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Survey on Blood Transfusion Practices among Medical and Paramedical Staff in the Pediatric Unit of the Mohammed VI University Hospital in Marrakesh, Morocco

Kaoutar Danaoui[1,2*], Widad Lahmini[1,2], Mounir Bourrous[1,2]

[1]Pediatric Emergency Department, CHU Med VI Marrakesh, Marrakesh, Morocco
[2]Faculty of Medicine and Pharmacy, Cadi Ayad University, Marrakesh, Morocco
Email: *kaoutar.dk@gmail.com

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Abstract

Blood transfusion is a complex activity, involving many actors. As a high-risk activity, it necessitates the implementation of specific methods for effective control. The safety of blood transfusion is significantly influenced by the beliefs of healthcare workers and organizational factors, constituting two major considerations. We conducted a cross-sectional, descriptive, and analytical survey to examine the knowledge and practices related to transfusion among the medical and paramedical staff at the Pediatric Department (Mother-Child) of CHU Mohammed VI from September 1, 2022, to December 31, 2022. Among the 135 staff members interviewed, only 41% had received training in blood transfusion. A majority (65.2%) of the staff noted that a mismatch in cross-matching led to transfusion complications. Two-thirds (66.7%) identified chills as the primary clinical sign of potential accidents. Regarding elements to monitor during a reaction, hemolysis (78.5%) and temperature (76.3%) were most commonly mentioned. Surprisingly, more than half (53.3%) of the personnel interviewed did not conduct post-transfusion monitoring. This survey highlighted significant deficiencies in knowledge and practices related to transfusion. To address these issues, we recommend implementing guidelines and providing tailored training for the staff, aiming to rectify these deficiencies and enhance overall practices.

Keywords

Blood Transfusion, Healthcare Personnel, Transfusion Safety, Post-Transfusion Incidents, Morocco, Hemovigilance

1. Introduction

Blood transfusion is a therapeutic procedure involving the transfer of blood or its cellular or plasma components from one or more subjects, referred to as "donors," to one or more sick subjects, termed "recipients" [1]. However, this medical practice is not trivial and can be poorly tolerated, exposing the recipient to numerous risks, including immunological, infectious, overload, or metabolic risks. Patients must be informed through the process of informed consent, and ensuring transfusion safety is imperative. This involves mastering all stages, from blood collection, preparation, and biological qualification to product selection and verification of compatibility with the recipient, as well as the procedure itself. Post-transfusion monitoring is also an integral part of ensuring safety.

Transfusion safety relies on strict adherence to the stages of a process that extends from the prescription of labile blood products and the necessary immuno-hematological tests to the administration of labile blood products (LBP) to the recipient and follow-up [2] [3]. Rigorous hemovigilance throughout the transfusion chain is essential. We conducted a survey of medical and paramedical staff at the pediatric unit of CHU Mohammed VI.

The aim of this study was to assess the knowledge and practices of pediatric blood transfusion among medical and paramedical staff working at the pediatric unit of CHU Mohammed VI.

2. Materials and Methods

This is a cross-sectional, descriptive, and analytical survey designed to examine the blood transfusion practices of medical and paramedical staff at the pediatric unit (mother and child hospital) of CHU Mohammed VI, Marrakesh. This study spanned a 4-month period, from September 1, 2022, to December 31, 2022.

The survey employed a questionnaire distributed to medical and paramedical staff. The questionnaire consisted of 32 questions, including some multiple-choice, some single-choice, and some open-ended.

The questions aimed to explore blood transfusion knowledge and practices and were categorized into six sections: Staff profile, Staff training level, General transfusion knowledge, Pre-transfusion phase, Transfusion phase, and Post-transfusion phase.

- Inclusion Criteria: Medical residents, interns, and nurses from the Mother-Child Hospital within the pediatric department were included in this study.
- Exclusion Criteria: Medical substitutes, medical externs, secretaries, physiotherapists, nutritionists, and maternity staff were excluded from this study.
- Data Collection: data were collected through a pre-established questionnaire distributed using the following formula to minimize investigator bias and ensure a consistent understanding among all surveyed physicians: a single medical resident distributed and collected questionnaires from medical residents, interns, and nurses based on anonymity and confidentiality.

3. Results

Out of the 200 questionnaires distributed, 135 were collected, resulting in a response rate of 67.5%. We assessed the knowledge and practices of a total of 135 members from the medical and paramedical staff at the pediatric unit of Marrakech University Hospital. Among them, 41.5% (n = 56) were nurses, 30.4% (n = 41) were internal physicians, and 28.1% (n = 38) were resident physicians (Table 1).

Three quarters of medical and paramedical staff (74.8%) had less than 5 years' experience (Figure 1).

Of the 135 staff members surveyed, only 41.5% (56 members) had received training in transfusion practices (Figure 2).

The majority of medical and paramedical staff (97.8%, n = 132) agreed that blood transfusion was not limited to red blood cells. The blood products most frequently mentioned in our study (Figure 3), apart from red blood cells, were fresh frozen plasma in 97.1% of cases (n = 131) and platelet concentrates in 90.4% of cases (n = 122).

Table 1. Breakdown of personnel by function.

Function	Number	Percentage (%)
Nurse	56	41.5%
Internal	41	30.4%
Resident	38	28.1%

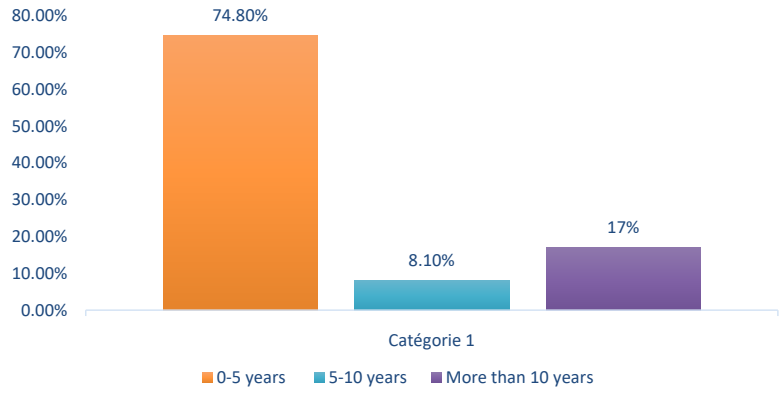

Figure 1. Length of employee experience.

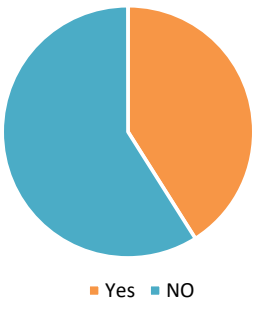

Figure 2. Staff training in blood transfusion.

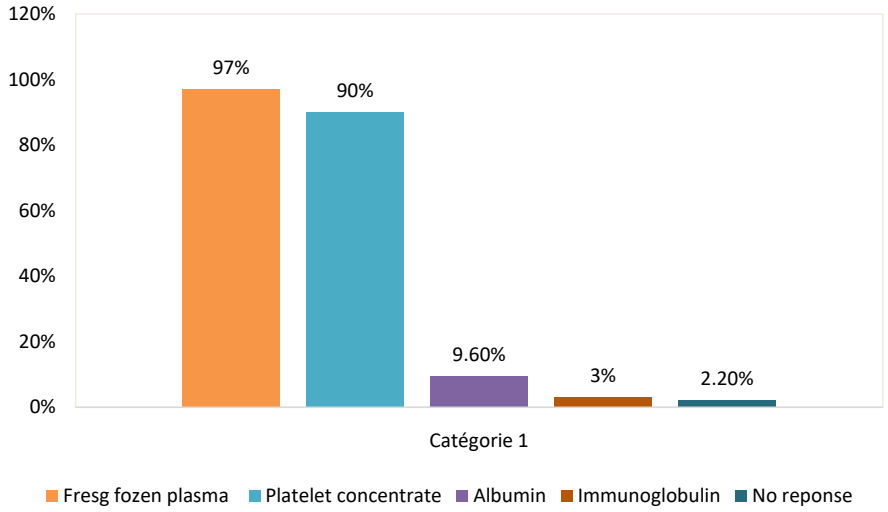

Figure 3. Transfusion of blood products by surveyed staff.

The immune systems prioritized by staff in standard phenotyping were primarily the Rhesus system in 95.6% (n = 129) and the ABO system in 87.4% (n = 118) of cases. The number of blood groupings was well-known to all medical and paramedical staff, with 100% (n = 135) specifying the number of blood groupings as 4 groups. Similarly, knowledge about the universal donor blood group "O" and the universal recipient blood group "AB" was also 100%.

According to nursing staff, the purpose of a transfusion, in more than half the cases (57.8%), was to attain hemoglobin levels above the dangerous threshold. In our study, the indication provided by medical and paramedical staff during the transfusion procedure relied on the hemoglobin value and the patient's condition in two-thirds of cases (66%). Of the 135 staff members surveyed, 97.8% (n = 132) mentioned that they performed two determinations. Pre-transfusion questioning by medical and paramedical staff was systematically carried out in 80.7% (n = 109) of cases. In our series, the majority of medical and paramedical staff inquired about transfusion history (74.8%) and transfusion reactions (74.1%), while 19.3% (n = 26) did not. Among the 135 staff interviewed, 92.6% (n = 125) correctly identified the tube with a pen, and 70.4% (n = 95) labeled the tube immediately after collection from the patient's bed, with 29.6% (n = 40) doing so before collection (**Figure 4**).

In our study, we observed that 70.4% (n = 95) indicated that the second determination was conducted on the same sample as the first. The majority of medical and paramedical staff (85.2%) stated that they carried out transfusions at any time as required.

We found that 31.9% (n = 43) performed the transfusion act several times a week, while 7.4% (n = 10) performed it daily. Almost all (97%) of the 135 staff members systematically performed the cross-match. Additionally, all medical and paramedical staff questioned in our series systematically verified the patient's identity when transfusing blood products.

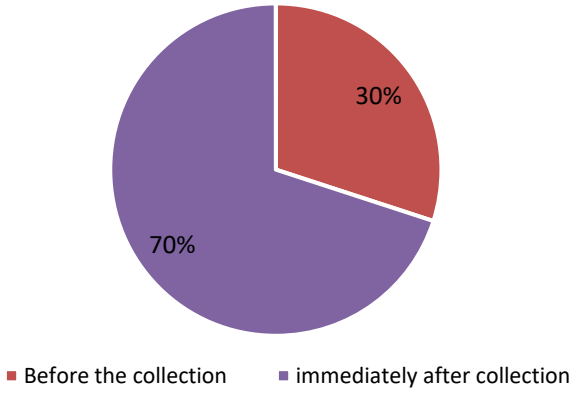

Figure 4. Time taken to complete tube labelling, according to staff interviewed.

In terms of transfusion monitoring, 40% (n = 54) of monitoring was conducted by the prescribing physician, and 31.3% (n = 42) by the nurse. Meanwhile, 23% (n = 31) mentioned that monitoring was carried out by all staff. Hemodynamic status, temperature, and shivering were monitored by 91.9% (n = 124) each, respiration by 88.9% (n = 120), and the state of consciousness by 83% (n = 112).

Among the 135 staff members, 44% (n = 59) had witnessed a transfusion reaction due to incompatibility. According to the experiences of the medical and paramedical nursing staff in our study, incidents or accidents during the transfusion of blood products were attributed to a cross-match not being made in 65.2% (n = 88) and a patient identification error in 59.3% (n = 80).

As per the knowledge of the nursing staff in our study, the clinical signs of accidents during the transfusion of blood products included shivering in 66.7% of cases, shock in 57% (n = 77), and hyperthermia in 51.9% (n = 70).

In response to a transfusion reaction, 100% (n = 135) stopped the blood transfusion, 34.1% (n = 46) stabilized the patient and treated with corticosteroids, 25.9% (n = 35) notified the doctor, and only 5.2% (n = 7) declared the accident.

Elements to be monitored for post-transfusion reactions, according to the interviewed staff members, included hemolysis (78.5%, n = 106), temperature (76.3%, n = 103), and volume overload (52.6%, n = 71).

Only 46.7% (n = 63) of the surveyed staff conducted a post-transfusion follow-up on the transfused patient. Among them, 35.6% (n = 48) requested a post-transfusion complete blood count (CBC). More than half (53.3%) did not (**Figure 5**).

4. Discussion

Blood transfusion is the culmination of centuries of scientific, medical, and technical advancements. Nobel Prizes awarded from 1901 onwards included recognition of contributions to transfusion medicine and blood transfusion [4]. Prior to 1901, the prevailing belief was that all humans shared the same blood group. However, Karl Landsteiner's 1901 discovery of ABO blood groups revolutionized this understanding, identifying three blood groups—A, B, and C (later

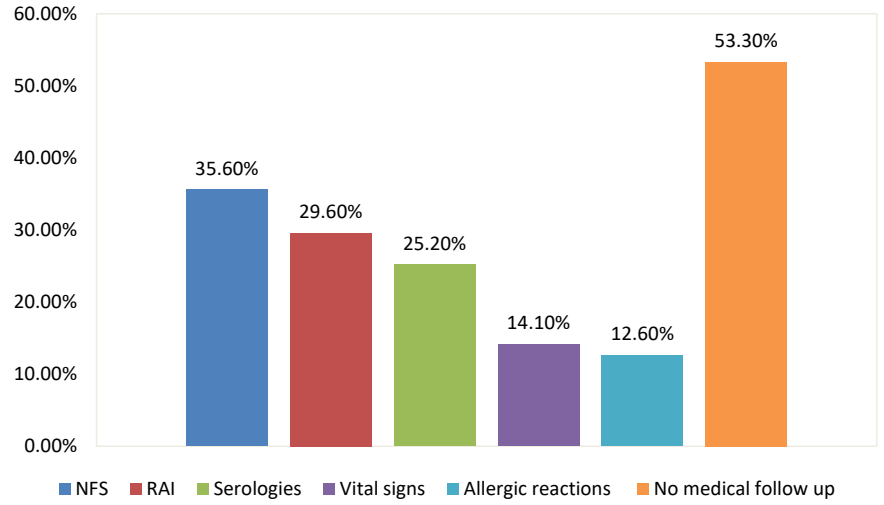

Figure 5. Biological and clinical assessment of post-transfusion follow-up.

renamed O) [5] [6].

Landsteiner, an Austrian immunologist, observed that human blood, when mixed in test tubes with other human blood specimens, sometimes caused agglutination. By incubating red blood cells from certain individuals with serum from others, he discerned patterns of agglutination, initially identifying three blood groups—A, B, and C (later renamed O) [7].

In 1902, Alfred Decastello and Adriano Sturli, former students of Landsteiner, discovered the fourth blood group, AB [8]. Landsteiner also made contributions to forensic science by developing a method for typing dried blood samples [9]. Despite being a significant discovery in transfusion medicine, ABO typing has not proven sufficient to prevent many fatal hemolytic transfusion reactions. In 1939, Philip Levine published a case report of post-transfusion hemolysis in a patient with blood group O who had received blood from her husband with blood group O [10].

Levine found that incubating the patient's serum with her husband's red blood cells resulted in agglutination. The name of the antibody in question derives from parallel experiments by Landsteiner and Alex Wiener, in which antibodies produced by immunizing rabbits and guinea pigs with rhesus monkey blood caused red blood cells to agglutinate in 85% of the humans tested [10]. Individuals whose red blood cells were agglutinated by these antibodies were classified as rhesus (Rh) positive [8]. Despite some successes by Blundell and his contemporaries, transfusions often failed to save lives and remained a rare procedure until the early 20th century. Coagulation remained a problem for preservation and storage.

Direct transfusion (donor artery anastomosed to recipient vein) was performed by Alexis Carrel in 1908, and direct transfusion using a three-way valve was used until the Second World War. While sodium citrate as an anticoagulant was considered as early as 1914 and used (along with glucose, by Rous and Turner) on a small scale during the First World War in establishing blood depots before a bat-

tle, blood could only be stored for a few days [11].

In 1943, Loutit and Mollison developed an acid dextrose citrate (ACD) solution, enabling blood to be stored for weeks instead of days, thus facilitating blood "banking." Additionally, acidification of the anticoagulant and preservative solution enables it to be autoclaved, reducing the risk of bacterial contamination in storage solutions [11]. The first real predecessor of the modern blood bank was created in 1935 at the Mayo Clinic [12].

Others attribute the first blood bank to Bernard Fantus, who set up a blood bank at Chicago's Cook County Hospital in 1937 [13]. At this facility, blood was collected in glass vials containing sodium citrate, sealed, and stored in the refrigerator. Pilot tubes were prepared for typing and serological testing. Fantus was the first to use the term "blood bank" for this operation, as blood could be stored and preserved for later use [14] [15].

Blood transfusion is a complex process that requires adequate training for the medical and paramedical staff involved. In our study, only 41.5% of members had received training in transfusion practices. These results align with a Tunisian study where only 42% had received training [16], the study conducted at France's CHU de Nantes in 2012, where only 43% of professionals surveyed had benefited from transfusion training [17], the study carried out in Bangladesh in 2020, where 59% had received training [18] and the survey conducted in Mali in 2012, where only 29.1% of staff had benefited from blood transfusion training [19]. Two studies carried out at the Marrakech HMA in 2016 [20] and 2022 [21] revealed that only 40.7% and 52.1% of staff, respectively, had received training. This suggests a deficiency in training across various hospital sites. The pre-transfusion phase is a crucial stage in the blood transfusion process, encompassing a series of tests and checks to ensure the safety of the blood product for the patient. This phase involves verifying the patient's identity, identifying the blood product, and checking its compatibility with the patient. The goal of this phase is to minimize transfusion errors and ensure patient safety. The pre-transfusion phase can be conducted by medical or paramedical staff and may involve tests such as blood grouping, Rh factor determination, and other compatibility tests [22].

Indications for transfusion vary according to the patient's health status and the purpose of the transfusion. The decision to transfuse a patient is not always straightforward, primarily because no single factor, be it the extraction ratio or the hemoglobin level, can serve as an absolute indicator of the need for transfusion [23].

Indications are primarily determined by the severity of anemia, assessed based on hemoglobin (Hb) concentration and clinical symptomatology [24]. According to a Spanish study conducted in 2019, 91.8% of the staff indicated that they always or usually consider additional data (in addition to Hb levels). Only 0.5% reported relying solely on Hb levels [25]. In our study, two-thirds (66%) of transfusion indications were based on hemoglobin values and the patient's overall con-

dition. Blood grouping is a laboratory procedure that involves identifying a person's blood groups. This information is crucial in various medical contexts, particularly in the context of blood transfusions. Blood group antigens present in human red blood cells (RBCs) can trigger immune antibodies capable of causing immune-mediated hemolysis. Screening for blood group antigens is, therefore, essential to safeguard the lives of patients receiving blood transfusions [26] [27] [28].

In our study, 97.8% of participants conducted two determinations, while only 2.2% performed a single determination. These figures surpass those reported in the national study conducted in 2016 [20], where 53.5% opted for two determinations, but closely align with the findings of the study conducted in 2022 [21], where 86.8% favored two determinations. The 2014 study at Caen University Hospital in France revealed that among the grouping requests examined, 46.7% involved a single grouping request, while 53.3% involved double determinations [29]. Additionally, in our study, pre-transfusion questioning by medical and paramedical staff was systematically carried out in 80.7% of cases.

The two studies carried out at the Marrakech HMA in 2016 [20] and 2022 [21] were compared with our study.

Blood tube labeling is a crucial step in the blood typing procedure. The objective is to accurately identify the collected blood samples, ensuring precise laboratory results and reducing the risk of medical errors. Proper labeling should include patient information. Additionally, it is crucial to ensure that blood tubes are visibly and legibly labeled to maintain traceability of samples throughout the testing process.

In the Spanish staff survey, 76.9% of respondents identified the tube using a pen, while 22.9% used a barcode for identification [29] [30].

According to a study conducted in Italy, two-thirds (69.9%) identified the tube using a pen, and the remaining participants used a barcode for identification [31]. For a national comparison, two studies carried out at the Marrakech HMA in 2016 [20] and 2022 [21] showed that 93% and 90.9% respectively identified the tube by pen.

In our series, 92.6% of participants identified the tube using a pen, while 3.7% used a laboratory barcode. The timing of tube labeling may vary depending on the protocols implemented at each healthcare facility. In some cases, labeling may occur immediately after sampling at the patient's bedside, while in others, it may take place prior to sampling. The recommendations explicitly state that "tubes must be positively identified after filling, and not before, by means of a firmly attached label" [32].

It is essential to highlight that the timing of labeling should align with the quality and safety criteria established at each institution.

In our study, 70.4% of participants performed labeling immediately after sampling at the patient's bedside. This result closely aligns with the study conducted in France, where 79% of the staff carried out tube labeling immediately after or at the time of sampling, and 21% before sampling [33]. Similarly, a study in

Sweden reported that 80% of staff labeled tubes immediately after sampling [34]. However, in the study conducted at Rabat University Hospital in 2015, 50.9% of the surveyed staff did not perform labeling immediately after sampling [35].

Second blood typing is a crucial process for ensuring transfusion safety, minimizing errors, and ensuring that the patient receives the correct blood product. This process can be conducted either immediately after blood collection or at a later date [36].

The study conducted at the Le Havre hospital group in France in 2016 revealed that, in 52% of cases, the two determinations were performed by a single person on a single sample [37]. The two studies carried out in Marrakech in 2016 [20] and 2022 [21] respectively demonstrated that 40.7% and 58.7% of the staff performed the second determination simultaneously with the first.

These results align relatively closely with our study, where 70.4% conducted the second determination on the same sample as the first. The frequency of transfusion practice varies based on several factors, including the patient's overall health, the severity of the disease, and the treatment protocols in effect.

Over the years, the frequency of transfusion practice has increased due to advancements in blood collection, storage, and preparation techniques, as well as improvements in patient selection protocols [11]. A survey conducted in Nigeria in 2021 indicated that only 23% of the surveyed staff performed transfusions more than once a week [38]. According to a study carried out in Mozambique in 2015, 56% of the staff reported administering transfusions more than once a week (including daily) [39]. Our study is consistent with these findings, where 31.9% performed the transfusion act several times a week, and 7.4% performed it daily.

Cross-match is a routine pre-transfusion test used to detect ABO incompatibility and other clinically significant antibodies [40].

In a study conducted in India in 2018, 85% of the staff knew that the cross-match must be carried out systematically before transfusion [41]. In the Turkish study conducted in 2017, 78% of participants described the cross-match test as an important step in guaranteeing ABO compatibility [42]. In our study, almost all staff (97%) performed the cross-match routinely.

Accurate patient identification is one of the critical steps in performing the transfusion procedure. Transfusing blood to the wrong patient is a major avoidable transfusion risk that can result from errors made anywhere in the transfusion process, including blood sample collection, laboratory testing and sample handling, blood recovery from blood transfusion refrigerators, and bedside monitoring just prior to transfusion [43].

In our series, all the medical and paramedical staff interviewed systematically checked the patient's identity when transfusing blood products. According to a study conducted in Turkey in 2017, 91% of staff affirmed the need to confirm patient identity [42]. The study carried out in Jordan in 2012 showed that 70% of nursing staff ensured the patient's identity, and this task was the responsibility of

the nurses [44].

In another Malaysian study conducted in 2021, 78% asked the patient about his or her identity before transfusion [45]. The same finding was reported by a French study conducted in 2018, where 78% verified the patient's identity [46]. Frequent visual observations during transfusion are essential to identify signs of adverse reactions or events [47]. It is performed by the nurse under the supervision of the doctor in charge of the transfusion to intervene as quickly as possible in the event of problems [48].

In our study, this was carried out by the prescribing physician in 40%, and by the nurse in 31.3%. The patient's vital signs (temperature, pulse, respiration, and blood pressure) should be recorded shortly before transfusion, and after the first 15 minutes, and compared with baseline values. Some patients' histories or clinical conditions may indicate the need for more frequent monitoring. During transfusion, the patient should be observed periodically, especially during the first 10 to 15 minutes, for signs and symptoms of transfusion reactions [49].

According to the study carried out in Tata in 2021, 81.67% of nurses were involved in monitoring the transfusion process. Transfusion accidents are caused by incompatible transfusion, a potentially dangerous situation that can occur when a patient receives a blood product that does not match his or her blood group. According to the study carried out in Burkina Faso in 2017, 51.5% have witnessed a blood transfusion accident [26]. In India, a study carried out in 2018 indicated that 38.6% of staff have witnessed it [50]. This remains close to our study, where 44% have already witnessed a blood transfusion accident due to incompatibility. It is, therefore, important to take the necessary precautions to minimize the risk of errors. According to Uganda's 2018 study, 64% of staff reported that patient misidentification was the most common cause of transfusion reactions [51]. In contrast to England's 2005 study, where 59% of incompatible transfusions were due to poorly performed cross-match [52].

These two results are close to those of our study, which showed that 65.2% of incompatible transfusions were due to a cross-match not having been made, and 59.3% to a patient identification error.

Clinical signs of transfusion accidents: Although transfusion is often beneficial for patients, it can also lead to undesirable effects, notably transfusion accidents. Transfusion events can be defined as any adverse reaction associated with blood transfusion, including immediate or delayed reactions and transfusion-related infections. Hence, the importance of monitoring for clinical signs of transfusion accidents to enable rapid intervention in the event of an adverse reaction [53].

In our study, two-thirds (66.7%) of the clinical signs of accidents that could occur during the transfusion of an LSP were shivering, shock (57%), and hyperthermia (51.9%).

According to the study carried out in Burkina Faso in 2017, 35% of accident signs were hyperthermia or shivering [26].

The survey conducted in Turkey in 2024 showed that the most reported signs

of transfusion accidents were fever and shock (96%) [54].

Our results are similar to those of two studies carried out in France, which showed that shivering-hyperthermia reactions were present in 50.3% of immediate incidents [55], and that shivering more or less associated with fever was present in 44% of cases [56].

The procedure to be followed in the event of a transfusion incident must be outlined in a local procedure known to those performing transfusions. Transfusion incidents must be reported to the establishment's hemovigilance correspondent [48]. In our study, stopping blood transfusion accounted for 100% of responses.

Post-transfusion reactions (PTRs) are adverse events that can occur after a blood transfusion. They can be divided into two main categories: immediate reactions and delayed reactions. Monitoring PTRs is important to ensure patient safety and improve the quality of care. The study carried out in Montreal, Quebec, in 2010, showed that volume overload accounted for 40.3% of transfusion reactions, while non-hemolytic febrile reaction accounted for 28.4% [57] [58]. In the study carried out in France in 2018, non-hemolytic febrile reaction was 63%, while volume overload was 10.9% [59]. For the study carried out in India in 2017, non-hemolytic febrile reaction accounted for 54.7% [60]. This is quite different from our study, where febrile reactions accounted for 76.3%, and overload accounted for 52.6%. All transfused patients must receive special information and monitoring, considering the inherent risks in the human-derived therapeutic administered to them. Follow-up of transfused patients is a necessity due to the human origin of blood products. Despite significant progress in recent years to ensure the safety of blood products (blood donor selection, blood product preparation techniques, and biological tests), transfusion therapy still carries immunological and infectious risks [61]. In our study, more than half (53.3%) did not follow up, and only a third (35.6%) requested a post-transfusion complete blood count (CBC).

5. Conclusion

The administration of blood transfusions in children is a critical component of medical care, demanding meticulous attention and diligence. Consequently, it is essential to establish continuous practical and theoretical training programs for healthcare professionals to enhance the quality and safety of pediatric transfusion practices. Emphasizing the significance of sustained investment in training endeavors is crucial to advancing blood transfusion practices and ensuring high-quality patient care.

Conflicts of Interest

No potential conflict of interest was reported by the authors.

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