Trauma Case Reports 48 (2023) 100955

Contents lists available at ScienceDirect

Trauma Case Reports

journal homepage: www.elsevier.com/locate/tcr

Case Report

Ultramassive transfusion and adjunctive therapies in a case of blood bank depletion

Max Jackson *, Spencer Berman, Mario Rueda, Robert Borrego, Lawrence Lottenberg, Faris Azar

Department of Surgery, Charles E. Schmidt College of Medicine, Florida Atlantic University, 800 Meadows Road, Boca Raton, FL 33486, United States of America
Division of Trauma, St. Mary's Medical Center, 901 45th Street, West Palm Beach, FL 33407, United States of America

ARTICLE INFO

Keywords:
Trauma
Ultramassive transfusion
Hemorrhagic shock
Thoracoabdominal gunshot wound

ABSTRACT

Background: We present the case of a patient who presents with a high velocity thoracoabdominal gunshot wound requiring ultramassive transfusion who exhausted the county blood bank requiring adjunctive therapies to balanced blood product transfusion while additional blood products could be obtained.
Summary: Thoracoabdominal gunshot wounds carry a high mortality of 14–37 % because of the risk to produce cardiopulmonary, solid organ as well as major vascular injuries (Mandal and Oparah (1989) [1]). Ultramassive transfusion (>20 units of blood product transfusion) also carries high morbidity and mortality and management has generally centered on balanced transfusion (Matthay et al. (2021) [2]).
Conclusion: Balanced blood product transfusion reduces mortality for patients requiring ultramassive transfusion but when this is not possible utilization of adjuncts to blood products may temporize resuscitation until additional blood products can be obtained.

Case report

Patient is a 52 year old male with history of depression not on anticoagulation who presented after high caliber assault rifle gunshot wounds to the right lower chest and back. He became hypotensive in the trauma bay. Chest radiograph demonstrated hemopneumothorax. Central venous and arterial access were obtained. A chest tube was placed with over 1 L return of bloody output. Massive transfusion protocol was initiated. Patient was brought to the OR and underwent right sided thoracotomy which demonstrated a large defect to the right hemidiaphragm with blood pooling from the abdomen. A laparotomy was performed and demonstrated damage consistent with a military weapon, a grade 5 liver injury to segments 6–8 and the retrohepatic inferior vena cava. The patient underwent partial hepatectomy of segments 6 and 7, diaphragm repair, IVC repair, liver packing and temporary chest and abdominal closure. At this point he had received 28 pRBC, 20 FFP, 2 cryo, 5 platelets and 1 Kcentra. He proceeded to the ICU for thromboelastography guided resuscitation but was taken back to the OR shortly after once his acidosis was corrected. He underwent relook thoracotomy and laparotomy with evacuation of hematoma, control of liver hemorrhage, exchange of packing and temporary chest and abdominal closure. During the takeback, our county's blood bank ran out of products. Intraoperatively at this point he had received

* Corresponding author at: Department of Surgery, Charles E. Schmidt College of Medicine, Florida Atlantic University, 800 Meadows Road, Boca Raton, FL 33486, United States of America.
E-mail address: maxjackson@health.fau.edu (M. Jackson).

https://doi.org/10.1016/j.tcr.2023.100955
Accepted 17 October 2023
Available online 18 October 2023

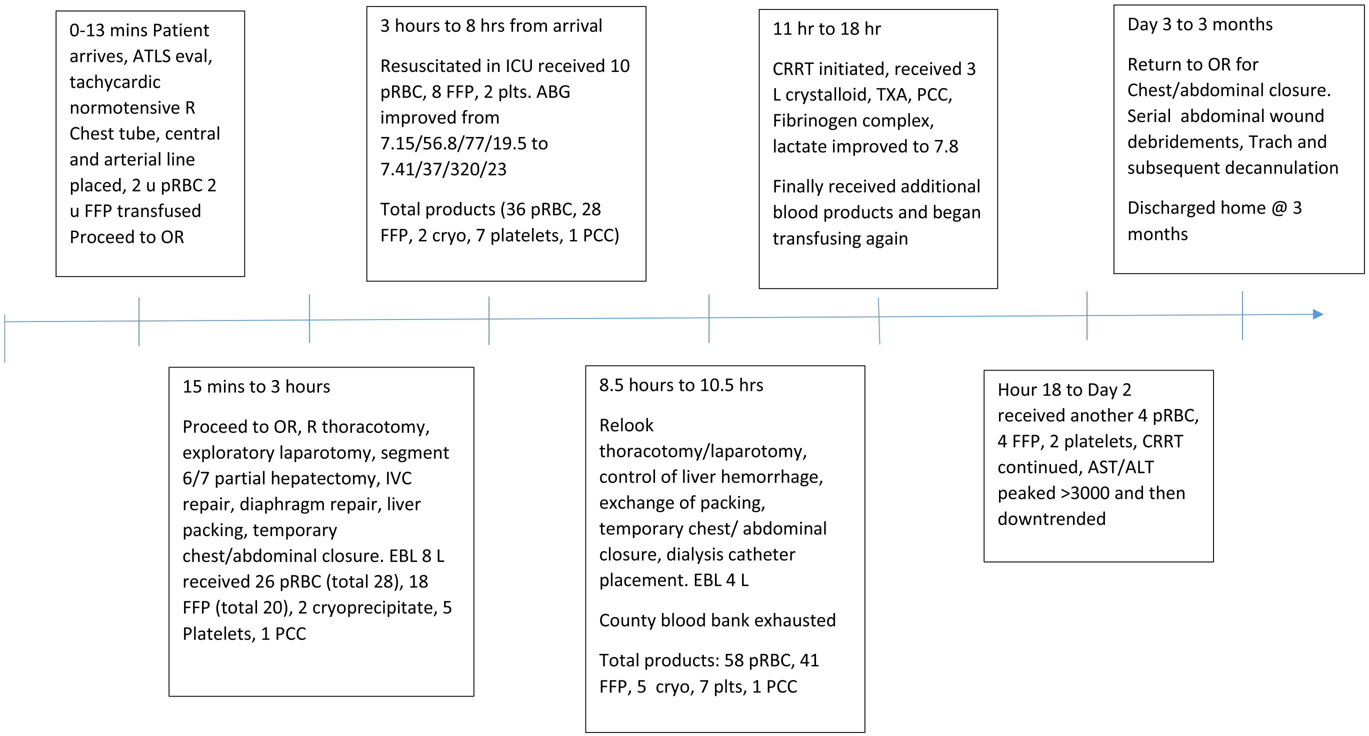

Fig. 1. Patient timeline.

a total of 58 units pRBCs, 41 units FFP, 5 units cryoprecipitate, 7 units platelets when the blood bank was exhausted. He subsequently received TXA, Prothrombin complex concentrate, Fibrinogen complex and CRRT was initiated. Approximately 8 h later additional blood products were able to be obtained. He had improvement of his acidosis at this time. He would return to the OR 2 days later after improvement of his acidosis for removal of the packing and closure of his chest and abdomen. He had a prolonged hospitalizations requiring tracheostomy with eventual decannulization and return to OR on several occasions for serial debridements of his chest wall wound. He was discharged home with family care after a 3 month hospital course (Fig. 1).

Discussion

Thoracoabdominal gunshot wounds carry high mortality due to their association with cardiopulmonary and major vascular injury [1]. Multiple studies have demonstrated that balanced blood product resuscitation decreases mortality and increases the chance of hemostasis within 24 h of traumatic injury, most notably the PROPPR and PROMMTT studies [3,4]. Ultramassive transfusion is defined as patient requiring >20 units of blood product and in these patients mortality still remains high at 60–70 % [5–7]. One recent study demonstrated the importance of balanced transfusion in this patient subset, but also demonstrated a majority of patients (52 %) still receive an unbalanced blood product ratio of RBC: PLT or RBC: FFP $\geq$ 1.5:1 [2]. Some may point to the continued use of lab-guided blood product resuscitation as the source for this large percentage of patients not receiving balanced blood products whether that be utilizing hematology labs, coagulation profiles or thromboelastography. However a contribution to this percentage may relate to blood product availability and that unbalanced transfusion ratios in these patients are in part due to the lack of availability as local blood banks are depleted, as seen in our case study.

Matthay et al., discussed the difficulty in maintaining balanced transfusion in their manuscript on ultramassive transfusion and how as blood banks become depleted by rapid hemorrhage, there is a hindrance in providers ability to track and adjust transfusion in real time as a transition to goal-directed resuscitation can occur even at large centers with established research protocols for balanced ultramassive transfusion [2]. Another study examined the ratios of blood product transfusion for patients receiving massive transfusion protocol versus “super” massive transfusion protocol (>30 blood product units) at a single center over a 7 year period and found that as blood product requirements increased there was a propensity towards unbalanced blood product transfusion [8]. With this in mind, it is important that we continue to evaluate current methods and fine-tune transfusion ratios to allow for the best outcomes in the subset of patients undergoing ultramassive transfusion. Additionally, it is vital to include anesthesia, emergency medicine and non-surgical ICU personnel involved in creation of massive transfusion protocols in order to optimize adherence to these protocols when those outside of the trauma surgeon are primarily responsible for the resuscitation of the patient.

Even with the implementation of balanced transfusion studies and protocols being established in the recent decade, little to no research has been done on decreasing mortality when blood becomes unavailable in an ultramassive transfusion situation. In our case, we used the aid of thromboelastography to guide our adjunct blood product decisions. The EAST multicenter trial did note that patients receiving cryoprecipitate had improved mortality, however when controlled for other factors this tendency did not have statistical significance [2]. In our patient, CRRT was used to further aid in fluid balance and electrolyte management. Along with the use of these agents, we chose to administer products that contain clotting factors, reduce overall blood loss, or aid in overall hemostasis such as Tranexamic acid (TXA), Prothrombin Complex Concentrates, and Fibrinogen complex which have been shown to decrease mortality and decrease transfusion requirements [9–12]. In patients such as ours requiring ultramassive transfusion, it is important to consider these adjuncts especially as blood products become depleted in one's institution. Blood salvage therapies (such as Cell Saver©), are alternative therapies that can be useful in hemorrhagic shock and in institutions with extracorporeal membrane oxygenation capabilities, this is another option to assist in patients with severe hemorrhagic shock requiring ultramassive transfusion [13].

Several studies have sought to evaluate futility in trauma resuscitation for patient's arriving in hemorrhagic shock by using transfusion volumes as well as arrival physiologic parameters [14,15]. We report an example of a survivor of >100 units of transfused blood products who would fall outside of the parameters of continued resuscitation in many of these studies.

This case is a great example of survival in an ultramassive transfusion patient, even when our county was depleted of blood products for >6 h. While systemic needs must be considered, hard cutoffs for transfusion volumes may obstruct trauma surgeons from saving potential lives. Data on this topic is limited and further studies are needed to evaluate best adjuncts to use in cases when balanced transfusion is not available.

Conclusion

Balanced blood product transfusion reduces mortality for patients requiring ultramassive transfusion but when this is not possible utilization of adjuncts to blood products may temporize resuscitation until additional blood products can be obtained.

Declaration of competing interest

All authors have reviewed the manuscript in its entirety and declare that they have no significant financial conflicts of interest. The order of authorship has been reviewed and approved by all authors. Florida Atlantic University has provided funds for publication of this manuscript.

References

[1] A.K. Mandal, S.S. Oparah, Unusually low mortality of penetrating wounds of the chest. Twelve years' experience, J. Thorac. Cardiovasc. Surg. 97 (1989) 119–125, https://doi.org/10.1016/S0022-5223(19)35136-0.

[2] Z.A. Matthay, Z.J. Hellmann, R.A. Callcut, et al., Outcomes after ultramassive transfusion in the modern era: an eastern association for the surgery of trauma multicenter study, J. Trauma Acute Care Surg. 91 (1) (Jul 1 2021) 24–33, https://doi.org/10.1097/TA.0000000000003121.

[3] J.B. Holcomb, D.J. del Junco, E.E. Fox, PROMMTT Study Group, et al., The prospective, observational, multicenter, major trauma transfusion (PROMMTT) study: comparative effectiveness of a time-varying treatment with competing risks, JAMA Surg. 148 (2) (Feb 2013) 127–136, https://doi.org/10.1001/2013.jamasurg.387.

[4] S. Baraniuk, B.C. Tilley, D.J. del Junco, PROPPR Study Group, et al., Pragmatic Randomized Optimal Platelet and Plasma Ratios (PROPPR) trial: design, rationale and implementation, Injury 45 (9) (Sep 2014) 1287–1295, https://doi.org/10.1016/j.injury.2014.06.001 (Epub 2014 Jun 10).

[5] W.S. Dzik, A. Ziman, C. Cohn, et al., Biomedical Excellence for Safer Transfusion Collaborative, Survival after ultramassive transfusion: a review of 1360 cases, Transfusion 56 (3) (Mar 2016) 558–563, https://doi.org/10.1111/trf.13370 (Epub 2015 Oct 9. Erratum in: Transfusion. 2016 May;56(5):1249).

[6] G.C. Velmahos, L. Chan, M. Chan, et al., Is there a limit to massive blood transfusion after severe trauma? Arch. Surg. 133 (9) (Sep 1998) 947–952, https://doi.org/10.1001/archsurg.133.9.947.

[7] A.J. Yu, K. Inaba, S. Biswas, et al., Supermassive transfusion: a 15-year single center experience and outcomes, Am. Surg. 84 (10) (Oct 1 2018) 1617–1621.

[8] C.J. Allen, S. Shariatmadar, J.P. Meizoso, et al., Liquid plasma use during "super" massive transfusion protocol, J. Surg. Res. 199 (2) (Dec 2015) 622–628, https://doi.org/10.1016/j.jss.2015.06.022 (Epub 2015 Jun 18).

[9] I. Roberts, H. Shakur, T. Coats, et al., The CRASH-2 trial: a randomised controlled trial and economic evaluation of the effects of tranexamic acid on death, vascular occlusive events and transfusion requirement in bleeding trauma patients, Health Technol. Assess. 17 (10) (Mar 2013) 1–79, https://doi.org/10.3310/hta17100.

[10] O. Grottke, J.H. Levy, Prothrombin complex concentrates in trauma and perioperative bleeding, Anesthesiology 122 (4) (Apr 2015) 923–931, https://doi.org/10.1097/ALN.0000000000000608.

[11] K. Sugiyama, H. Fujita, S. Nishimura, Effects of in-house cryoprecipitate on transfusion usage and mortality in patients with multiple trauma with severe traumatic brain injury: a retrospective cohort study, Blood Transfus. 18 (1) (Jan 2020) 6–12, https://doi.org/10.2450/2019.0198-18 (Epub 2019 Jan 22).

[12] H. Schöchl, U. Nienaber, M. Maegele, et al., Transfusion in trauma: thromboelastometry-guided coagulation factor concentrate-based therapy versus standard fresh frozen plasma-based therapy, Crit. Care 15 (2) (2011) R83, https://doi.org/10.1186/cc10078 (Epub 2011 Mar 4).

[13] E.C. Alberto, Y. Zheng, Z.P. Milestone, et al., Patterns of paediatric massive blood transfusion protocol use in trauma and non-trauma patients, Transfus. Med. 31 (6) (Dec 2021) 439–446, https://doi.org/10.1111/tme.12829 (Epub 2021 Oct 27).

[14] A.M. Loudon, A.P. Rushing, J.J. Hue, et al., When is enough enough? Odds of survival by unit transfused, J. Trauma Acute Care Surg. 94 (2) (Feb 1 2023) 205–211, https://doi.org/10.1097/TA.0000000000003835 (Epub 2022 Nov 10).

[15] J.M. Van Gent, T.W. Clements, D.T. Lubkin, et al., Predicting futility in severly injured patients: using arrival lab values and physiology to support evidence-based resource stewardship, J. Am. Coll. Surg. 236 (4) (Apr 1 2023) 874–880, https://doi.org/10.1097/XCS.0000000000000563 (Epub 2023 Jan 18).