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ORIGINAL PAPER

International Society for Blood Transfusion international survey on blood product wastage in low- and middle-income countries

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Background and objectives In 2015, the ISBT Working Party on Blood Supply Management published the results of an international survey on blood product wastage in hospitals. The responses were predominantly from Europe and North America, and it was decided to form another survey concentrating on low- and middle-income countries (LMIC).

Materials and methods The survey was designed by the authors and translated into an online survey tool by the ISBT office. A pilot survey was produced and completed by 3 volunteer contributors. Where necessary, amendments were made and the survey was sent by the ISBT to 33 participants from LMIC. The survey was further distributed by participants to colleagues in their or other countries.

Results In total, 31 completed surveys were received from 11 different countries. Not all respondents answered all questions meaning different questions may have been answered by a different combination of respondents. The demographics of hospital type, size and distance from the blood supplier varied considerably. Red-blood-cell (RBC) wastage was estimated to be <5% (n=9 respondents), 5-10% (n=3) or 10-25% (n=5). The most important category of wastage was outdated RBCs in the blood bank or after issue. Wastage as a result of an RBC being issued to a patient and not completely transfused because the patient did not require the entire volume was <10% (n=18), 10-20% (n=3), 20-30% (n=1), 40–50% (n=1) and >50% (n=1).

Conclusion Wastage rates varied considerably between countries, and innovative solutions will be required to reduce this problem.

Key words: blood components, blood supply, blood wastage

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Introduction

Minimizing blood product wastage is an essential element to maintaining an adequate inventory and is a pillar of lean manufacturing. In well-financed and resourced blood services, dedicated programmes have been implemented to review losses in the supply chain and make improvements where necessary. However, there is still an expectation that some losses will occur and it is assumed that these can be made up from available resources. This assumption may not be the case for blood services in low- and middle-income countries (LMIC) where resources of budget, consumables, donors and ultimately blood components can be extremely limited and losses may not be replaceable. Discarded red-blood-cells (RBCs) cannot

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always be replaced by an equivalent blood component, and the effect may be that a patient that requires a transfusion does not receive one.

In 2015, the ISBT Working Party on Blood Supply Management (BSM) published the results of an international survey on blood product wastage in hospitals [1]. This survey investigated blood component wastage rates and mechanisms from blood services around the world. There were 85 analysed responses, but these were predominantly from Europe (62%) and North America (22%) with the remainder from Oceania, Asia or the Middle East. In general, the blood product wastage rates were low. The survey noted that the Global Database on Blood Safety had collected information from 148 countries in the year 2011 and that the World Health Organisation (WHO) estimated that of the 96·4 million whole blood donations made around the world, as many as 5 million (5·2%) were wasted [2]. There is therefore a significant wastage issue that may not have been detected by the original survey due to the demographics of the responding blood services and hospitals.

The Working Party took the decision to further investigate wastage, focusing on LMIC where the situation may be different, the issues to resolve more complex and the wastage likely to occur in areas not covered by the original survey.

Methods

The survey was designed in English by members of the ISBT Working Party on BSM. The intended participants in the survey included physicians at dedicated blood centres, blood centres co-located with hospitals and different categories of hospitals in LMICs.

The survey was encoded in an online tool (surveymonkey.com) by the ISBT office. Three volunteer participants from Pakistan, India and Nigeria were sent a link to the draft survey so that the completeness and comprehensibility of the survey could be validated. Comments were incorporated into the final version.

The survey organizers and the ISBT office produced a list of potential participants from low- and middle-income countries who were ISBT members and who had email addresses on file with the ISBT. The countries targeted for the survey consisted of the 31 low-income economy countries and the 52 lower-middle-income economy countries according to the 2017 World Bank classification [3]. The survey link was emailed in June 2017 to 12 ISBT members in 11/31 (35%) low-income economy countries and 21 ISBT members in 16/52 (29%) lower-middle-income countries. Participants were not offered any incentives to participate.

Information was requested for the calendar year 2016. Where deemed necessary, the survey included brief descriptions of the reason for a specific question or the expectations for answering the question.

The survey concentrated on RBCs and consisted of sections requesting basic demographic information about the participant and the facility represented, questions on the logistics of delivery of RBC products, information about the RBC products provided and wastage information (Fig. 1).

Results

Initially, there were 8/33 responses (24%). Response rate to web-based surveys vary, but improve with each subsequent reminder, with an eventual expectation of approximately 30% [4]. A thank you was sent to those that had completed the survey, and one reminder was sent to the others who had not yet responded. The overall response rate was 31 responses from 11 countries (Table 1).

Some recipients of the original email had sent on the survey to colleagues in their or other countries, and it was not known how many people received the email invitation to the survey. Thus, an accurate response rate cannot be calculated. Of the original 27 countries that were contacted, 8/27 (30%) returned at least one response. There were responses from four countries not on the original distribution list including two countries (Namibia and South Africa) that were considered upper-middle-income countries. These were included in the analysis because they had responded.

Not all respondents completed all questions, and the numbers that answered each question were recorded. One responder did not identify the country or the institution, but the survey was completed and the results were included in the analysis.

Of those that responded, 26 were from hospitals and 5 were from other institutions where no further detail was given. Three responses were from Hospital networks covering 2, 4 and >200 hospitals. The demographics are shown in Table 2 where respondents chose the most appropriate category without definitions being supplied.

The supply chain logistics that hospitals operated with varied considerably. The distances involved translate into different average and maximum delivery times for RBCs to the hospitals (Table 3).

The next section in the survey asked for information on the number of RBCs issued by the facility. 63% (14/22) who answered the question requesting information on the number of RBCs issued in the 2016 calendar year could provide details. Details could not be provided by 8/22 and 9/31 skipped the question. Two issued <200, 6 issued between 200 and 10,000, 5 issued between 10 000 and 50 000 and a single facility issued 290 000 RBC units.

All questions are based on the calendar year (1st January through to 31st December) 2016
Basic information
1. Institute name
2. Country
3. Contact name
4. Contact email address
5. Is your institute a hospital?
Hospital Information
6. Is the hospital; **Definitions** to go here
a. Regional
b. Provincial
c. District
d. Local or other
7. What type of hospital? **Definitions** to go here
a. Major teaching
b. Graduate teaching
c. Limited teaching
d. Non-teaching
e. Paediatric specialty
f. Other (please give details)
8. Are you responding for a single hospital, or a network of hospitals?
9. If a network, please indicate number of hospitals in the network
10. How many beds are in your hospital (or network of hospitals)?
a. 0 – 20
b. 20 – 50
c. 50 – 100
d. 100 - 200
e. More than 200
11. How far is your hospital from your main supplier of red blood cell units?
a. <5 km
b. 5 - 10 km
c. 11 – 25 km
d. 25 – 50 km
e. >50 km
12. What is the **longest** delivery time that the hospital would normally experience?
13. What was the total number of red cells issued for the calendar year 2015?
14. What is the maximum amount of time a red cell unit can be outside the hospital blood bank without being in a temperature controlled device (cooler) before it is unable to be returned to inventory?
15. Which of the following red cell products are routinely available in your hospital's blood bank (select all that apply) and what is the maximum shelf life of the red cell products?
a. Whole blood
i. Shelf life 7 days
ii. Shelf life 14 days
iii. Shelf life 21 days
iv. Shelf life 28 days
v. Shelf life 35 days
vi. Shelf life 42 days
b. CPD red cells
i. Shelf life 7 days
ii. Shelf life 14 days

Fig. 1 Survey questions used for the web-based survey.

iii. Shelf life 21 days
iv. Shelf life 28 days
v. Shelf life 35 days
vi. Shelf life 42 days
c. Red cells in additive solution
i. Shelf life 7 days
ii. Shelf life 14 days
iii. Shelf life 21 days
iv. Shelf life 28 days
v. Shelf life 35 days
vi. Shelf life 42 days
16. Does your hospital receive smaller volume split red cell units from the blood supplier?
17. Does your hospital's blood bank have the capability of splitting whole units into smaller volume units? If yes go to 18 if no go to 20
18. How does your blood bank produce the split red cell units? (select all that apply)
a. Attaching an additional satellite pack using a sterile docking device
b. Syringe
c. Other (please give details)
19. How many smaller volume units does your hospital routinely produce from a full volume red cell unit? (select all that apply)
a. Two
b. Three
c. Four
d. Six
e. Eight
f. Ten
g. More than 10
20. Would it be useful to have smaller volume split whole blood or red cell units that have been produced using systems that maintain sterility, either provided to you by your blood supplier or produced at the hospital? If yes go to 21 if no go to 22
21. How many smaller volume split red cell components would you like to get from a full volume red cell component (select all that apply)?
a. Two
b. Three
c. Four
d. Six
e. Eight
f. Ten
g. More than 10
22. Estimate the percentage of red cell units issued to patients that are **not completely transfused** because the patient did not require the entire volume of the unit. An example of an incompletely transfused unit would be one that is issued to a pediatric patient but is not transfused entirely because the patient did not require the full volume of the unit and a smaller volume unit was not available or could not be made
a. <10%
b. 10 - 20%
c. 20 – 30%
d. 30 – 40%
e. 40 – 50%
f. More than 50%

Fig. 1 Continued.

23. Please rank the following categories of waste from 1, the most important cause of red cell unit waste in your hospital to 4, the least important cause of red cell unit waste
a. Time expired
b. Out of temperature
c. Operator error
d. Red cell component outside of the blood bank or storage facility for too long
e. Other. Please give details.
24. Please **estimate** the annual red cell component waste as a percentage of the units that were received from the blood supplier. For example if 10 red cell components were received per year and 1 unit was wasted, the wastage rate would be 10%
a. <5%
b. 5 -10%
c. 10 – 25%
d. 25 – 50%
e. >50%
f. If the annual red blood cell unit wastage figure is accurately known please enter it here
25. Which, if any, of the following blood product waste reduction strategies have been implemented at your institute (select all that apply)
a. Lectures to nurses, physicians and hospital administrators on the topic of blood product waste
b. Waste tracking reports
c. Communications to nurses and physicians regarding appropriate storage conditions
d. General blood product wastage awareness such as posters, screen savers, pamphlets etc.
e. No specific waste strategies implemented
f. Other (please specify)
How can discards be reduced?
26. What are the best ways to reduce discards? Think about your process now and what improvements could be made. Also think about what other equipment or consumables would help increase the availability of blood products and reduce losses Please make suggestions here.
Go to end

Fig. 1 Continued

Table 1 Countries from which responses to the survey were received

South Africa	Namibia	Zimbabwe	Nigeria	Ghana	India
10 (30%)	2 (6%)	2 (6%)	1 (3%)	1 (3%)	6 (18%)
Pakistan	Palestine	Philippines	Indonesia	Bhutan	Not completed
2 (6%)	1 (3%)	1 (3%)	3 (9%)	1 (3%)	1 (3%)

The maximum amount of time a red cell unit could be outside the hospital blood bank without being in a temperature-controlled device (cooler) before it is unable to be returned to inventory influences discards due to storage non-compliance. Six facilities did not allow RBCs to be returned to inventory after issue, 12 defined the maximum time of 1 hour, 2 allowed 2 hours and 4 allowed returns after 4 hours.

Facilities were asked to identify which RBC products were routinely available in the hospital's blood bank and what was the maximum shelf life of the red cell products. In total, 26 respondents answered at least one section (whole blood, CPD/CPDA1, additive solution). There were differences in the shelf lives of the RBC products (Figure 2), even within the same product definition.

Splitting full volume RBCs into multiple red cell components enables the provision of red cell products for patients requiring smaller volumes. Fourteen facilities were able to perform this manufacturing step, and 10 reported that they were not able to split RBC products. Only one respondent reported that this was done using a donation pack with multiple satellite packs. The others docked on satellite packs using a sterile connecting device as need dictated. Six facilities produced 2 RBCs splits from a full volume pack, 6 produced 3 splits, 4 produced 4 splits, 1 produced 6 splits, and 2 produced 10 or more.

Table 2 Demographics of the responses

Is your institute a hospital?			
Yes		No	
26/31 (84%)		5/31 (16%). No further detail.	
Is the hospital?			
Regional	Provincial	District	Local/other
7/26 (27%)	6/26 (23%)	5/26 (19%)	8/26 (31%)No further detail
What type of hospital?			
Major teaching	Graduate teaching	Limited teaching	Non-teaching
14/28 (50%)	3/28 (11%)	4/28 (14%)	3/28 (11%)
• 2 respondents answered this question but not the previous question.			
• Other 4/28 (14%) – Tertiary care super specialty corporate hospital, General District Hospital, Private Hospital and Blood Centre			
Are you responding for a single hospital, or a network of hospitals?			
Single hospital		Hospital network	
25/28 (89%)		3/28 (11%)	
How many beds are in your hospital (or network of hospitals)?			
20–50	50–100	100–200	>200
1/28 (4%)	3/28 (11%)	4/28(14%)	20/28 (71%)
How far (km) is your hospital from your main supplier of red-blood-cell units?			
Co-located	<5	5–10	>50
15/28 (54%)	6/28 (21%)	1/28 (4%)	6/28 (21%)

The number who agreed with the section of the question/the number of responses to the question and the percentage.

Table 3 Average and maximum RBC delivery times to institutions

Delivery time (hours)	No. of responses with this average delivery time	No. of responses with this maximum delivery time
0	9/31 (29%)	7/31 (23%)
1	10/31 (32%)	5/31 (16%)
2	4/31 (13%)	4/31 (13%)
3		4/31 (13%)
4	7/31 (23%)	3/31 (10%)
6	1/31 (3%)	8/31 (26%)

Eighteen respondents reported that being able to split RBC components, using systems that maintain sterility, would be useful. When asked how many split volume RBCs it would be useful to obtain from a full volume RBC, 10 suggested 2 split RBC components, 6 said 3, 5 said 4, 2 said 6 and 1 suggested 10.

Wastage as a result of an RBC being issued to a patient and not completely transfused because the patient did not require the entire volume was estimated. Eighteen respondents believed the wastage was <10%, whilst others identified wastage as 10–20% (3), 20–30% (1), 40–50% (1) and >50% (1).

The participants were asked to rank the causes of wastage in terms of their relative importance at their facility (Fig. 3).

The wastage reported as other was due to leaking units, either due to direct damage or due to manufacturer defects, transportation issues, predominantly using courier services, expired units after 24 h splitting using an open system, transfusions that were planned but did not happen leading to the wastage of the RBC, over prescription of blood products by clinicians and problems with the RBC components themselves including high bilirubin, DAT positive, sero-positive or visible clots within the units. There were also two comments about haemolysis due to staff placing an RBC in hot water to normalize the temperature prior to transfusion, which led to a notable change in the colour of the RBC and consequent discard.

Facilities were asked to estimate the overall RBC wastage. Most suggested that it was <5% (9), whilst others reported 5–10% (3) or a high 10–25% (5). Many facilities had implemented waste reduction strategies (Fig. 4) to reduce wastage. Those that responded Other had implemented inventory management practices, including First In First Out (FIFO), management Quality Indicators, Corrective and Preventative Actions (CAPA) or, in one case, an intranet-based Transfusion Medicine Manual.

An open question was asked on what was felt to be the best ways of reducing RBC wastage. Training (8), enhanced compliance with cold chain storage (6) and inventory management (6) were identified as important issues. Promoting voluntary donation, improved targeting

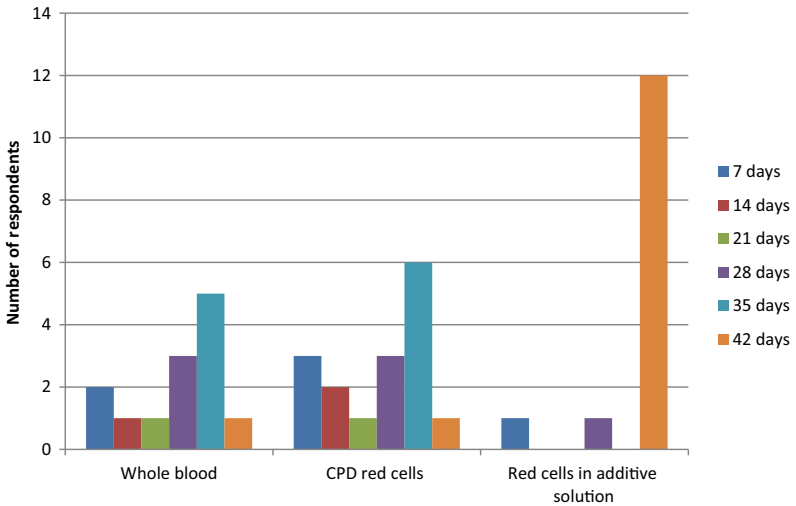

Fig. 2 RBC products offered and the shelf lives used by facilities.

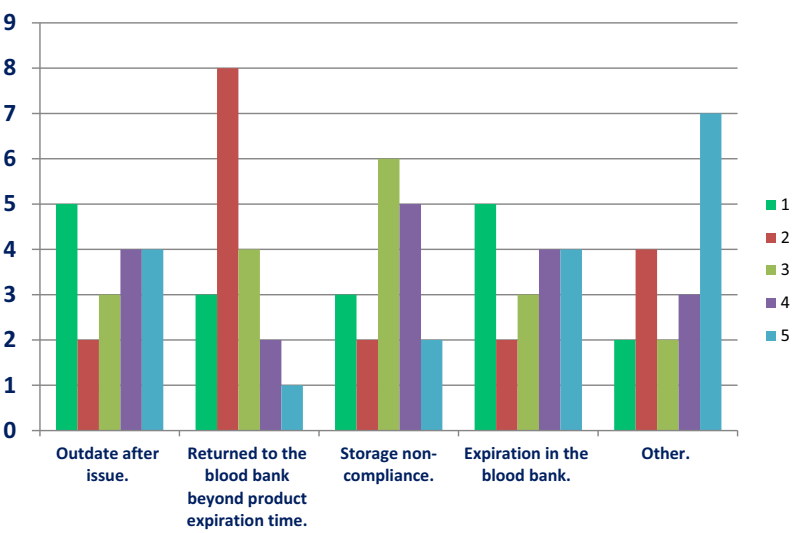

Fig. 3 Ranked categories of RBC wastage, (1 – most important, 5 – least important) showing the number of responses for each category.

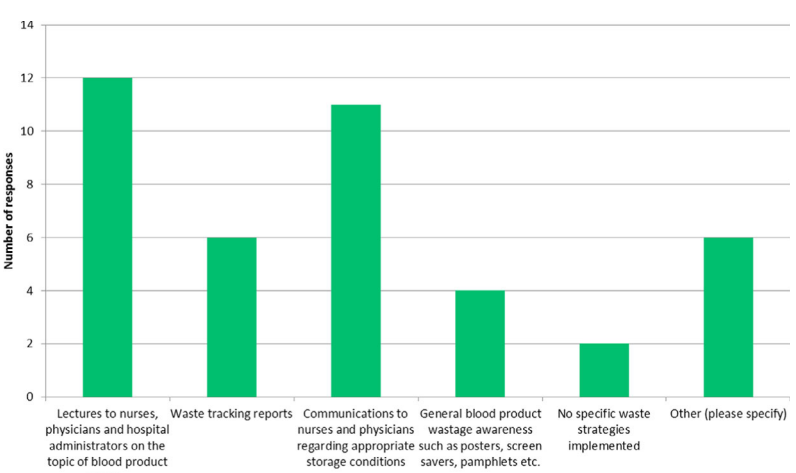

Fig. 4 Wastage reduction strategies used by the respondents to this survey.

of donations and estimating inventory requirements were also identified as was the need for better equipment and consumables, such as sterile connecting devices.

Discussion

Blood product wastage is an important consideration for blood collectors and hospitals, and it is an especially acute issue in LMIC where replacement products might not be readily available. This is one of the few surveys of blood product wastage that specifically targeted these countries [5,6]. As a whole, the results of this study tend to confirm that wastage of RBCs is variable and could reach high percentages in these countries making supply difficult to manage.

The supply chain logistics varied amongst the respondents with 6 survey participants being located at least 50 km from the blood supply, resulting in 5 hospitals where, on average, the blood took at least 4 h to arrive. Thus, advanced planning for transfusions would be essential, as would be maintaining a stock of RBCs for cases of emergency bleeding.

The RBC products produced and the shelf life used showed marked variation, presumably due to the different manufacturing methodologies and the use, or not, of sterile connecting systems. Of the 24 responses to this question, only 12 used an additive solution RBC with a shelf life of 35 or 42 days. Here, it is clear that the use of different consumables or the availability of additional manufacturing equipment, such as sterile connection devices, would improve the inventory profile and reduce wastage.

Ten respondents were not able to split RBC products into smaller volumes and will impact both the availability of RBCs for patients (mainly children and neonates) that do not require a full volume and wastage. The availability of split RBCs was widely seen as advantageous. The lack of availability of split RBCs can translate directly into high wastage figures where the full volume of the RBC was not required by the patient, meaning that the remaining red cells were discarded once the required volume was transfused. This is demonstrated by 6 responses showing a wastage rate greater than 10%, and up to 50% in one, under these circumstances.

The WHO has suggested that in high transmission settings, children with severe anaemia and hyperventilation (resulting from malaria) should be treated by transfusion, but also say that this is not a strong evidence-based recommendation [7]. Transfusing anaemic children with malaria is current practice, and it has been pointed out that the norms of blood component production in high-income countries, where whole blood is separated into blood components, may not suit the local environmental, organizational and logistical issues in lower-income countries, where whole blood may be preferred [8]. The ability to split RBC components, irrespective of whether they are whole blood or separated RBCs, is beneficial.

Wastage of all types was estimated to be between 10 and 25% for 5 facilities, a figure where it would be extremely difficult to replace lost RBCs with new products. More training, better cold chain compliance and improved inventory management are key enablers to wastage reduction. As there are different pressures on the inventories between high- and low-income countries, a direct comparison is not informative.

This survey has several limitations including the relatively small number of responses received. This perhaps limits the generalizability of these findings to the areas with the greatest number of respondents. It is also possible that some respondents might have misunderstood the nature of the questions being asked because of a language barrier.

The survey was intended to be used to determine what more could be done to reduce wastage and increase the availability of blood products. The results of the survey suggest that this could broadly be achieved in five areas: increased training across a wide spectrum of activities, improvements in the cold chain, better advice on inventory management, the availability of a wider range of, or improved, donation and manufacturing consumables and the availability of donation and manufacturing systems that result in products being produced from a closed system.

Work in conjunction with international experts and collaboration with manufacturers can help to reduce wastage. Expert bodies should work with manufacturers to define which existing or novel consumable systems and equipment may be required to reduce wastage and improve RBC availability for patients.

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Conflicts of interest

The authors have no conflicts of interest to disclose.

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