



Case report

Management of hemorrhagic shock when blood is not an option

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Abstract

Objective: To describe an alternative approach to management of severe life-threatening hemorrhagic shock and the outcome when blood was not a treatment option.

Design: Case Report of the use of a Hemoglobin Based Oxygen Carrier (HBOC-201) when control of hemorrhage and intravenous crystalloids were unsuccessful in reversal of hemorrhagic shock and progressive ischemia.

Setting: Trauma Center.

Patients: Jehovah's Witness.

Outcome: Hospital discharge and 6 month follow-up uneventful.

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1. Case report

A 23 year-old 70.3-kg Jehovah's Witness man was a pedestrian struck by a car and admitted to the trauma center at University of Maryland, Baltimore, MD. He complained of pelvic and abdominal pain and shortness of breath. On examination, blood pressure (BP) was 118/65 mmHg, heart

rate (HR) was 99 bpm, respiratory rate (RR) was 28 breaths per minute, and oxygen saturation (SpO₂) was 96% on face mask oxygen. He was noted to have abrasions on his right flank, abdomen, and thorax with tender abdomen and 2+ hematuria. Radiography showed multiple fractures of the right ribs, a small left pneumothorax, fractures of the left iliac wing, left acetabulum, and anterior column, and separation of the symphysis pubis and both sacroiliac joints. He had a grade 3 liver laceration involving the posterior segment of the right hepatic lobe extending into the right hepatic vein and portal system. Active bleeding

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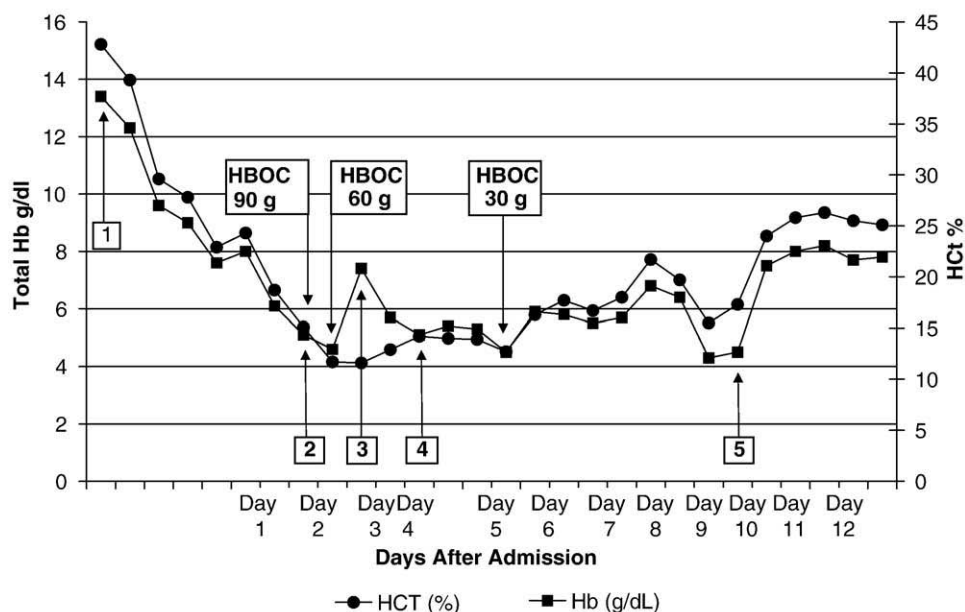


Fig. 1 All values of red blood cell and plasma (total) Hb (left y-axis [g/dL]) and Hct (right y-axis [%]) throughout hospitalization of a Jehovah's Witness patient. Arrows = the timing of dosages (Hb [g]) of Hb-based oxygen carrier (HBOC-201; Hemopure; Biopure Corp). Point 1 = Hb and Hct admission values; point 2 = when consent was obtained to administer HBOC-201; point 3 = postadministration values of 150 g of HBOC-201; point 4 = half-life (19 hrs) of HBOC-201; point 5 = 8 days after first administration of HBOC-201, showing intrinsic increases in Hb and Hct values.

was noted in the space of Retzius and periurethral region. There was bleeding from both right and left internal iliac arteries and his hepatic artery. His admission hemoglobin (Hb) was 13.4 g/dL and progressively decreased to a nadir of 4.5 g/dL (Fig. 1, point 1 to point 2). Despite infusion of 2,550 mL of crystalloid, 500 mL of hetastarch, and efforts to control bleeding, BP values decreased to 84/44 mmHg, with a HR of 110 bpm for the initial 8 hours. He refused blood transfusion.

The patient's trachea was intubated, he was sedated, and his lungs were mechanically ventilated with neuromuscular block to minimize oxygen consumption, because serum lactate was increasing despite efforts at fluid resuscitation (Table 1). A left tube thoracostomy was performed to relieve the pneumothorax. Ninety minutes after admission, he underwent angiographic selective gel foam embolization until hemostasis of the bleeding sites was achieved, in the left and right internal iliac arteries and their subdivisions, and in segmental branches of the right hepatic artery. An inferior vena caval filter was placed. He next underwent percutaneous screw fixation of his sacral disruption, which resulted in good posterior pelvic alignment. Eight hours after this minimal blood loss procedure, his Hb was 6.1 g/dL and his lactate increased from 3.0 to 4.3 mmol/L. The patient was then begun on a course of vitamin K (10 mg), erythropoietin (14,000 U/d for 6 days, then 20,000 U on alternate days), iron supplements (100 mg), and vitamin C (500 mg) to maximize erythropoiesis.

Because the patient's trachea was intubated, he was sedated and receiving mechanical ventilation, we obtained

consent from the patient's family to use a nonhuman, Hb-based, acellular oxygen-carrying solution (HBOC-201, Hemopure; Biopure Corp, Cambridge, MA). Under a Food and Drug Administration (FDA) compassionate use and institutional review board-approved protocol, 150 g of HBOC-201 was administered on hospital day 2. With HBOC-201 dosing, there was an increase in total Hb (plasma Hb plus Hb in the red cells) from 4.6 to 7.4 g/dL within 24 hours. At this same time, hematocrit (Hct, %) after HBOC-201 infusion decreased from 11.7% to 11.6%, indicating volume expansion by the cell-free HBOC-201 (Fig. 1, point 2 to point 3). Increased plasma Hb from HBOC-201 augmented oxygen carriage of the circulating red cells, as judged by the normalization of serum lactate (Table 1). The half-life of HBOC-201 is about 19 hours because total Hb decreases from 7.4 to 5.1 g/dL by hospital day 4 (Fig. 1, points 3 to 4). To maintain efficacy (in this case, Hb concentration), we

Table 1 Serum lactate levels after the patient's admission

Hours after admission	Level (mmol/L)
0	3.0
2	4.2
7	4.2
9	4.3
12	3.3
17	2.5
30	1.9

Total number of hours after admission was 30.

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