

LifeFlow® PLUS for Management of Severe Hemorrhagic Shock

BACKGROUND

Uncontrolled hemorrhage is the leading cause of preventable mortality in civilian and military trauma,¹⁻³ and deaths associated with exsanguination most often occur in the pre-hospital setting.^{4,5} To improve trauma survival, Tactical Combat Casualty Care (TCCC) Guidelines advocate damage control resuscitation principles prioritizing immediate hemorrhage control and early delivery of whole blood titrated to minimally acceptable

(TECC) guidelines emphasize the importance of achieving a systolic BP of >100-110 in the presence of TBI.^{6,10} Hemorrhaging patients with respiratory failure are at particular risk of peri-intubation cardiac arrest and require immediate restoration of blood volume. In all of these situations, standard methods of blood infusion are often too slow, particularly when vascular access is limited to smaller-gauge IV's or IO. In-line warmers create additional resistance that



Fig.1 – EMS administering blood using LifeFlow PLUS Blood & Fluid Infuser

blood pressure.⁶ Civilian EMS agencies are also now increasingly implementing pre-hospital whole blood transfusion to reduce morbidity and mortality from trauma.⁷

Patients with severe hemorrhagic shock are at high risk of death if blood volume is not restored quickly. This is particularly true for traumatic brain injury patients for whom every minute of hypotension increases mortality.^{8,9} While hypotensive resuscitation (systolic BP 80-90mmHg) is an important principle in the management of hemorrhagic shock, both TCCC and civilian Tactical Emergency Casualty Care

may further slow infusion speed. Mechanical rapid infusers available in most trauma centers are complex and can be difficult and time-consuming to set up, presenting possible challenge and delay in emergent situations.

LifeFlow Plus is a hand-held rapid infuser that recently received FDA clearance for delivery of blood products [Fig. 1]. Clinical use of the device began in a limited number of hospitals and EMS services in October 2020. The following are representative cases where sufficient detail could be obtained from medical record review and the providers directly involved in patient care.

LifeFlow® PLUS for Management of Severe Hemorrhagic Shock

CASES

Case #1: 60-year-old motor vehicle collision (MVC)

An approximately 60-year-old male was involved in a high-speed MVC with extensive damage to the car requiring a prolonged extrication. The flight paramedics found him unresponsive with BP of 60/40 and evidence of head, extremity, and chest injuries including open rib fractures. A 20G IV was placed and LifeFlow Plus was used to deliver 500mL of whole blood during the 4 minute flight to the trauma center. The QinFlow™ Warrior was used to warm the blood during rapid transfusion. The patient arrived with BP of 90/60, and subsequently underwent intubation and immediate surgical intervention. He survived neurologically intact after a prolonged ICU course.

systolic pressure dropped to the 70's. He was given 1L of normal saline via LifeFlow Plus with immediate increase in systolic BP to the 90's, then 1 unit un-crossmatched O negative whole blood via LifeFlow with improvement of systolic BP to 130. He received Tranexamic acid (TXA) and local hemostasis was achieved with direct pressure to the scalp and gentle packing of the open skull wound. He was taken immediately to CT where an additional unit of whole blood was infused via LifeFlow and he was then transferred to the OR for closure of his open fracture. He received 4 additional units of warmed blood products during the procedure. The following day he was following commands and was extubated. By day 5 he had a normal neurological exam and was discharged to home.

Case #2: 14-Year-old with severe traumatic brain injury (TBI)

A 14-year-old male was involved in a dirt bike accident resulting in a severe traumatic brain injury with open skull fracture [Fig. 2]. He was ambulating and initially talking when friends found him after the unwitnessed crash. When EMS arrived he was unresponsive and apneic and required bag valve mask ventilation en route to the trauma center. On arrival his Glasgow Coma Scale was 3 and he was actively bleeding from the scalp and exposed brain. After emergent intubation his



Fig. 2 – Initial head CT

accident resulting in a severe traumatic brain injury with open skull fracture [Fig. 2]. He was ambulating and initially talking when friends found him after the unwitnessed crash. When EMS arrived he was unresponsive and apneic and required bag valve mask

Case #3: 45-year-old gun shot wound (GSW) to left chest

An approximately 45-year-old male sustained a gunshot wound to the left chest. On EMS arrival he was noted to be hypotensive and in respiratory distress. He was immediately intubated, a left thoracostomy was performed yielding fresh blood from a presumed hemothorax, and intraosseous access was obtained. Blood pressure became undetectable and 2 units of O positive whole blood were rapidly transfused using LifeFlow Plus through the QinFlow Warrior blood warmer with return of systolic BP in the 90's. A central venous catheter was placed at the scene and he received a third unit of whole blood during the flight to the trauma center. Upon arrival he was transferred directly to the OR where he underwent operative repair of his thoracic injuries. He survived and apparently suffered no permanent sequelae.

LifeFlow® PLUS for Management of Severe Hemorrhagic Shock

Case #4: 20-year-old MVC

A 20-year-old female sustained multiple long bone fractures when her car struck a tree at high speed. She was restrained and the air bags deployed. She was initially responsive at the scene and required a prolonged extraction. On arrival to the trauma room she became tachycardic and less responsive and was noted

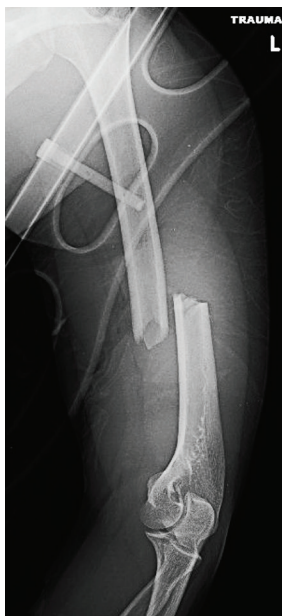


Fig. 3 – X-ray indicating multiple fractures

to have multiple extremity deformities including an open femur fracture. X-rays revealed bilateral humerus and femur fractures, pelvic fractures, and a left tib-fib fracture [Fig. 3]. The patient's heart rate was 160 and BP could not be obtained. Initial ABG showed pH 6.9, hematocrit of 15, and lactate >20. She received 1L Lactated Ringer's while awaiting blood, and HR decreased to the 130's. She then was

given 1u PRBC's and 1u FFP within 4 minutes via LifeFlow Plus, after which she became responsive and was able to relate the details of the accident. She received several additional units of warmed blood products intraoperatively and made a full recovery.

Case #5: 18-year-old with limb amputation

An 18-year-old male was found at the scene of an accident with a near-complete traumatic limb amputation. A tourniquet was placed and he was transferred to a trauma center where he was noted to be pale, confused, tachycardic, and hypotensive with a systolic BP of 70mmHg. After an unsuccessful IV attempt a tibial IO was placed and 1u O positive un-crossmatched whole blood was transfused rapidly using the LifeFlow Plus with improvement in systolic BP to 90mmHg. An additional unit was infused via LifeFlow during transport to the OR for recurrent hypotension. He underwent successful surgical re-anastomosis of the severed limb. He remained hemodynamically stable during the case and required 1,500mL crystalloid but no further blood products. He has fully recovered.

CONCLUSION

The goal of LifeFlow Plus is to improve the speed and efficiency of hemorrhagic shock treatment through the early and precise delivery of blood products in almost any clinical environment. In each case presented patients were suffering severe hemorrhagic shock requiring immediate resuscitation. Several also had traumatic brain injury and two presented with traumatic cardiac arrest. Using LifeFlow Plus, providers were able to deliver up to three units of whole blood using a variety of vascular access

catheters. LifeFlow Plus was used successfully with the QinFlow Warrior warming device and in cases without a warmer to deliver blood rapidly. There were no observed or reported complications associated with these transfusions.

LifeFlow Plus is an effective tool for rapid resuscitation of patients with severe hemorrhagic shock, particularly in environments where large bore IV access and traditional rapid infusers are not immediately available.

LifeFlow® PLUS for Management of Severe Hemorrhagic Shock

BIBLIOGRAPHY

1. Mabry RL, DeLorenzo R. Challenges to improving combat casualty survival on the battlefield. *Mil Med.* 2014;179(5):477-482. doi:10.7205/MILMED-D-13-00417
2. Schauer SG, Naylor JF, April MD, et al. Prehospital resuscitation performed on hypotensive trauma patients in afghanistan: the prehospital trauma registry experience. *Mil Med.* 2019;184(5-6):e154-e157. doi:10.1093/milmed/usy252
3. Eastridge BJ, Mabry RL, Seguin P, et al. Death on the battlefield (2001-2011): implications for the future of combat casualty care. *J Trauma Acute Care Surg.* 2012;73(6 Suppl 5):S431-7. doi:10.1097/TA.0b013e3182755dcc
4. Kotwal RS, Howard JT, Orman JA, et al. The effect of a golden hour policy on the morbidity and mortality of combat casualties. *JAMA Surg.* 2016;151(1):15-24. doi:10.1001/jamasurg.2015.3104
5. Spinella PC, Cap AP. Prehospital hemostatic resuscitation to achieve zero preventable deaths after traumatic injury. *Curr Opin Hematol.* 2017;24(6):529-535. doi:10.1097/MOH.0000000000000386
6. Committee on Tactical Combat Casualty Care. *Joint Trauma System TCCC Guidelines.* Defense Health Agency; 2019. <http://www.cotccc.com>. Accessed November 2, 2019.
7. Pokorny DM, Braverman MA, Edmundson PM, et al. The use of prehospital blood products in the resuscitation of trauma patients: a review of prehospital transfusion practices and a description of our regional whole blood program in San Antonio, TX. *ISBT Sci Ser.* 2019;14(3):332-342. doi:10.1111/voxs.12498
8. Spaite DW, Bobrow BJ, Keim SM, et al. Association of statewide implementation of the prehospital traumatic brain injury treatment guidelines with patient survival following traumatic brain injury: the excellence in prehospital injury care (EPIC) study. *JAMA Surg.* 2019;154(7):e191152. doi:10.1001/jamasurg.2019.1152
9. Spaite DW, Hu C, Bobrow BJ, et al. Mortality and prehospital blood pressure in patients with major traumatic brain injury: implications for the hypotension threshold. *JAMA Surg.* 2017;152(4):360-368. doi:10.1001/jamasurg.2016.4686
10. Committee for Tactical Emergency Casualty Care. *Emergency Casualty Care (TECC) Guidelines for BLS/ALS Medical Providers.* March 2019. <http://www.c-tecc.org/guidelines>. Accessed January 2, 2021.

QinFlow Warrior is owned and manufactured by QinFlow, Inc.