Improving Blood Transfusion Ratios and Reducing Waste in Major Haemorrhage Cases

Abstract

Haemorrhage as a result of traumatic injury is the leading cause of death in people under the age of 40. These patients may require a massive transfusion (MT), defined as a transfusion of more that 4 units in 1 hour or 10 units in 24 hours. Evidence suggests that these patients can benefit from damage control resuscitation (DCR) which involves the transfusion fresh frozen plasma (FFP), platelets and red blood cells (RBC) in a 1:1:1 ratio. The purpose of this quality improvement project was to institute a protocol and additional measures that would result in patients receiving transfusions with this target ratio where MT is required. As there is evidence to suggest that protocols aiming to achieve this ratio are associated with increased blood component waste, the secondary objective was to institute measures that would ensure waste was kept at a minimum. After the protocol was instituted, the percentage difference from target ratio decreased by 30% and was maintained throughout the course of the project. 30 day survival rates were uptrending throughout, and this was partly correlated with the improvement in ratio. FFP and Platelet waste were reduced by 13% and 10% respectively, with RBC waste being maintained at low levels. Hence, this project demonstrates effective measures that can be implemented to improve transfusion ratios in MT cases whilst reducing blood component waste.

What is already known on this topic?

Haemorrhage as a result of traumatic injury is a major cause of mortality in patients under 40. Evidence suggests that transfusions of fresh frozen plasma (FFP), platelets and red blood cells (RBC) in a 1:1:1 ratio are associated with improved outcomes.

What this study adds?

This study outlines a massive transfusion protocol and blood component administration procedure that can be used to achieve transfusion ratios closer to the 1:1:1 target ratio in cases where massive transfusion is required. Additional measures to ensure improvements from the protocol are maintained with minimal blood component waste are also described.

How might this study affect research, practice or policy?

The integration of similar protocols and procedures may be beneficial to other trauma centers in the UK.

Introduction

Problem

Traumatic injury is the leading cause of death and permanent disability in people under the age of 40. In the UK alone, traumatic injuries are responsible for up to 17,000 deaths per year and over 5 million worldwide. Half of all trauma fatalities result from haemorrhage, and this is often considered the largest cause of preventable death worldwide[1][2].

In roughly 3% of cases, patients will require a massive transfusion (MT). Definitions of MT can vary, but the most commonly used is a transfusion of more than 4 units in 1 hour or 10 units in 24 hours. Although a small proportion of

patients will require a MT, these patients consume roughly 70% of all blood transfused at a trauma center and have mortality rates ranging from 40% to 70% at leading trauma centers[3][4].

Background

Evidence suggests that these patients may benefit from damage control resuscitation (DCR). DCR is defined as rapid haemorrhage control through early administration of blood components in a balanced ratio of 1:1:1 for fresh frozen plasma (FFP) to platelets to red blood cells (RBC), prevention and correction of coagulopathy and minimization of crystalloid fluids. The combination of blood components in this ratio most closely resembles the composition of whole blood, and is associated with improved trauma outcomes[1][5][6][7].

Aims

The primary objective of this project was to institute measures that would result in blood components being administered in a 1:1:1 ratio where MT is required. However, there is evidence to suggest that protocols geared towards achieving this ratio are associated with increased blood component waste[5]. Hence the secondary objective was to employ measures to reduce waste, or at the very least prevent an increase. Based on the levels of waste for each component at the start of this project, the aims were to reduce FFP and Platelet waste by 10% and to maintain RBC waste below 10%.

This project took place in the emergency department (ED) at the Royal Victoria Hospital (RVH), which is the major trauma center for Northern Ireland.

Method

Interventions

A driver diagram was used to identify key interventions that would meet the project aims. These are described as follows:

1. Introduction of a massive transfusion protocol (MTP) within the ED - The purpose of this protocol is to standardize the treatment of patients that require a MT. Trauma packs are ordered as part of this protocol which contain balanced quantities of RBC, FFP and platelets. The protocol is shown in Figure 1.
2. Introduction of a blood component administration procedure - Upon discussion with the medical team, there were some queries raised about the order in which blood components should be administered when trauma packs are received. Hence, a standardized blood component administration procedure was formulated, shown in Figure 1. This procedure outlines the order in which components should be administered starting with components that are available in the department, followed by those present in trauma packs, and aiming to maintain a balanced ratio.
3. Organisational changes - Three interventions were implemented to improve the efficiency with which blood components would reach the department and be administered to the patient. The first was to assign two porters to handle the transfer of blood components during MT cases, instead of previously having a single porter assigned. The second was to pre-alert the blood bank prior to the patient reaching ED in cases where MT would be required. The third was to organize blood trolleys which contain all of the necessary medical apparatus required during treatment.
4. Participation in trials - The ED at RVH took part in the Cryostat-2 trial which aimed to determine the impact of adding 3 pools of cryoprecipitate to massive transfusion procedures[8]. In order to take part, the department needed to have a standardized protocol that met the requirements of the study, serving as further motivation to establish and maintain the protocol.
5. Educational and staff training changes - A number of interventions were introduced to educate staff about the existence and importance of the new transfusion protocol. This included interactive videos with multiple choice question (MCQ) test sign-offs. Yearly simulation sessions and 1 to 1 induction sessions were organized for new trainees, and feedback sessions after each MT case were arranged to ensure the protocol is instituted effectively.
6. Blood component storage changes - A blood fridge was introduced for thawed FFP storage. This enables FFP to be administered immediately with the O +/- blood already present in the department, allowing a 1:1 FFP:RBC ratio to be achieved until platelets and additional units can reach the department.

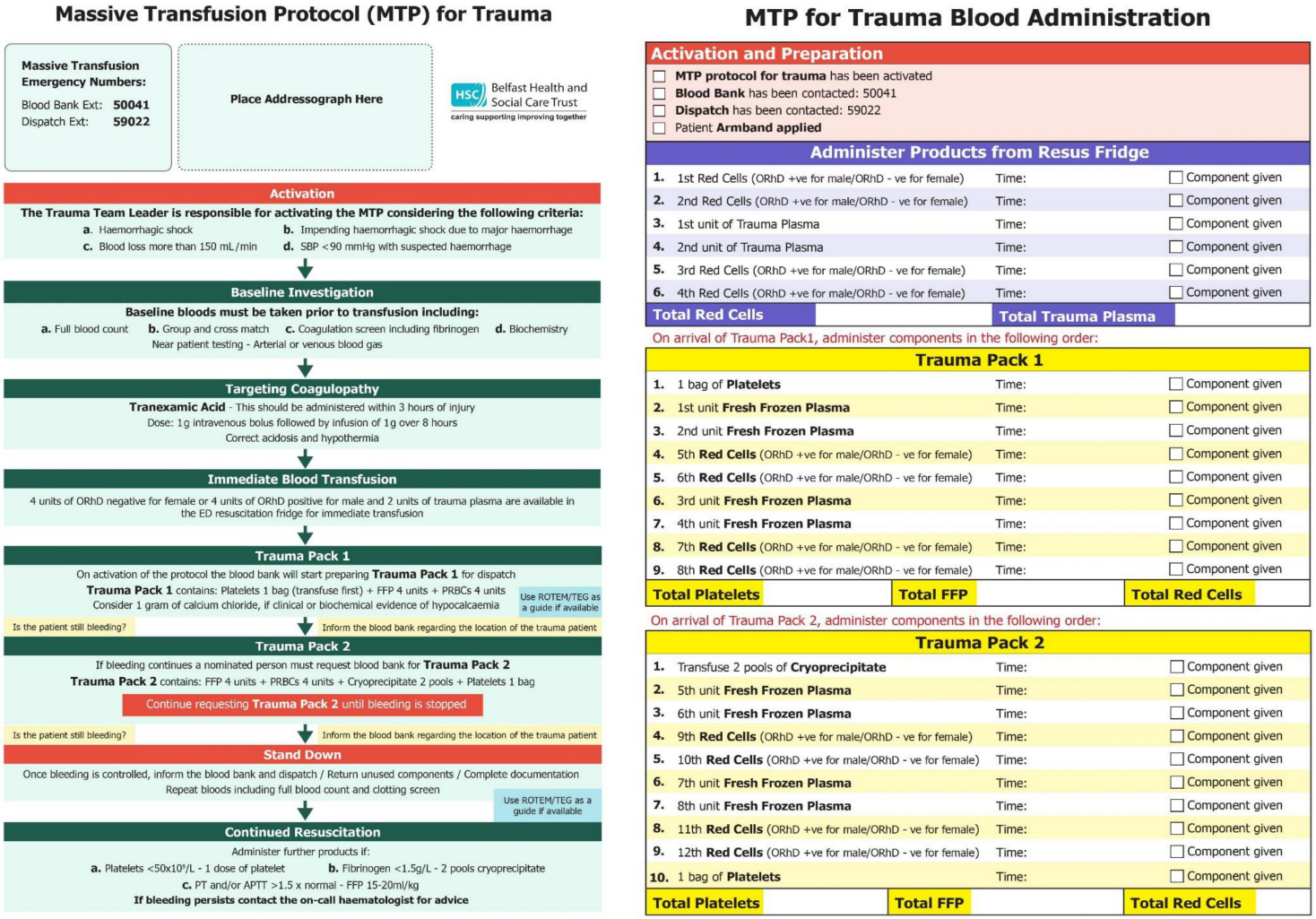

Figure 1: Massive Transfusion Protocol and Administration Procedure - By step 7 of the administration procedure, the 1:1:1 ratio will be reached. Components are then administered in an alternating manner to maintain this. Note 1 bag of platelets is equivalent to 6 units.

Strategy

The interventions listed above were structured into two Plan-Do-Study-Act (PDSA) cycles. The first cycle aimed to improve transfusion ratios over a 2 year period, with interventions in the second cycle aiming to maintain any improvement through educational and training sessions. Another cycle was run in parallel to these two cycles, monitoring blood component waste over a 6 year period. The outcomes for each cycle were evaluated on a yearly basis and conclusions were drawn from any established trends over the cycle duration. Details of the individual cycles with their interventions are shown below.

PDSA Cycle 1 (2017 - 2019) - Improving Transfusion Ratio

The interventions employed in this cycle are as follows:

1. Implementation of MTP
2. Blood component administration procedure
3. Assigning two porters per MTP activation
4. Pre-alerting the blood bank in cases where massive transfusions are required

5. Organizing blood trolleys
6. Storing thawed FFP within the ED
7. Participation in trials

PDSA Cycle 2 (2019 - 2023) - Maintaining Transfusion Ratio

Maintenance interventions implemented in the second cycle are as follows.

1. Educational videos with MCQ test sign off
2. Yearly simulation sessions
3. 1 on 1 induction sessions with new trainees
4. Feedback after each MT case

Parallel PDSA Cycle (2017 - 2023) - Reducing Blood Component Waste

Interventions to reduce blood component waste are listed as follows.

1. Storing thawed FFP within the ED
2. Educational videos
3. Yearly simulation sessions
4. 1 on 1 induction sessions with new trainees
5. Feedback after each MT case

Balancing Measures

It is important to ensure there are no adverse effects resulting from the study interventions. This is unlikely considering the clinical evidence in support of the 1:1:1 ratio, however, each MT case was assessed to confirm this. The 30 day survival rate was also evaluated on a yearly basis and correlated with any change in transfusion ratio for further confirmation.

Results

Improving Transfusion Ratio

Results for the change in average yearly transfusion ratios throughout both PDSA cycles are shown in Figure 2 along with corresponding 30 day survival rates.

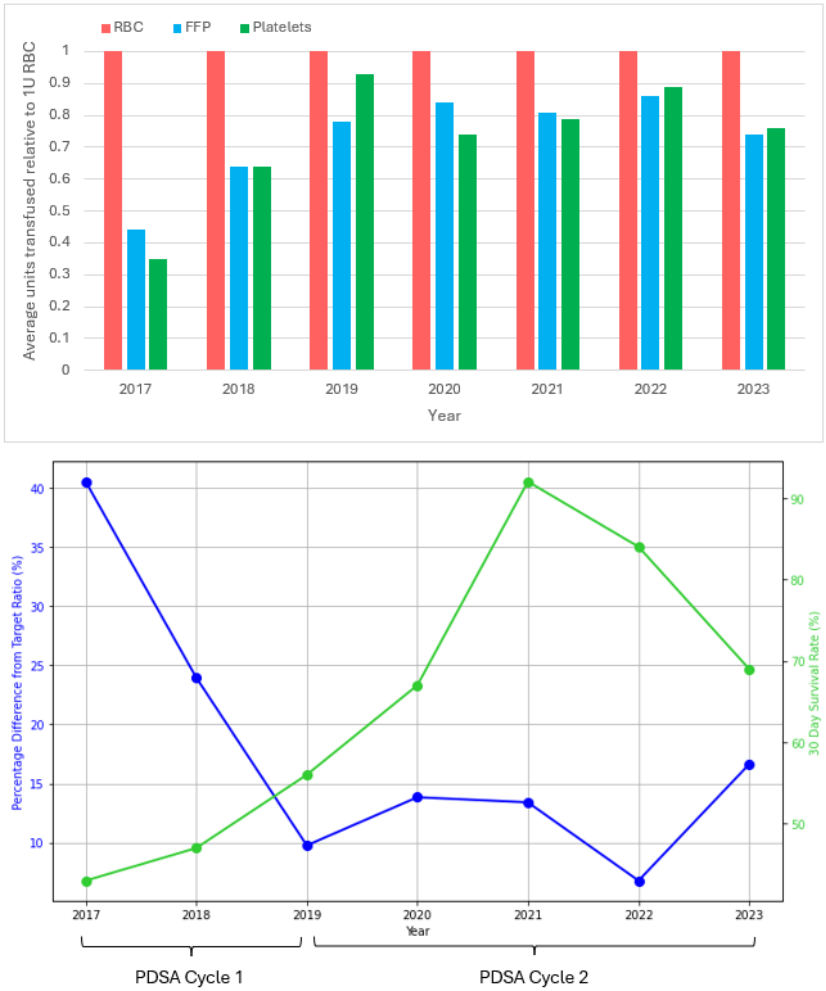

Figure 2: The top chart shows the average yearly transfusion ratio between 2017 and 2023 normalized to be relative to 1 unit of RBC. The bottom chart shows the percentage difference from target ratio for each yearly ratio plotted with corresponding 30 day survival rates.

The results in Figure 2 show a clear improvement in transfusion ratio throughout cycle 1, with a steady maintenance through cycle 2. For a more quantitative comparison, the percentage difference from the target ratio was calculated for each yearly ratio. Figure 2 shows that the percentage difference from target ratio decreases by 30% in cycle 1, and this reduction is maintained throughout cycle 2 aside from a slight increase in 2023. Promisingly, the 30 day survival rate has been uptrending since 2017 and this is partly due to the improvement in ratio. The Pearson correlation coefficient for percentage difference from target ratio and 30 day survival was calculated to be -0.703 ($p = 0.039$) indicating a moderate to strong negative correlation, i.e as the transfusion ratio approaches the target ratio, 30 day survival increases.

Reducing Waste

Figure 3 shows the average percentage waste for each blood component evaluated on a yearly basis between 2017 and 2023.

Figure 3: Average yearly percentage waste for each blood component between 2017 and 2023

Results in Figure 3 demonstrate 13% and 10% reductions in FFP and Platelet waste respectively and maintenance of RBC waste below 10% aside from an increase in 2019 and a slight increase in 2021. These are positive results and indicate that the new protocol can be implemented whilst minimizing waste.

Discussion

The primary objective of moving transfusion ratios closer to the 1:1:1 target ratio has certainly been achieved with the employed interventions in PDSA cycle 1. Reaching the exact target ratio in each MT case is not practically feasible without the administration of whole blood, as blood component transfusions may be stopped based on the clinical picture prior to the target ratio being achieved. Nevertheless, the instituted protocol and administration procedure ensures the transfusion ratio will be relatively close to the target ratio even if transfusions are stopped before the target ratio is reached.

It was important to ensure that improvements from the new protocol could be maintained within the department and this was partly the reason for organizational interventions in PDSA cycle 1, such as assigning two porters per MTP activation, pre-alerts to the blood bank etc. However, it was felt that additional interventions geared towards training and education would be required to maintain improvements in the long run, hence the requirement for PDSA cycle 2 which lasted a significantly longer period of time. The results from cycle 2 demonstrate that improvements to transfusion ratios can be maintained within the department, which is a promising result given that the maintenance interventions are fairly sustainable.

Making an effort improve and maintain transfusion ratios would not be a useful endeavour unless it translated into improved patient outcomes, hence the assessment of 30 day survival which also served as a balancing measure. Reassuringly, the 30 day survival rate has been uptrending since the beginning of this project, and based on the analysis, this is partly correlated to the improvement in transfusion ratios.

Finally, it was important to ensure that the interventions did not substantially increase blood component waste, hence the requirement for the parallel PDSA cycle where measures to reduce waste were implemented. Encouragingly, FFP and Platelet waste has been downtrending throughout the duration of the cycle, with reductions of 13% and 10% respectively by the end. RBC waste was maintained at a low level, under 10% aside from increases in 2019 and 2021. These results demonstrate that the interventions to improve transfusion ratios can be employed whilst simultaneously reducing waste.

Lessons and Limitations

The implementation of new protocols can often be a difficult endeavour, as there tends to be a significant degree of organizational inertia in large organizations with complex structures. There was additional resistance given that this protocol was developed by the ED team who would not normally be responsible formulating a MTP. This project highlighted the importance of effective communication between multiple teams and serves as an example of breaking silos resulting in improved outcomes for patients.

Conclusion

This project has described procedures that can be implemented to improve blood transfusion ratios, targeted towards achieving a 1:1:1 FFP:Platelet:RBC ratio in accordance with clinical evidence that suggests this ratio provides optimal survival outcomes in major haemorrhage. In addition, measures to implement these procedures whilst maintaining low blood component waste have also been discussed with evidence to support their efficacy.

References

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