Use of whole blood deployment programs for mass casualty incidents: South Texas experience in regional response and preparedness

Angelo Ciaraglia, MD, Erika Brigmon, MD, Maxwell Braverman, DO, Emily Kidd, MD, CJ Winckler, MD, Eric Epley, BS, Jose Flores, BS, John Barry, BS, Daniel DeLeon, MD, Elizabeth Waltman, MD, Brian Eastridge, MD, Ronald Stewart, MD, Lillian Liao, MD, Susannah Nicholson, MD, MS, *and* **Donald Jenkins, MD***, San Antonio, Texas*

INTRODUCTION: Firearm-related deaths have become the leading cause of death in adolescents and children. Since the Sutherland Springs, TX mass casualty incident (MCI), the Southwest Texas Regional Advisory Council for trauma instituted a prehospital whole blood (WB) program and blood deployment program for MCIs.

METHODS: The program was adopted statewide by the Texas Emergency Medical Task Force, of which Southwest Texas Regional Advisory Council is the lead for Emergency Medical Task Force 8. The recent active shooter MCI in Uvalde, TX was the first time the MCI blood deployment program had been used. To our knowledge, no other similar programs exist in this or any other country.

RESULTS: On May 24, 2022, 19 children and 2 adults were killed at an MCI in Uvalde, TX. The MCI WB deployment protocol was initiated, and South Texas Blood and Tissue Center prepared 15 U of low-titer O-positive whole blood and 10 U of leukoreduced O packed cells. The deployed blood arrived at Uvalde Memorial Hospital within 67 minutes. One of the pediatric patients sustained multiple gunshots to the chest and extremities. The child was hypotensive and received 2 U of leukoreduced O packed cells, one at the initial hospital and another during transport. On arrival, the patient required 2 U of low-titer O-positive whole blood and underwent a successful hemorrhage control operation. The remaining blood was returned to South Texas Blood and Tissue Center for distribution.

CONCLUSION: Multiple studies have shown the association of early blood product resuscitation and improved mortality, with WB being the ideal resuscitative product for many. The ongoing efforts in South Texas serve as a model for development of similar programs throughout the country to reduce preventable deaths. This event represents the first ever successful deployment of WB to the site of an MCI related to a school shooting in the modern era. (*J Trauma Acute Care Surg.* 2022;93: e182–e184. Copyright © 2022 Wolters Kluwer Health, Inc. All rights reserved.)

LEVEL OF EVIDENCE: Therapeutic/Care Management; Level V.

KEY WORDS: Mass casualty; whole blood; trauma systems.

According to the recently released report from the Center for Disease Control and Prevention, firearm-related deaths have become the leading cause of death in adolescents and children with a notably sharp incline in the mortality rate from 2019 to 2020.[1] On May 24, 2022, a mass casualty incident (MCI) took place at an elementary school in Uvalde, TX, where 22 individuals (19 children, 3 adults) were killed and another 18 sustained physical injuries, some of whom required emergency release blood transfusion.

PATIENTS AND METHODS

On November 5, 2017, the Sutherland Springs, TX MCI occurred during a church service that resulted in the deaths of 26 individuals and wounding several others. Since 2018, the Southwest Texas Regional Advisory Council (STRAC) for trauma has led and developed a consortium of trauma centers, emergency medical service agencies, blood banks, local police and fire departments, and other governmental entities to establish the use of whole blood (WB) for prehospital resuscitation. The events of the Sutherland Springs MCI led to the development of an additional program in which WB could be rapidly deployed to the site of an MCI throughout the South Texas region providing critical and lifesaving hemostatic resuscitation at a critical junction before patient arrival at a designated trauma center. In addition, the Assistant Secretary for Preparedness and Readiness of Health and Human Services at the Federal Government level issued a report in support of such a program.

The WB deployment program is sponsored by the Texas Emergency Medical Task Force (EMTF), which consists of eight multi-regional advisory council geographic regions, and STRAC is the lead regional advisory council for EMTF-8 and is also designated as the State Coordination Office for the entire Texas EMTF program[2] (Fig. 1). Although other MCIs have occurred in Texas, including the El Paso and Midland shootings, the recent active shooter

Submitted: July 17, 2022, Revised: September 11, 2022, Accepted: July 30, 2022, Published online: August 31, 2022.

From the Department of Surgery (A.C., E.B., M.B., B.E., R.S., L.L., S.N., D.J.), University of Texas Health Science Center at San Antonio; Acadian Ambulance Service (E.K.); and STRAC Regional Whole Blood Program (C.J.W., E.E., J.F., J.B., D.D., E.W.), San Antonio, Texas.

This study was presented at the Pediatric Trauma Society Annual Meeting, November 4, 2022, Portland, OR.

Address for correspondence: Angelo Ciaraglia, MD, Department of Surgery, University of Texas Health Science Center at San Antonio, 7703 Floyd Curl Dr, Mail Code 7740, San Antonio, TX 78229; email: ciaraglia@uthscsa.edu.

DOI: 10.1097/TA.0000000000003762

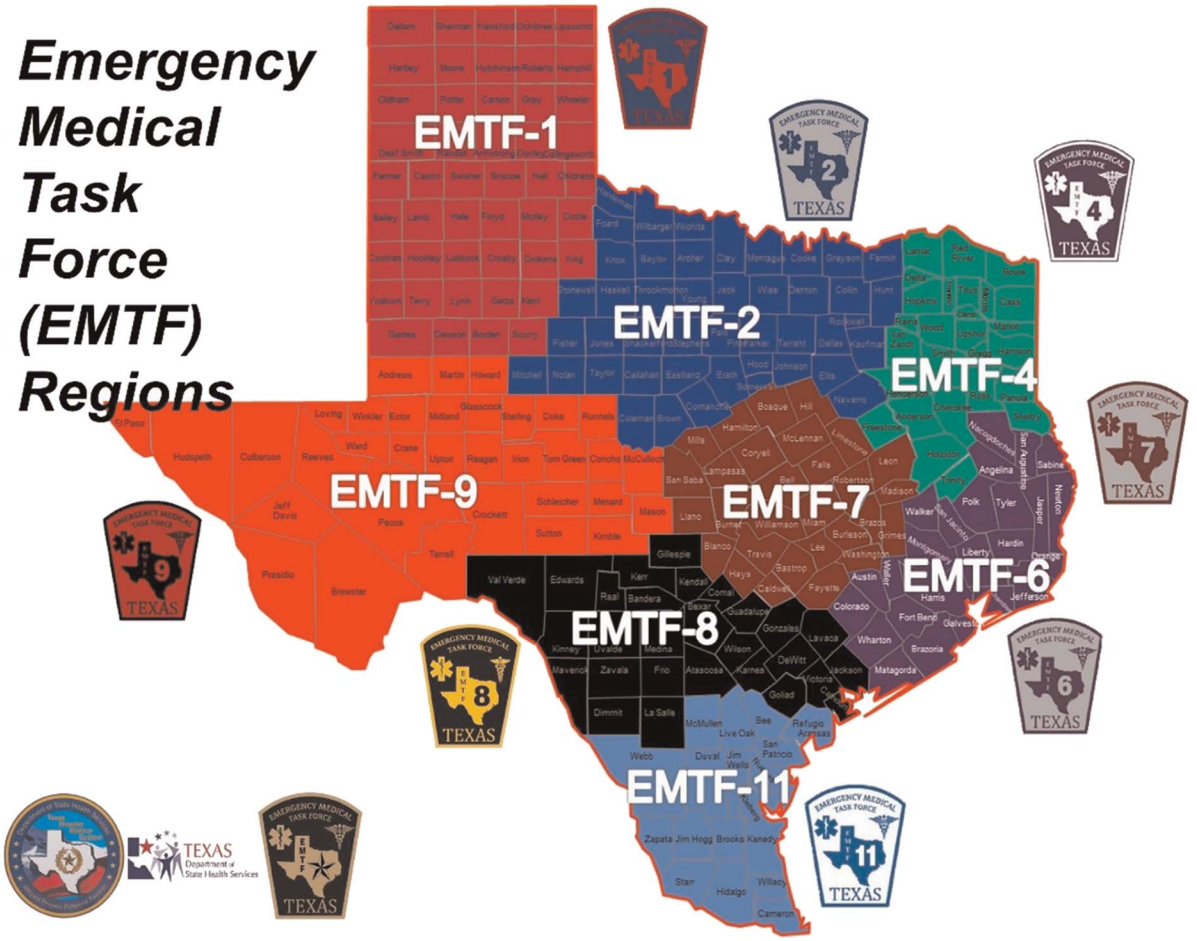

Figure 1. Map of EMTF regions for Texas for the purpose of building alternate care capacity with an acute medical focus that could be deployed during large mass casualty events.

MCI in Uvalde, TX was the first time the EMTF MCI Whole Blood deployment program has ever been used; we know of no other programs such as this in this or any other country.

RESULTS

On May 24, 2022, when the events of the Uvalde MCI were being reported to state and local authorities, the EMTF State Coordination Office activated the MCI Whole Blood protocol. South Texas Blood and Tissue (STBTC) began preparing 15 U of low-titer O-positive whole blood (LTO-WB) and 10 U of leukoreduced O packed cells for deployment while an air medical helicopter was dispatched to transport the blood. The MCI WB package arrived at Uvalde Memorial Hospital within 67 minutes because of rapid response of the regional WB deployment program (Fig. 2). Costs incurred for the WB and air

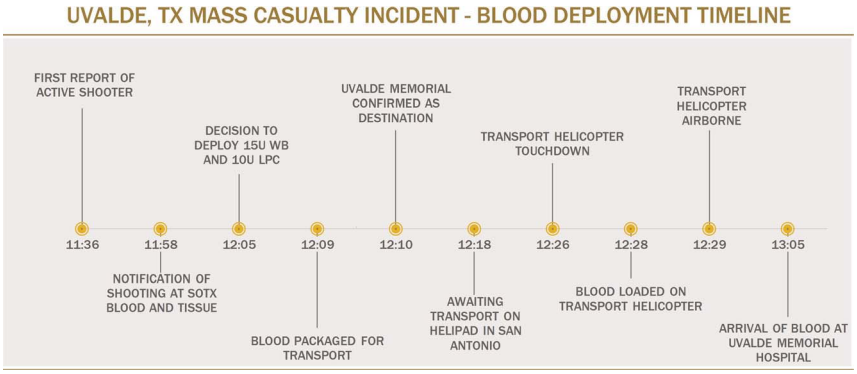

Figure 2. Timeline of events of WB deployment to Uvalde, TX MCI.

medical helicopter transport were underwritten as part of the EMTF program through the State of Texas.

One of the pediatric patients sustained multiple gunshot wounds to the chest and extremities. The patient was intubated, received bilateral tube thoracostomies, and bilateral upper extremity tourniquets before arrival. The child was hypotensive and received 2 U of deployed leukoreduced O packed red blood cells, one at the initial hospital and another during transportation to our level I trauma center. On arrival to the regional level I trauma center, the patient was still hypotensive and required 2 additional units of LTO-WB. The patient underwent a successful operation for hemorrhage control and remains hospitalized at this point. One of the adult patients received 1 U of LTO-WB in Uvalde before and during transport to the other regional level I trauma center. Of the 25 U available, 2 U of leukoreduced O packed cells and 1 U LTO-WB were used, and the rest returned back to STBTC on May 26, 2022, for distribution to regional facilities. No additional units of LTO-WB were used at either regional level I trauma center. Costs incurred for the blood and air medical helicopter transport were underwritten as part of the EMTF program through the State of Texas.

In addition to the WB deployment program, there were an additional 20 U of blood products at Uvalde Memorial Hospital or at the local airfield ready for use if needed. These additional blood products were provided through neighboring counties and regional collaborators as part of a call to action to EMS agencies in neighboring counties in response to the MCI. Thus, in approximately 90 minutes from the initial notification of STRAC and STBTC, there were 45 additional units of blood product available to augment the local hospital blood bank supply, which typically has an inventory of 55 U of packed red blood cells and 50 U of fresh frozen plasma of various blood types and rhesus antigen status. Of note, Uvalde Memorial Hospital has no platelets available as part of their normal inventory. Several studies[3–7] have shown the critical function of platelets in hemostatic resuscitation and clot formation, especially in traumatically injured patients. Thus, the additional units provided in the WB deployment to Uvalde not only provided additional units but also a superior hemostatic resuscitation fluid.

CONCLUSION

With more than 200 MCIs occurring in 2022 alone, regional trauma system response is paramount to reducing the number of preventable deaths with early hemostatic resuscitation with LTO-WB. Multiple studies[8–11] have shown that early administration of blood products is associated with improved mortality rates, with WB being the ideal resuscitative product for a growing number of providers.[12] The ongoing efforts in South Texas can serve as a model for development of regional prehospital blood transfusion programs and programs for rapid deployment of blood products in the event of an MCI. To our knowledge, this event represents the first ever successful deployment of WB to the site of an MCI related to a school shooting in the modern era. This event highlights how national and regional cooperation between medical providers and community leaders can lead to the development of lifesaving measures in response to an MCI and potentially lead to reduction in preventable deaths due to early hemostatic resuscitation before and during transport to definitive care. Hopefully, the Health and Human Services Office of the Assistant Secretary for Preparedness and Response will recognize this as a best practice and encourage widespread adoption of such a program in the United States.

AUTHORSHIP

A.C., E.B., M.B., B.E., R.S., L.L., S.N., and D.J. contributed in the writing, data collection, literature search, and critical revision of the manuscript. E.K., C.W., E.E., J.F., J.B., D.D., and E.W. contributed in the critical revision and data collection of this study.

DISCLOSURE

The authors declare no conflicts of interest.

REFERENCES

1. Goldstick JE, Cunningham RM, Carter PM. Current causes of death in children and adolescents in the United States. *N Engl J Med*. 2022;386(20):1955–1956.
2. Southwest Texas Regional Advisory Council. STRAC. Available at: https://strac.org/. Accessed June 14, 2022.
3. Trivedi A, Potter DR, Miyazawa BY, Lin M, Vivona LR, Khakoo MA, et al. Freeze-dried platelets promote clot formation, attenuate endothelial cell permeability, and decrease pulmonary vascular leak in a murine model of hemorrhagic shock. *J Trauma Acute Care Surg*. 2021;90(2):203–214.
4. Vulliamy P, Kornblith LZ, Kutcher ME, Cohen MJ, Brohi K, Neal MD. Alterations in platelet behavior after major trauma: adaptive or maladaptive? *Platelets*. 2021;32(3):295–304.
5. Miyazawa B, Trivedi A, Togarrati PP, Potter D, Baimukanova G, Kornblith LZ, et al. Regulation of endothelial cell permeability by platelet-derived extracellular vesicles. *J Trauma Acute Care Surg*. 2019;86(6):931–942.
6. Chipman AM, Jenne C, Wu F, Kozar RA. Contemporary resuscitation of hemorrhagic shock: what will the future hold? *Am J Surg*. 2020;220(3):580–588.
7. Fields AT, Matthay ZA, Nunez-Garcia B, Matthay EC, Bainton RJ, Kornblith LZ, et al. Good platelets gone bad: the effects of trauma patient plasma on healthy platelet aggregation. *Shock*. 2021;55(2):189–197.
8. Braverman MA, Smith AA, Eastridge BJ, Nicholson SE, Stewart RM, Jenkins DH, et al. Prehospital whole blood reduces early mortality in patients with hemorrhagic shock. *Transfusion*. 2021;61(Suppl 1):S15–S21.
9. Sperry JL, Guyette FX, Brown JB, Yazer MH, Peitzman AB, Mazen ZS, et al. Prehospital plasma during air medical transport in trauma patients at risk for hemorrhagic shock. *N Engl J Med*. 2018;379(4):315–326.
10. Guyette FX, Sperry JL, Peitzman AB, Billiar TR, Daley BJ, Brown JB, et al. Prehospital blood product and crystalloid resuscitation in the severely injured patient: a secondary analysis of the prehospital air medical plasma trial. *Ann Surg*. 2021;273(2):358–364.
11. Leeper CM, Yazer MH, Triulzi DJ, Neal MD, Gaines BA. Whole blood is superior to component transfusion for injured children: a propensity matched analysis. *Ann Surg*. 2020;272(4):590–594.
12. Yazer MH, Spinella PC, Bank EA, Cannon JW, Jenkins DH, Holcomb JB, et al. THOR-AABB working party recommendations for a prehospital blood product transfusion program. *Prehosp Emerg Care*. 2021;1–13.