup>

In this retrospective study, determining the reasons for ineffective use of pedipacks during face-to-face meetings, providing awareness and collaboration of clinicians and transfusion laboratory staff, and solving problems like adding pedipack alternatives to software programs increased pedipack use in pediatric

patients without wastage of pedipacks due to expiry.

However newborn transfusions decreased in the last evaluation due to decreasing occupancy in the neonatal intensive care unit. This was mainly due to the establishment of new neonatal intensive care units in the district and the referral of some patients to these units. Lowering the transfusion threshold and referral of COVID-19 positive pregnant women to pandemic hospitals were also other factors for reduced transfusion numbers in the newborn intensive care unit.

The Google questionnaire was performed presuming that inefficient use of pedipacks was a general problem in the country. Answers revealed that like home-center, unawareness of the physicians and transfusion laboratory staff about the subject and lack of communication between clinicians and laboratory staff were the main reasons in addition to the anxiety of wastage of pedipacks due to expiry. Reducing expired blood components was the responsibility of the transfusion laboratory but hospital administrations were unaware of the wasted volumes in the pediatric clinic and these were never recorded. The short expiry date of irradiated blood components and always delivering two pedipacks even if one was ordered were other reported reasons.

The Google questionnaire results were shared with directors of the Red Crescent Blood Service and some recommendations were given to decrease the waste of blood components: a) supplying pedipack RCC (either irradiated or not) according to the order of the transfusion laboratories instead of routinely supplying two pedipack units, b) Preparing pooled platelets from two random donations for pediatric patients.

The limitation of the study is that the number of transfusions per patient, and the number of donor exposures of each patient were not calculated. Additionally, the Google questionnaire could not be submitted to all of the centers in the country.

Increasing the use of pedipacks and decreasing the wasted volume of blood components is possible with training and good communication among physicians, transfusion laboratory staff, and blood services.

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### Ethical approval

Ethical approval was obtained from Ethics Committee of Kocaeli University (No.2018/28).

### Author contribution

The authors confirm contribution to the paper as follows: study conception and design: NS; data collection: NAK; analysis and interpretation of results: NAK, EZ, SAG; draft manuscript preparation: NS, NAK. All authors reviewed the results and approved the final version of the manuscript.

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### Conflict of interest

The authors declare that there is no conflict of interest.

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