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Massive Blood Transfusion in Patients with Ruptured Abdominal Aortic Aneurysm

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WHAT THIS PAPER ADDS
This paper highlights the importance of a planned transfusion strategy in patients with ruptured AAA. A majority of patients undergoing EVAR for ruptured AAA received massive transfusion but with smaller transfusion volumes and with lower FFP/RBC and PLT/RBC ratios than patients treated with open repair. A lower risk of mortality was seen in patients transfused with a ratio close to 1:1 FFP/RBC.

Objectives: The aim was to study blood transfusions and blood product ratios in massively transfused patients treated for ruptured abdominal aortic aneurysms (rAAAs).
Methods: This was a registry based cohort study of rAAA patients repaired at three major vascular centres between 2008 and 2013. Data were collected from the Swedish Vascular Registry, hospitals medical records, and local transfusion registries. The transfusion data were analysed for the first 24 h of treatment. Massive transfusion (MT) was defined as 4 or more units of red blood cell (RBC) transfused within 1 h, or 10 or more RBC units within 24 h. Logistic regression was used to calculate the odds ratio of 30 day mortality associated with the ratios of blood products and timing of first units of platelets (PLTs) and fresh frozen plasma (FFP) transfused.
Results: Three hundred sixty nine rAAA patients were included: 80% men; 173 endovascular aneurysm repairs (EVARs) and 196 open repairs (ORs) with median RBC transfusion 8 units (Q1—Q3, 4—14) and 14 units (Q1—Q3, 8—28), respectively. A total of 261 (71%) patients required MT. EVAR patients with MT ($n = 96$) required less transfusion than OR patients ($n = 165$): median RBC 10 units (Q1—Q3, 6—16.5) vs. 15 units (Q1—Q3, 9—26) ($p = .002$), FFP 6 units (Q1—Q3, 2—14.5) vs. 13 units (Q1—Q3, 7—24) ($p < .001$), and PLT 0 units (Q1—Q3, 0—2) vs. 2 units (Q1—Q3, 0—4) ($p = .01$). Median blood product ratios in MT patients were FFP/RBC (EVAR group 0.59 [0.33—0.86], OR group 0.84 [0.67—1.2]; $p < .001$], and PLT/RBC (EVAR 0 [0—0.17], OR 0.12 (0—0.18); $p < .001$]. In patients repaired by OR a FFP/RBC ratio close to 1 was associated with reduced 30 day mortality ($p = .003$). The median PLT/RBC ratio was higher during the later part of the study period ($p < .001$, median test), whereas there was no significant difference in median FFP/RBC ratio ($p = .101$, median test).
Conclusion: The majority of rAAA patients undergoing EVAR required MT. EVAR patients treated with MT had lower FFP/RBC and PLT/RBC ratios than OR patients with MT. The mortality risk was lower with FFP/RBC ratio close to 1:1 in open repaired patients requiring MT. The 24 h PLT/RBC ratio increased over the study period.

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INTRODUCTION

Massive haemorrhage in patients with ruptured abdominal aortic aneurysm (rAAA) undergoing open repair (OR) or endovascular aortic repair (EVAR) has been associated with a worse outcome.[1] The optimal haemostatic resuscitation in rAAA patients has not been well defined. Most recent guidelines for transfusion and resuscitation in massively bleeding patients are largely based on the trauma

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literature.[2] It has been suggested that high ratios of fresh frozen plasma (FFP) and platelets (PLTs) to red blood cells (RBCs) are beneficial to the outcome in massively bleeding trauma patients.[3] In previous studies, early transfusion of plasma and PLTs improves survival in patients operated on for rAAA.[4,5] Also, a mortality benefit has been seen with increased FFP.[6]

EVAR in rAAA patients is associated with considerably smaller blood transfusion volumes than OR.[7,8] The proportion of patients that require massive transfusion (MT) among patients treated with EVAR for rAAA is not known. The purpose of this national multicentre study was to investigate blood transfusion and possible associations between blood product ratios and outcome in MT rAAA patients undergoing OR or EVAR. Also, associations between early administration of FFP and PLT and outcome were analysed as well as altered transfusion strategies during the study period.

METHODS

Study design

During the study period, between May 8, 2008, and December 31, 2013, 406 patients underwent rAAA repair at three of the largest vascular centres in Sweden (Karolinska University Hospital, $n = 140$, and Södersjukhuset, $n = 117$, Stockholm; Skåne University Hospital, $n = 149$, Malmö). Twenty-nine patients were excluded because of failure to match with the transfusion registry, and eight patients lacked transfusion data. The final study cohort comprised 369 patients with rAAA repair.

Inclusion/exclusion criteria

All patients reported in the Swedish Vascular Registry (SWEDVASC) as ruptured AAA during the study time were searched for in the local transfusion registries. Patients undergoing OR and EVAR were included in the study. Patients were analysed together and separately as appropriate according to operative methods. Only patients that required MT were analysed with regard to transfusion ratios and time, and association with outcome. Patients that died before aortic repair was attempted and patients that died in the operating theatre were excluded, as their deaths were considered not to be affected by the transfusion strategy.

Data collection

Patient data, medical history, and data related to the rAAA repair and outcome were collected from the validated Swedish Vascular Registry[9] (SWEDVASC) and the hospitals medical records.

Blood transfusion data were gathered from the local transfusion registries. The transfusion registries included data on exact issuing time, number of units, and type of blood products ordered. The registry has previously been validated as accurate for using as an alternative to manually retrieving the data from each of the patients' medical records and anaesthesiologists' charts.[10] Little inconsistency was seen in issuing time and actual transfusion time (median 0.14 h; Q1—Q3, 0.0—2.5 h).[10]

Method of repair

The vascular surgeon in charge decided on the method of repair according to his or her judgement. EVAR is the preferred primary method of repair in rAAA at the enrolled centres. The complexity of anatomy, hemodynamic status, personal competence in performing advanced EVAR or complex OR, and the hospitals resources were all factors that were processed before deciding upon the method of repair.

Definitions

MT was defined as ≥ 4 units of RBCs transfused in 1 h or 10 units of RBCs transfused in 24 h.[11] Patients reaching either of the two definitions were defined as patients requiring MT.

Transfusion of blood products

RBCs were suspended in additive solution SAGMAN (sodium chloride, glucose monohydrate, adenine, and mannitol) in a total volume of approximately 280 mL for each unit of RBCs. The plasma units were either FFP, stored at $-30\ ^{\circ}C$ or liquid plasma stored for up to 14 days in a blood refrigerator at 2—6 °C, both in units of approximately 250 mL. PLTs were prepared from buffy coats pooled from four to six donors and kept at 22 °C. Each unit contained more than 240×10^9 PLTs suspended in 350 mL, 70% platelet additive solution (PAS), and 30% plasma. All blood components were prestorage leukocyte reduced. The ideal ratio of FFP/RBC transfusion in massively transfused patients in Sweden is, according to national guidelines, 1:1. The optimal ratio of PLT/RBC is defined as 1:4 and not 1:1, because in Sweden a transfusion unit of PLTs is pooled from four to six donors. Hence, the agreed national optimal ratio in massively transfused patients is 4:4:1 (RBC/FFP/PLT). Guidelines are provided by the Swedish Society for Thrombosis and Haemostasis, updated June 30, 2014 (www.SSTH.se).[12]

Statistical analysis

Data are presented as mean $\pm$ SD or median (25th percentile [Q1] to 75th percentile [Q3]) as appropriate. To test whether the 24 h ratio of FFP to RBC and PLT to RBC changed during the study period, the ratio for the years 2008—2010 was compared with the ratio for the years 2011—2013 using the median test. Thirty day mortality was used as the primary endpoint. The associations between both (1) time to first transfusion and 30 day mortality and (2) 24 h ratio and 30 day mortality were modelled using logistic regression. Associations for FFP and PLT were analysed separately.

Time to first transfusion was split into two parts: a dummy variable indicating whether transfusion was received or not and a continuous variable measured in log (hours from first order of blood products + 1). The