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REVIEW

Damage control surgery of the critical Jehovah's Witness patient– a narrative review

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Summary
South Africa has a high burden of trauma related injuries with haemorrhage remaining a leading treatable complication of trauma. Expedient management of haemorrhage serves to reduce patient morbidity and mortality. Damage control surgery aims to minimise haemorrhage, contain contamination, and allow restoration of physiology in an intensive care unit (ICU) before proceeding to definitive surgery. Over time, damage control surgery has found favour in non-trauma-related surgeries in unstable patients.
The Jehovah's Witness (JW) religion believes that blood is sacred and strictly do not consent to blood or blood product transfusions, including in emergency settings. Thus, the management of a bleeding or bled-out JW patient proves to be a unique challenge in modern medicine. For the JW patient who is undergoing damage control surgery, the primary goal is to win time for recovery of the haemoglobin level by maintaining adequate oxygen delivery to tissues.
We review the multiple methods available to optimise haemodynamic stability in a bleeding JW patient. These include techniques aimed at (i) minimising blood loss, (ii) optimising oxygen delivery (DO_2), (iii) optimising oxygen consumption (VO_2), and (iv) correction of coagulopathy.
The management of haemorrhage in the JW patient remains challenging. It is imperative for healthcare professionals to be aware of all options available when treating these patients in order to provide optimal treatment whilst maintaining respect for their beliefs.
Keywords: damage control surgery, Jehovah's Witness, trauma-related injuries

Introduction

Trauma contributes significantly to morbidity and mortality worldwide.[1] Internationally, trauma remains the leading cause of death from the first to the fifth decades of life. At least one-fifth of this occurs in Africa. South Africa has a high burden of trauma-related injuries. There is no current trauma database in South Africa, but extrapolation from hospital and mortuary records reported between 33 000 and 50 000 trauma-related injuries in 2007 and 2009 respectively.[1,2] Most of these injuries occur as a result of violence and traffic incidents. For every one mortality, there are approximately 10–30 trauma survivors.[2]

Haemorrhage is one of the treatable complications of trauma. Expedient management of haemorrhage serves to reduce patient morbidity and mortality. Damage control surgery, an approach suggested in the early 1900s to reduce haemorrhage following liver trauma, was resurrected in civilian trauma centres in the late twentieth century.[3] The principles of damage control surgery aim to minimise haemorrhage, contain contamination, restoration of physiology in the intensive care unit (ICU) and then definitive surgery. Over time, damage control surgery has found favour in non-trauma-related surgeries in unstable patients. The ability to reduce haemorrhage and contamination, then resuscitate and restore physiology has decreased mortality in these patients.[4]

The Jehovah's Witness (JW) religion was established in 1881 and has approximately 7.8 million followers worldwide. The religion believes that blood is sacred and that blood itself can be a conveyor of sin from one individual to the next. The blood of Christ, however, is deemed holy and serves as a potential for salvation. Given these beliefs, JW strictly do not consent to blood transfusions, including in emergency settings.[5]

Thus, the management of a bleeding or bled-out JW patient proves to be a unique challenge in modern medicine. A challenge which can be met with appropriate prehospital management, damage control resuscitation and postoperative critical care.

Important aspects of the prehospital care that may influence your ongoing resuscitation include any history of active arterial bleeding, use of an external arterial tourniquet and any early administration of medical measures to limit blood loss (e.g., tranexamic acid or topical haemostatic agents). Furthermore, given the variability of acceptance of blood-related products and/or procedures to the JW patient, any advanced directive or in-person consent given to the paramedic on scene should be sought.

For the JW patient who is undergoing damage control surgery, the primary goal is to win time for recovery of the haemoglobin level by maintaining adequate oxygen delivery to cellular level.[6] Achieving haemodynamic goals in the anaemic patient can be difficult when the primary oxygen

carrying molecule (haemoglobin) falls below 7 g/dL, as tissue oxygenation is jeopardised.[7] The risk of death for a JW patient after major trauma is, however, not significantly higher than that of non-JW patients who receive red cell transfusions.[8] This is likely due to the enhanced medical and surgical care used to optimise haemodynamics in all patients.

Optimising haemodynamic stability in a bleeding JW patient should involve the following four specific goals: (i) minimising blood loss, (ii) optimising oxygen delivery (DO_2), (iii) optimising oxygen consumption (VO_2) and (iv) correction of coagulopathy (Table I).[5]

Minimising blood loss

Surgical measures

The crux of surgical measures to decrease blood loss rests on meticulous attention to haemostasis. Surgical techniques to minimise blood loss may include use of diathermy and/or ultrasonic scalpels for dissection.[9] Operative techniques such as laparoscopic rather than open surgery, or staged procedures for complex operations must be considered to minimise blood loss.[10]

The application of an external arterial tourniquet remains controversial,[11] and has been shown to not decrease intraoperative blood loss in a study conducted on JW patients undergoing total knee arthroplasties.[12]

Table I: Optimising haemodynamic stability in a bleeding Jehovah's Witness patient

Minimising blood loss

General measures
- Limit phlebotomy

Medical measures
- PPI or octreotide therapy for upper GI bleeding
- Progesterone for uterine bleeds

Surgical measures
- Use of diathermy/harmonic scalpel
- Operative technique and staging of procedure aimed to decrease blood loss
- External arterial tourniquet (usage is controversial)
- REBOA– reserved for damage control settings
- Tamponade balloons – useful for variceal and uterine bleeds
- Intraoperative cell salvage and re-infusion#
- Topical haemostatic agents
  - Haemostats
    - Bone wax
    - Gelatin (porcine derived)#
    - Collagen (bovine derived)#
    - Surgicell
  - Sealants
    - Fibrin sealants (e.g., Evicel, Tisseel, and CryoSeal)#
    - Synthetic sealants (e.g., ProGel, CoSeal and DuraSeal)
  - Adhesive agents
    - Cyanoacrylates (e.g., Super-glue, Dermabond).
    - Glutaraldehyde cross-linked albumin (e.g., Bioglue)#

Anaesthetic measures
- Acute normovolaemic dilution#

Improving DO_2
- Intravascular volume resuscitation and inotropic support as required
- Supplemental oxygen with/without invasive ventilation
- Treatment of lung pathology
- Artificial oxygen carriers
  - Bovine haemoglobin (HBOC-201; Haemopure)#
  - Perfluorocarbons*
- Hyperbaric oxygen therapy
- Iron, B12 and folate supplementation
- Erythropoietin

Decreasing VO_2
- Sedation
- Muscle relaxation

Correction of coagulopathy
- Stop anti-coagulant drugs
- Cryoprecipitate (containing Factor VIII/vWF, fibrinogen, fibronectin and Factor XIII)#
- Haemosolvate (containing factor VIII)#
- Haemosolvex (containing factor IX)#

– Acceptance remains controversial amongst JWs. Potentially acceptable depending on beliefs
* – Currently not available for clinical use in South Africa
PPI – proton pump inhibitor, GI – gastrointestinal, REBOA – resuscitative balloon occlusion of the aorta

Table II: Variable acceptability of different products/procedures among Jehovah's Witness patients

Not acceptable	May be acceptable	Acceptable
• Whole blood • Plasma • Red cells • White cells • Platelets (Regardless of the origin of the blood)	*Minimising blood loss*	
	• Intraoperative cell salvage and immediate closed-circuit re-infusion. • Topical haemostatic agents • Acute normovolaemic dilution	• Medical treatments such as proton pump inhibitors, somatostatin analogues and progesterone when/if indicated. • External arterial torniquet • REBOA • Tamponade balloons (e.g., Sengstaken-Blakemore tube)
	Improving DO_2	
	• Artificial oxygen carriers – Bovine haemoglobin (HBOC-201; Haemopure)	• Artificial oxygen carriers – perfluorocarbons • Hyperbaric oxygen therapy • Iron, B12 and folate supplementation • Erythropoietin stimulation of red cell production
	Reducing VO_2	
		• Sedation and muscle relaxation
	Correction of coagulopathy	
	• Cryoprecipitate • Haemosolvate • Haemosolvex	• Vitamin K

The resuscitative balloon occlusion of the aorta (REBOA) is an established method used to control bleeding in the damage control setting[4] and is a procedure that should be considered to minimise blood loss during massive haemorrhage in the JW patient.[13]

The use of tamponade balloons such as the oesophageal Sengstaken-Blakemore tube for an upper gastrointestinal bleed,[14] or the Bakri balloon for a uterine bleed[5] may be a life-saving manoeuvre in the bleeding JW patient.

The use of intraoperative cell salvage and autologous blood transfusion has become an important method of minimising blood loss.[15] Its use in the damage control setting is well established and is an important part of the intraoperative management of the JW patient who refuses allogeneic blood or blood product transfusions.[15] However, its acceptance remains controversial amongst JWs. The JW Liaison Committee describes the immediate closed circuit autotransfusion of cell salvaged blood as being potentially acceptable to the JW, whilst the preoperative autologous blood collection and storage for later reinfusion is not acceptable on religious grounds.[16] Given these issues, consent for cell salvage needs to be obtained on an individual basis. Cell salvage is also not without its own potential complications, the most common of which is known as salvaged blood syndrome. In this syndrome, activation of intravascular coagulation along with increased capillary permeability may result in an acute lung injury and/or acute kidney injury.[17]

A wide variety of topical haemostatic agents exist and their role in minimising blood loss is well established.[18] Whilst none of the topical haemostatic agents contain whole blood, plasma, red cells, white cells or platelets (which would not be accepted by a JW patient), many of these agents contain further fractioned products from human and animal blood (e.g., albumin, collagen, thrombin and fibrinogen). Our review of the existing literature has revealed no definitive direction on the acceptability of these haemostatic agents to the JW patient but the Hospital Information Services for JWs states that the acceptance of blood fractions is a personal conscientious decision for each patient.[16] The personal decision would be applicable to all blood fractions, regardless of the origin of the blood.[5,10,16] Topical haemostatic agents may be classified into three broad areas: (i) haemostats, (ii) sealants and (iii) adhesives (Table II).[19]

Haemostats may be mechanical or active in nature

Mechanical agents which form a physical obstacle to the flow of blood or provide a physical matrix for clot initiation.[18] The most commonly used mechanical haemostat, bone wax, is derived from beeswax and products of crude oil.[18] A number of new mechanical agents have been developed including gelatin (porcine derived), collagen (bovine derived) and oxidised cellulose materials (plant derived), like Surgicel.[18,19]

Active agents contain thrombin which converts fibrinogen into fibrin for effective haemostasis.[19] They are currently available as the bovine-derived Thrombin-JMI®, the human plasma-derived Evithrom, and rhThrombin (recombinant human thrombin), which is neither human nor animal derived.

Sealants may be fibrin (animal derived) or synthetic in nature

Fibrin sealants (e.g., Evicel, Tisseel, and CryoSeal) are derived from human or animal blood products.[19] They are composed of two components which are combined upon application. These components are thrombin (mostly human derived) and fibrinogen (usually human or animal plasma derived).[18] The components interact during application to form a stable clot.

Synthetic sealants (ProGel, CoSeal and DuraSeal) are composed of polyethylene glycol polymers and at least one additional (non-human/non-animal derived) component. These agents form a mechanical sealant to tissue fluids, as well as a barrier to cell ingrowth.[18]

Adhesive agents include cyanoacrylates and glutaraldehyde cross-linked albumin

Cyanoacrylates (e.g., Super-glue, Dermabond) are synthetic liquid monomers that rapidly form polymers in the presence of a minimal quantity of water and thereby quickly glue adjacent surfaces together.[18] Cyanoacrylate glue is established as one of the methods available to endoscopically control the bleeding of oesophageal varices.[14]

Glutaraldehyde cross-linked albumin (e.g., Bioglue) consists of a 10% glutaraldehyde solution and a 45% bovine serum albumin solution which are mixed upon administration.[18] It may be used as accessory therapy for large vessel haemostasis but should not be used in the paediatric population as it produces an inelastic seal.[19]

General measures to reduce anaemia

Cumulative blood loss from regular phlebotomy can be a significant contributor to the development of anaemia.[20] Phlebotomous processes, therefore, should be justified and limited to essential tests especially during the acute bleed.[21] The use of a paediatric or micro-sample tube has been shown to be effective in mitigating the iatrogenic causes of anaemia.[21] It is generally considered prudent to manage these patients in a high care or ICU setting.[22]

Medical measures

Common occurring bleeding conditions such as peptic ulcers should be prevented and managed using proton pump inhibitors (PPIs) with the potential use of a somatostatin analogue (e.g., Octreotide®) in the treatment of a variceal bleed.[14] Progesterone has been proposed as a means to control normal menstrual bleeding or treat abnormal uterine bleeding.[23]

Anaesthetic measures

The actively bleeding patient warrants prompt and guided therapy. The surgeon aims to control or stop the haemorrhage, whilst the anaesthetist aims to minimise loss whilst cautiously promoting oxygen delivery to essential organs often utilising permissive hypotensive techniques. These permissive hypotensive techniques have been shown to minimise intraoperative blood loss in patients who refuse allogenic blood transfusions.[24] In the damage control setting, permissive hypotensive use needs to be measured against the need for aggressive resuscitation and maintenance of tissue perfusion.[25] Furthermore, in patients with comorbid conditions such as coronary artery disease, peripheral artery

disease and renal failure, permissive hypotension has been associated with increased morbidity compounded greatly in the JW patient.[26,27]

Acute normovolaemic dilution is another technique that may be considered to minimise blood loss. It involves the removal of whole blood from a patient preoperatively and replacing the intravascular volume with a crystalloid fluid. The removed whole blood may then be later re-infused once haemostasis has been achieved. This manoeuvre dilutes haematocrit and therefore decreases the intraoperative red cell loss.[28] As long as the extracorporeal blood remains in direct contact with the patient (via an administration set) this technique is acceptable to some JW patients.[29]

Optimising oxygen delivery (DO_2)

Delivery of oxygen at a tissue level is dependent on multiple factors defined in the following equation: Oxygen delivery = cardiac output x (1.39 x Hb x oxygen saturation) + (0.003 x PaO_2).[22]

During damage control surgery in the JW patient, optimisation of haemoglobin level may not be possible. Cardiac output can be optimised by intravascular volume resuscitation (preload) together with the use of inotropic support as required.[30] Supplemental oxygen with or without invasive ventilation together with appropriate treatment of concomitant lung pathologies (e.g., insertion of an intercostal drain for a pneumothorax) improves oxygen saturation and dissolved oxygen in blood (PaO_2).[30] Thus, even in the setting of a severe anaemia (and a refusal of blood product transfusion), optimisation of cardiac output and oxygenation can ensure an adequate delivery of oxygen to the tissue.[31]

Technological advancement has led to the development of artificial oxygen carriers which may be an alternative to blood transfusion in the JW patient. Research into these agents is ongoing. Two major categories of oxygen carriers are currently being investigated for use in humans: haemoglobin-based oxygen carriers (HBOCs) and perfluorocarbons (PFCs).[6] Bovine haemoglobin (HBOC-201; haemopure) has been approved by the Medicines Control Council for use in South Africa, however, it's accessibility outside of the clinical trial setting remains low. This agent has been found to be a suitable means of maintaining adequate oxygen delivery in hypovolaemic shock states (in trauma, post-partum haemorrhage or in the prehospital setting).[32] The South African consensus guideline on haemopure usage finds it to be well tolerated in normal adults and indicated in patients who are unwilling to receive blood transfusions.[32] Whilst haemopure contains no human blood products, it is bovine derived and therefore may not be acceptable to certain JW patients.[16,22] Unlike HBOCs, PFCs are not animal or human derived and are completely synthetic. By design they are able to dissolve large amounts of oxygen and thus provide tissue oxygenation.[22] These agents are the subject of ongoing clinical trials as further research on their safety and efficacy is needed. PFCs are currently not available for clinical use in South Africa.

Other methods that have been used to improve delivery of oxygen in the JW patient include hyperbaric oxygen therapy, iron, vitamin B_{12} and folate supplementation, and erythropoietin stimulation of red cell production.[5] However, due to the lag in improvement in tissue oxygenation associated with these methods, they are of little use in the emergency (damage control) setting.

Optimising oxygen consumption (VO_2)

In addition to minimising bleeding and optimising oxygen delivery, anaemia tolerance can be improved by optimising oxygen consumption at a tissue level.

Active or passive cooling to achieve mild intraoperative hypothermia (34–36 °C) has been used in JW patients as a means of decreasing oxygen demand.[5,30,33] However, even mild hypothermia (< 1 °C) has been shown to significantly increase blood loss and transfusion requirements.[34] Furthermore, in the trauma setting, hypothermia is known to worsen coagulopathy, metabolic acidosis, and cardiac dysrhythmias. Maintenance of normothermia remains a pillar of damage control surgery.[35] We believe that in the damage control setting, the postulated benefits of hypothermia on minimising VO_2 do not outweigh the side effects of its use.

Sedation may be used during the damage control resuscitation and intraoperatively to reduce oxygen consumption. The use of propofol, midazolam, opioids, or thiopentone to produce a clinically desirable level of sedation in spontaneously breathing patients has been shown to reduce VO_2 by 10–15%[36,37] and thus improve the JW patient's tolerance of anaemia. The use of neuromuscular blockage may also serve to decrease the oxygen requirements of respiratory effort and is commonly used intraoperatively.[33]

Correction of coagulopathy

Management of coagulopathy is a tenet of damage control resuscitation.[35] Assessing for coagulopathies is especially valuable in the bleeding JW patient. At first encounter one should assess for and stop any drugs that may impair coagulation (e.g., nonsteroidal anti-inflammatories and anti-coagulants). This may involve the administration of an antidote if necessary.[5] Further evaluation is done by performing coagulation screening tests, including platelet count, viscoelastic testing, activated partial thromboplastin time and the international normalised ratio.[28] Correction of coagulopathy is based largely on the results of these tests. Fresh frozen plasma, which contains all the coagulation factors at normal physiological levels, is not accepted by JW patients.[16] Further fractionated factor concentrates that may be acceptable on an individual basis to JW patients include cryoprecipitate (containing factor VIII/vWF, fibrinogen, fibronectin and factor XIII), haemosolvate (containing factor VIII), and haemosolvex (containing factor IX).[5,38] As these preparations are directed at treating more specific factor deficiencies, they do not contain all the coagulation factors and are therefore less effective in correcting global coagulation factor deficiencies.[28] Vitamin K is essential for the production of clotting factors II, VII, IX, and X and proteins C and S.[5] It should be administered when the international normalised ratio is above 1.0.[5,28] Desmopressin (DDAVP) is a synthetic analogue of the antidiuretic hormone vasopressin and is acceptable to the JW patient. DDAVP increases hepatic release of factor VIII and endothelial release of tissue plasminogen activator and von Willebrand factor (VWF).[39] It has been successfully used as a method of haemostasis when administered to patients with mild haemophilia and von Willebrand disease.[40] However, its use in the JW patient without a known bleeding disorder remains controversial. A 2004 Cochrane review concluded that there is no convincing evidence that DDAVP minimises perioperative blood or blood product transfusion in patients who do not have congenital bleeding disorders. Whilst

data does exist showing the use of DDAVP as a method of reducing perioperative blood loss, the observed reductions were small and generally not clinically important.[41] Based on the currently available evidence, the use of DDAVP to reduce perioperative blood loss in the JW patient cannot be supported.

Legal rights and consent in South Africa

Consent and refusal of components of treatment are issues that may occur during the emergency management of a JW patient. An adult (age > 18 years old) of sound decisional capacity may refuse (in part or all) life-saving treatment with blood or blood products as per their belief.[42] If adults are not of sound decisional capacity (either as a result of their injuries or a pre-existing condition), they may not refuse life-saving intervention unless stated in an advanced directive or by a proxy decision-maker.[43]

The key principle in the care of the JW patient who is a minor is that the child's best interests are paramount. Factors that may need to be taken into consideration, bearing in mind that they may conflict with each other include: the maturity of the child concerned, the wishes and opinions of the parents/guardian and the clinical condition of the child. In the emergency setting in which the injured child and/or the parent/guardian are refusing the life-saving administration of blood or blood products to a minor, the HPCSA guidance states that a healthcare practitioner may treat the child, provided it is in the child's best interests and that the treatment given is "limited to treatment which is reasonably required in [the] emergency."[44] This decision to proceed with emergency treatment against a parents/guardian's religious beliefs should be made in conjunction with the superintendent of a hospital or the senior in charge if the superintendent is not available.[44] In non-urgent situations, alternative methods of improving tissue oxygen delivery over time may be used. These include hyperbaric oxygen therapy, iron, vitamin B_{12} and folate supplementation, and erythropoietin stimulation of red cell production can be used.[5]

Conclusion

The management of haemorrhage in the JW patient remains challenging. However, the resurrection of previous practices and the advent of new medical, haemostatic and surgical therapies has mitigated some of these challenges. It is imperative for healthcare professionals to be aware of all options available when treating these patients; especially as knowledge of available treatment modalities will reduce morbidity and mortality in this population group whilst maintaining respect for their beliefs.

The JW Hospital Liaison Committee Network offers a free service to healthcare professionals who treat JW patients. This service is available 24 hours a day and is useful when navigating issues of consent and counselling. They may be contacted by telephone: +27 83 226 5959 or email: hid.za@jw.org

Conflict of interest

The authors declare no conflict of interest.

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