

An audit of fluid resuscitation practice in trauma patients with major haemorrhage at Christchurch Hospital

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ABSTRACT

AIMS: Damage control resuscitation with limited crystalloids and early use of blood products is now considered standard care in major trauma. The purpose of this study was to audit resuscitation practice in trauma patients where a massive transfusion protocol (MTP) had been activated, to determine whether crystalloid administration and adherence to the MTP had improved since an audit and education sessions in July 2017.

METHODS: We conducted a retrospective study looking at trauma patients presenting to Christchurch Hospital who had a MTP activated from the 1 May 2016 to 1 March 2019. Patients were identified by cross-referencing the trauma call database with the electronic transfusion registry.

RESULTS: Thirty-four patients were included in the audit. There was no significant difference in mean crystalloid administration before and after July 2017 (5.74 litres and 4.86 litres respectively). Patients presenting before July 2017 received a significantly lower mean fresh frozen plasma to red blood cells (FFP:RBC) compared to patients after July 2017.

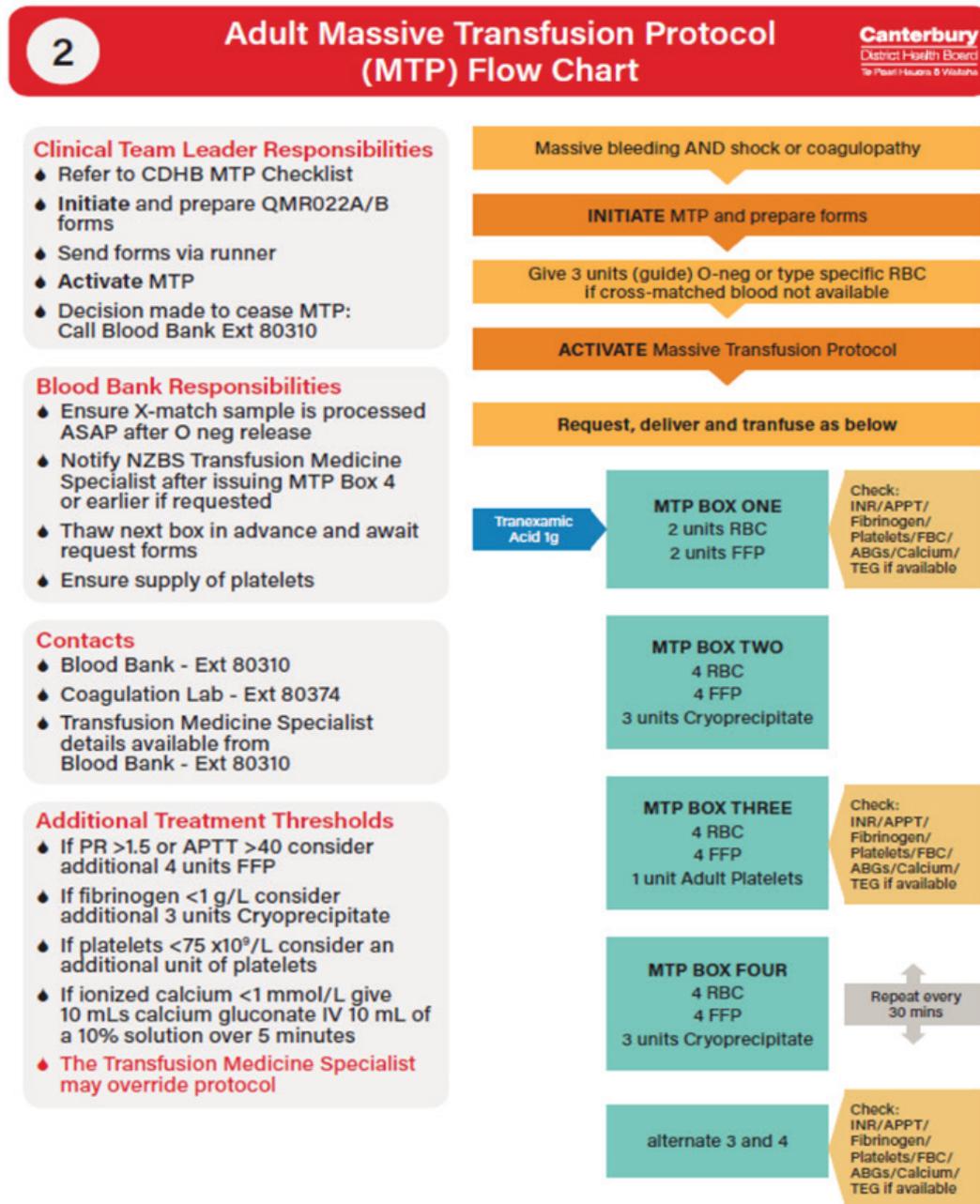
CONCLUSIONS: Trauma patients with major haemorrhage at Christchurch Hospital are still receiving excess crystalloids; however, our audit suggests that compliance with the MTP has improved. Further education involving the entire trauma team is required to improve fluid resuscitation practice.

The incidence of major trauma in New Zealand is approximately 48 per 100,000 population per year, with a fatality rate of 8.4%. The majority of these deaths are due to traumatic brain or spinal cord injury, but approximately 12.6% of fatalities are due to haemorrhage, a potentially preventable cause of traumatic death. Although deaths due to traumatic haemorrhage in New Zealand have reduced during recent years, New Zealand is still lagging behind other countries where fatality rates in major trauma due to haemorrhage are closer to 3%.^{1,2}

Damage control resuscitation (DCR) is now considered a standard of care in the management of severe trauma. The aim of DCR is the prevention or minimisation of the lethal trauma triad of acidosis, coagulopathy and hypothermia. In major haemorrhage, DCR focuses on limitation of crystalloid fluid resuscitation and early use of blood products.³

Despite recent literature supporting the use of whole blood products, protocolised blood component therapy is still used in New Zealand for patients requiring massive

Figure 1: Adult massive transfusion protocol at Christchurch Hospital, Canterbury District Health Board.



transfusion.⁴ The Canterbury District Health Board (CDHB) massive transfusion protocol (MTP) is shown in Figure 1. Massive transfusion is defined as the transfusion of 10 units of red blood cell units in 24 hours, or greater than four units of blood products in one hour.⁵ The MTP provides a system for rapid transfusion of packed red blood cells (RBC), fresh frozen plasma (FFP), platelets and cryoprecipitate in predetermined ratios.⁶

The optimal ratio of blood product administration is a subject of debate in the literature, however there is growing

support for the administration of higher ratios of FFP to RBC.⁷ After three initial units of RBC the CDHB MTP uses a ratio of 1 FFP to 1 RBC in each MTP box (if crossmatched blood is available) with alternating administration of cryoprecipitate and platelets from the second and third boxes respectively. Recently, in some centres, there has been a shift to individualise resuscitation therapy by using specialised point-of-care testing such as rotational thromboelastometry (ROTEM) and thromboelastography (TEG) to provide goal-directed treatment, however there is

still a lack of evidence for the accuracy of these assays and their availability is still limited to large tertiary centres.⁸

In the past, large volumes of crystalloid were frequently administered to major haemorrhage cases, however current Advanced Trauma Life Support (ATLS) guidelines recommend a maximum of 1.5 litres in adult patients during the initial resuscitation phase, in line with current DCR principles.⁹ In 2017, an audit was conducted at Christchurch Hospital reviewing the administration of fluids in trauma patients where a MTP had been activated (unpublished data, Wadham et al, 2017). Christchurch Hospital is a 726-bed hospital serving a population of approximately 630,000 people in the wider Canterbury region. The Emergency Department sees approximately 300 patients per day and on average one major trauma patient (Injury Severity Score >12) is admitted per day.² The audit found that the patients received on average 5.5 litres of crystalloid within the first 24 hours of care. The audit results were presented in educational sessions in July 2017 and up-to-date guidelines were promulgated.

Objective

The purpose of this study was to audit recent resuscitation practice in trauma patients with major haemorrhage where the MTP had been activated. We were specifically interested in the volume of crystalloid administered in the first 24 hours and the ratio of administered blood components, and whether there had been a change since 2017.

Methods

The study was approved as a quality improvement project by the Department of Surgery at Christchurch Hospital. No patient or staff identifiers were collected.

This was a retrospective study looking at trauma patients admitted to Christchurch Hospital who had a MTP activated from the 1 May 2016 to 1 March 2019. Patients were identified by cross-referencing the trauma call database with the electronic transfusion registry held by the New Zealand Blood Service. Inclusion criteria included patients 16 years of age or older, trauma call activation and MTP activation within the first 24 hours of care at Christchurch Hospital. Paper and electronic clinical records, including Emergency Department (ED), ward and Intensive Care Unit (ICU) assessment documents, fluid charts, blood product charts and anaesthetic charts were reviewed to determine the volume and timing of crystalloid, blood product and tranexamic acid (TxA) administration within the first 24 hours of care. In addition, patient demographics including age, gender, mechanism of injury, ISS and survival outcomes were recorded.

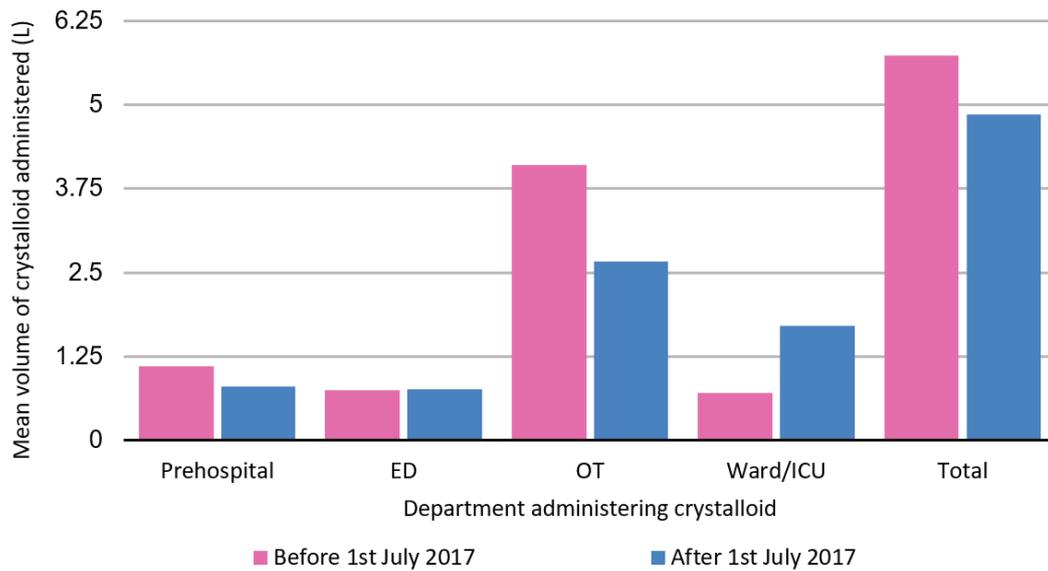
We compared the data for patients presenting before and after 1 July 2017 dating back to the 1 May 2016 when the Trauma Call Database at Christchurch Hospital began. Patient details were summarised using descriptive statistics. When the assumption of normality was met T-Tests were used, while Mann-Whitney U

Table 1: Details of patients presenting before and after 1 July 2017.

	Before 1 July 2017 (n=19)	After 1 July 2017 (n=15)
Mean age (years)	45.2	41.4
Male (%)	74	80
Blunt force trauma (%)	74	87
Received TxA (%)	79	93
Median ISS*	21	38
Survived (%)	68	73

*ISS assesses the severity of polytrauma patients and is based on the anatomical injury severity classification, The Abbreviated Injury Scale (AIS), which divides the body into six regions: head and neck, face, chest, abdomen, extremities and external. This ISS is calculated as the sum of the squares of the highest AIS code in the three most severely injured regions. ISS range from 1–75 with scores greater than 12 signifying major trauma.

Figure 2: Mean volume of crystalloid administered by departments during the first 24 hours of care.



tests were performed when this assumption was not met, in order to determine if there was a significant change in clinical practice following the previous audit in 2017.

Results

Thirty-four patients were included in the audit, with 19 presenting prior to the quality improvement project in July 2017, and 15 presenting after this date. Demographics for the two patient groups are summarised in Table 1.

There was no significant difference in the total volume of crystalloid administered to patients presenting before 1 July

2017 (mean volume 5.74 litres, SD=2.79) compared to those presenting after 1 July 2017 (mean volume 4.86 litres, SD=2.16), $t(32)=1.007, p=0.16$. The mean volumes of crystalloid administered by different departments during the first 24 hours of care are summarised in Figure 2.

The mean ratio of blood products (RBC:FFP:cryoprecipitate:platelets) administered prior to 1 July 2017 was 1:0.46:0.11:0.05 compared to 1:0.74:0.29:0.06 received by those patients presenting after 1 July 2017 as illustrated in Figure 3. The mean volumes of individual blood products administered before and after 1 July 2017 are demonstrated in Table 2.

Figure 3: Mean ratio of blood products administered proportional to the RBC transfused.

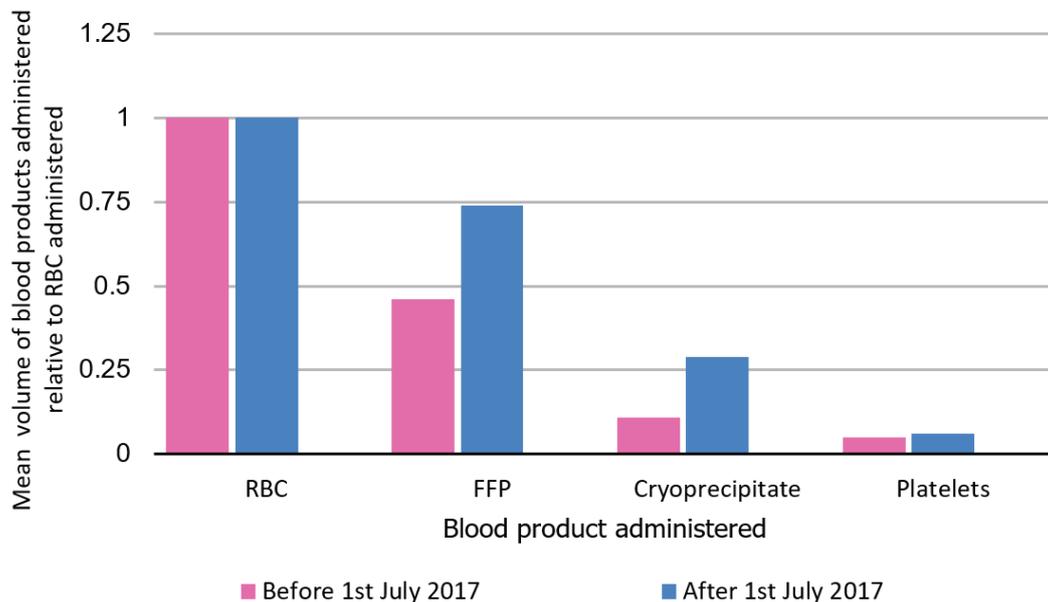


Table 2: Volumes of individual blood products administered before and after 1 July 2017.

	Before July 2017 (n=19)		After July 2017 (n=15)	
	Mean (units)	Range (units)	Mean (units)	Range (units)
RBC	8.8	4-28	11.4	2-45
FFP	5.1	0-28	9.2	0-36
Cryoprecipitate	1.6	0-9	3.9	0-15
Platelets	0.5	0-2	1.1	0-5

Patients presenting prior to 1 July 2017 (mean ratio 0.465, SD=0.30) received significantly less FFP relative to RBC compared to those presenting after 1 July 2017 (mean ratio 0.741, SD=0.43), $T(32)=-2.21$, $p<0.05$. Similarly patients presenting prior to 1 July 2017 (mean ratio 0.113, SD=0.17) received significantly less cryoprecipitate relative to RBC than those patients presenting after 1 July 2017 (mean ratio 0.294, SD=4.87), $T(32)=-1.91$, $p<0.05$. However, there was no significant difference in the ratio of platelets administered before and after 1 July 2017; $U=119$, $p=0.21$.

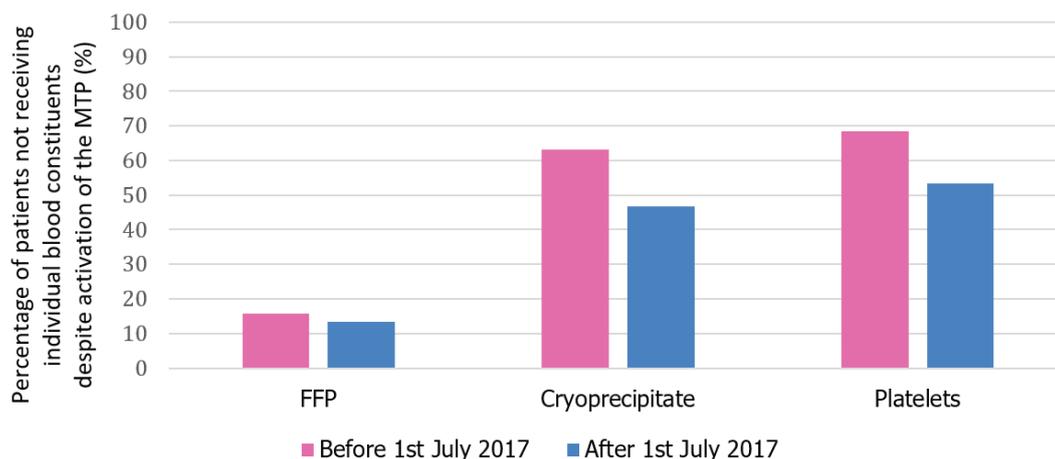
Figure 4 below demonstrates how a large proportion of patients received no FFP, cryoprecipitate or platelets despite activation of the MTP. Although there was an improvement in the number of patients receiving each component of the MTP, this was not significant.

Discussion

This audit has two key findings. Firstly, trauma patients with major haemorrhage at Christchurch Hospital are still receiving

large volumes of crystalloid, in excess of five litres during the first 24 hours of care. There has been no change in practice since educational sessions and promulgation of guidelines in July 2017. Secondly, the ratio of FFP to RBC administration has increased since July 2017. This suggests better adherence to the MTP once activated.

Limitation of crystalloids in the immediate management of trauma patients is a key part of DCR. The rationale for minimising crystalloid administration relates to minimisation of hydraulic disruption of early thrombus formation and prevention of haemodilutional coagulopathy. Our audit showed that relatively large volumes of crystalloid are being administered in the operating theatres, wards and ICU, and more targeted educational sessions may be required in these areas. However, due to the retrospective nature of this audit it was difficult to accurately ascertain the timing and volume of fluids and blood products administered, as there were some discrepancies between fluid prescription charts and clinical summaries. Furthermore, using the first 24 hours of care as the end point,

Figure 4: Percentage of patients who did not receive individual blood products despite activation of an MTP.

rather than the point at which haemorrhagic control had been achieved, may have resulted in an overestimate of the crystalloid use during initial resuscitation. When looking solely at crystalloid administered pre-hospital and within the Emergency Department, an average of 1.8 litres was administered before July 2017 and 1.6 litres after July 2017, more in keeping with current ATLS recommendations. In addition, the difference in volumes of crystalloids administered between departments may in part relate to the difference in time spent in each department.

A further limitation of this study is that it did not take into account physiological parameters or estimated blood loss, which would both potentially have had an impact on volumes of crystalloid and blood products administered. In particular this study did not differentiate patients with traumatic brain injuries in whom a higher blood pressure would have been appropriate.

The early use of protocolised blood component therapy, such as the CDHB's MTP, has been shown to reduce morbidity and mortality in trauma patients with major haemorrhage.³ Our audit suggests that adherence to the MTP may have improved since July 2017, however a significant proportion of patients still did not receive any FFP, platelets or cryoprecipitate. This may relate to our decision to use MTP activation as a criterion for inclusion, rather than evidence of massive haemorrhage (eg, 10 units of RBC in 24 hours). The range of RBC administered was 2–45 units and it is likely that the MTP was discontinued at an early stage for some patients, before administration of non-RBC components, thus leading to lower ratios of FFP, cryoprecipitate and platelets to RBC. The pre-July 2017 group had a lower average ISS than the post-July 2017 group indicating less severe injuries and it is possible that the MTP was discontinued earlier in more pre-2017 patients. This study was likely subject to both survival and reverse survival bias, which has been a common limitation in this area of research, and is likely to have impacted significantly on volumes of crystalloid and blood products administered.^{10,11}

Poor compliance with MTP is not solely a local concern, with previous work showing

compliance levels as low as 27% despite evidence that poor compliance is associated with increased morbidity and mortality.^{12,13} It is reassuring that our audit suggests improved compliance since the previous quality improvement project, but there is further room for improvement.

Although this study was based around a single district health board's MTP and there are subtle differences in MTP throughout New Zealand, the concept of limiting crystalloids and proactively using blood products in trauma patients requiring massive transfusion is still paramount. We would support a nationwide review of resuscitation practices in this cohort of patients. Our audit suggests a need for more education in our institution about fluid resuscitation in trauma patients with severe haemorrhage. This education should be multidisciplinary and aimed at the entire team responsible for the care of trauma patients—including staff in ED, operating theatres, wards and ICU. We plan to disseminate the results of this audit, along with current local trauma management guidelines and selected international references. Further monitoring and audit of trauma resuscitation practice in relation to physiological parameters will be required to assess compliance with the guidelines.

Conclusion

Damage control resuscitation has now become a standard of care in the management of severe trauma. During the last decade, trauma guidelines have shifted from the liberal use of crystalloid as a first-line resuscitation fluid to limited use of crystalloid and early use of protocolised blood component therapy.

Our audit shows that patients with major haemorrhage are still receiving large volumes of crystalloid compared to current trauma management guidelines, but there has been some improvement in adherence to the local MTP.

Further education of the entire trauma care team is required to help bring our practice into line with current trauma resuscitation guidelines and we plan to continue to audit resuscitation practice at Christchurch Hospital.

Competing interests:

Nil.

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