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CASE REPORT PAIN MANAGEMENT

Acute normovolemic hemodilution as a blood conservation strategy in a Jehovah's Witness undergoing above-knee amputation: a case report

Akhmad Fauzan Firdaus [1] , Reza Widianto Sudjud [2] , Budiana Rismawan [3]

Authors affiliations:

1. Akhmad Fauzan Firdaus, Department of Anesthesiology & Intensive Care, Faculty of Medicine, Padjadjaran University Dr. Hasan Sadikin Central General Hospital, Bandung, Indonesia. Email: firdausakhmadfauzan@gmail.com
2. Reza Widianto Sudjud, Anesthesiology & Intensive Care, Faculty of Medicine, Padjadjaran University / Dr. Hasan Sadikin Central General Hospital, Bandung, Indonesia. Email: reza.widianto.sudjud@unpad.ac.id
3. Budiana Rismawan, Anesthesiology & Intensive Care, Faculty of Medicine, Padjadjaran University / Dr. Hasan Sadikin Central General Hospital, Bandung, Indonesia. Email: budianarismawan@gmail.com

Correspondence: Akhmad Fauzan Firdaus, **Email:** firdausakhmadfauzan@gmail.com **Phone:** +62 85211848937

ABSTRACT

Major surgery is frequently associated with significant blood loss, and allogeneic transfusion remains standard therapy. Jehovah's Witness patients may refuse blood products for religious reasons, creating major perioperative challenges. Acute normovolemic hemodilution (ANH) is a blood conservation strategy that may be acceptable to these patients when performed using a closed-circuit system.

A 65-year-old woman with acute right lower-limb ischemia, initially classified as Rutherford grade IIA (marginally threatened limb), with rapid clinical progression requiring emergency above-knee amputation under general anesthesia. The patient, a Jehovah's Witness, refused allogeneic blood transfusion. Preoperative hemoglobin was 9.7 g/dL with a hematocrit of 32.1%. After induction of general anesthesia and achievement of hemodynamic stability, acute normovolemic hemodilution was performed using a sterile closed-circuit system via a right internal jugular large-bore catheter. A total of 500 mL of whole blood (approximately 12% of estimated total blood volume) was withdrawn gradually with simultaneous colloid infusion to maintain normovolemia, and autologous blood was reinfused after surgical hemostasis. Surgery lasted 4 hours with an estimated blood loss of 1,000 mL. Intraoperative management included balanced general anesthesia, antifibrinolytic therapy, strict hemodynamic control, active warming, and reinfusion of autologous blood after surgical hemostasis. Hemodynamics and oxygenation remained stable throughout. Postoperative hemoglobin was 8.4 g/dL, and the patient remained hemodynamically stable without vasopressor support, with an uncomplicated clinical course.

ANH reduces red blood cell loss while preserving oxygen delivery through physiologic compensatory mechanisms. In patients with cardiovascular risk factors, conservative hemodilution targets are recommended. This case highlighting the importance of meticulous anesthetic planning, a conservative and reproducible ANH protocol, objective outcome reporting, explicit adverse-event monitoring, and formal ischemia severity classification to define urgency and perioperative risk.

Acute normovolemic hemodilution can be a feasible and safe blood conservation strategy in selected Jehovah's Witness patients undergoing high-risk surgery, provided it is carefully planned, performed using a closed-circuit system, and supported by meticulous anesthetic management and close perioperative monitoring.

Keywords: Acute normovolemic hemodilution; blood conservation; Jehovah's Witness; acute limb ischemia; anesthesia; case report.

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1. INTRODUCTION

Acute normovolemic hemodilution (ANH) involves withdrawal of a portion of the patient's whole blood immediately after induction of anesthesia, with simultaneous replacement by crystalloid and/or colloid solutions to maintain normovolemia. The withdrawn autologous blood is subsequently reinfused after the major bleeding phase of surgery has passed. The primary objective of ANH is to reduce perioperative red blood cell loss while preserving oxygen delivery and coagulation capacity.[1,2]

Oxygen delivery (DO_2) is determined by the product of cardiac output and arterial oxygen content. Although ANH decreases hemoglobin concentration, compensatory mechanisms—including increased cardiac output, redistribution of blood flow to vital organs, and enhanced oxygen extraction—generally maintain adequate tissue oxygenation within a defined physiological range.[1,3] In patients with cardiovascular risk factors, conservative hemodilution targets (hematocrit approximately 24–30%) are recommended to minimize the risk of myocardial ischemia and systemic hypoperfusion.[2,4]

Jehovah's Witness patients may decline allogeneic blood transfusion because of religious beliefs, posing significant ethical and clinical challenges when major blood loss is anticipated. Blood conservation strategies, including ANH, antifibrinolytic therapy, meticulous surgical hemostasis, and optimization of oxygen delivery, are therefore central to perioperative planning. When performed using a closed-circuit system, ANH may be acceptable to some Jehovah's Witness patients because it maintains continuity between the patient and the collected blood.[2,7]

We report the anesthetic management of a Jehovah's Witness patient with acute limb ischemia undergoing above-knee amputation using acute normovolemic hemodilution as the principal blood conservation strategy, highlighting practical considerations for safe and reproducible implementation in the setting of urgent limb-threatening ischemia.

2. CASE REPORT

A 65-year-old woman (weight 60 kg) presented with a 24-hour history of sudden onset severe pain in the right lower extremity, followed by progressive sensory loss and decreased motor function. On arrival at the emergency department, physical examination revealed a cold, pale right leg with delayed capillary refill, absent distal pulses, and markedly reduced sensation below the knee. Motor weakness progressed to near-complete paralysis. The patient had a history of chronic hypertension but no documented ischemic heart disease.

Initial diagnostic evaluation at admission with duplex Doppler ultrasonography demonstrated absent arterial flow distal to the femoral level, consistent with acute limb ischemia. Based on the clinical and imaging findings, including absent distal arterial flow, sensory deficit without fixed paralysis, and evolving motor weakness, the patient was initially classified as having acute limb ischemia Rutherford grade IIA (marginally threatened limb). Given the rapid progression of neurologic deficit, proximal extent of ischemia, and lack of feasible revascularization options, the multidisciplinary team assessed the limb as progressing toward non-viability with a high risk of irreversible ischemic injury. Emergency above-knee amputation was therefore planned due to the anticipated extent of muscle necrosis and the risk of systemic complications. Emergency above-knee amputation was therefore planned because of the high risk of extensive muscle necrosis and systemic complications.

Preoperative laboratory evaluation showed hemoglobin 9.7 g/dL, hematocrit 32.1%, platelet count within normal range, normal PT/INR and aPTT, and preserved renal function. Because of the urgency of surgery, arterial blood gas and serum lactate measurements were not obtained. During preoperative assessment, the patient declared herself a Jehovah's Witness and explicitly refused allogeneic red blood cells, plasma, and platelets were refused, while closed- circuit ANH and autologous reinfusion were accepted; albumin and intraoperative cell salvage were discussed but not used

After preoperative discussion, the patient consented to acute normovolemic hemodilution and autologous blood reinfusion using a closed-circuit system, while refusing allogeneic red blood cells, plasma, and platelets. Following induction of general anesthesia and achievement of hemodynamic stability, acute normovolemic hemodilution (ANH) was initiated using a sterile closed-circuit system. A large-bore right internal jugular venous catheter was connected to non-collapsible extension tubing, three-way stopcocks, and

two CPDA-1 anticoagulant blood bags, assembled to maintain uninterrupted blood continuity between the patient and the collection system. Baseline Non-invasive blood pressure, heart rate, electrocardiography, and oxygen saturation were documented prior to blood withdrawal. Total blood volume was estimated at approximately 3,900 mL based on body weight (60 kg, 65 mL/kg).

Whole blood was withdrawn by gravity drainage in a slow, stepwise manner into the CPDA-1 blood bags that remained continuously connected to the patient's circulation. Blood removal was intermittently paused to assess hemodynamic tolerance under continuous invasive blood pressure and electrocardiographic monitoring. Simultaneously, an equal volume of colloid solution was infused through a separate venous access to maintain normovolemia. A total of 500 mL of whole blood (approximately 12% of the estimated total blood volume) was collected. The collected blood bags were sequentially labeled and kept in the operating room at controlled ambient temperature while remaining within the closed circuit. Reinfusion was planned after completion of the major bleeding phase and achievement of surgical hemostasis, following a first-collected, first-reinfused principle and completed within 4 hours of collection.

Hemodynamic targets during withdrawal were mean arterial pressure 65–75 mmHg and heart rate <100 beats/min. Predetermined stop criteria included a >20% decrease in mean arterial pressure from baseline, persistent tachycardia, electrocardiographic evidence of myocardial ischemia, oxygen desaturation, oliguria, or clinical signs of inadequate perfusion. None occurred.

Anesthesia was induced with intravenous propofol 2 mg/kg, fentanyl 2 µg/kg, and Atracurium 0,5 mg/kg, followed by tracheal intubation with a 7.0-mm cuffed endotracheal tube. Maintenance was achieved with sevoflurane 2-3 Vol% in an oxygen–air mixture. Mechanical ventilation was volume-controlled with tidal volume 6–8 mL/kg predicted body weight, FiO_2 0.5, positive end-expiratory pressure 5 cmH_2O, and an end-tidal CO_2 target of 35– 40 mmHg. Monitoring included continuous electrocardiography, noninvasive blood pressure, pulse oximetry, capnography, and temperature. Mean arterial pressure was maintained between 65 and 75 mmHg using crystalloid and colloid solutions. Norepinephrine were prepared as rescue vasopressors but were not required. Tranexamic acid 1 g was administered intravenously after induction. Active warming was applied using forced-air warming.

Surgery lasted approximately 4 hours, with an estimated blood loss of 1,000 mL. In addition to ANH replacement, the patient received 1,500 mL crystalloid and 500 mL colloid.

After definitive surgical hemostasis, the entire 500 mL of autologous blood was reinfused. Hemoglobin/hematocrit values were 9.7/32.1 preoperatively, 8.9/29.4 after ANH withdrawal,

8.6/27.9 at the end of surgery, and 8.4/27 on postoperative day 1. The patient remained hemodynamically stable without vasopressor support. Intraoperative urine output averaged >0.5 mL/kg/h. No excessive surgical bleeding or coagulation abnormalities were observed.

The postoperative course was uncomplicated. The patient was managed in the surgical ward, required no reoperation, and demonstrated no clinical evidence of hypoperfusion or myocardial ischemia. She was discharged on postoperative day 4 with a stable stump condition and hemoglobin of 8.6 g/dL.

Adverse-event monitoring: During phlebotomy, hemodilution, reinfusion, and the first 24 postoperative hours, the patient was monitored for hypotension, arrhythmia, electrocardiographic ischemic changes, hypothermia, dilutional coagulopathy, transfusion reactions, and postoperative bleeding. No adverse events were observed.

3. DISCUSSION

Acute limb ischemia represents a condition of severe regional hypoperfusion that frequently necessitates urgent surgical intervention. Formal classification using the Rutherford system provides an objective framework to define ischemia severity, surgical urgency, and perioperative risk. Major amputation is associated with substantial blood loss, and refusal of allogeneic transfusion mandates a carefully coordinated blood conservation strategy.

In this case, the patient initially fulfilled the criteria for Rutherford grade IIA acute limb ischemia, characterized by sensory deficit without fixed paralysis, indicating a marginally threatened limb requiring urgent intervention to prevent progression to irreversible ischemia. In this context, anesthetic management must balance the need for rapid surgical treatment with careful physiologic optimization. Acute limb ischemia of this severity is associated with an increased risk of metabolic derangements, systemic inflammatory response, and cardiovascular stress, all of which heighten anesthetic risk, particularly in older patients with comorbidities. These considerations supported the use of a conservative ANH strategy with strict hemodynamic control.

The physiological rationale of ANH is to reduce red blood cell loss during surgical bleeding while preserving preload and cardiac output through normovolemic replacement. Although arterial oxygen content decreases,

global oxygen delivery may be maintained through compensatory increases in cardiac output and oxygen extraction. In patients with cardiovascular risk factors, conservative hemodilution targets (hematocrit approximately 24– 30%) are recommended to reduce the risk of myocardial ischemia.

In this patient, a limited withdrawal volume (approximately 12% of estimated total blood volume) was selected to target a postoperative hemoglobin above 8 g/dL, balancing blood conservation with physiologic safety. Because advanced perfusion monitoring such as serum lactate or central venous oxygen saturation was not available, systemic perfusion was assessed using hemodynamic stability, urine output, and the absence of ischemic electrocardiographic changes.

Jehovah's Witness patients present unique ethical and medicolegal challenges. Respect for patient autonomy requires acknowledgment of informed refusal of allogeneic blood products, even when such refusal may increase perioperative risk. The four principles of biomedical ethics—autonomy, beneficence, non-maleficence, and justice—must guide clinical decision-making. When acceptable to the patient, closed-circuit ANH and other blood conservation strategies can offer a compromise that aligns medical safety with religious beliefs.

From a medicolegal perspective, documentation must clearly record the patient's decisions, including signed refusal forms and detailed informed consent specifying accepted and declined interventions. Effective interdisciplinary communication and, when appropriate, ethics committee consultation is recommended to ensure alignment of clinical management with ethical and legal standards. In this case, careful documentation, preoperative discussion, and adherence to a closed-circuit technique allowed the anesthetic team to respect the patient's beliefs without compromising perioperative safety.

From an anesthetic standpoint, ANH should be viewed as part of a multimodal patient blood management strategy, integrated with antifibrinolytic therapy, strict maintenance of normovolemia and systemic perfusion, and a low threshold for terminating hemodilution if signs of inadequate oxygen delivery emerge.

4. CONCLUSION

Acute normovolemic hemodilution is a feasible and safe alternative to allogeneic transfusion in selected Jehovah's Witness patients undergoing high-risk surgery. Successful implementation requires meticulous preoperative planning, conservative hemodilution targets, strict maintenance of systemic perfusion, explicit adverse-event monitoring, objective outcome reporting, and clear definition of ischemia severity and surgical urgency.

5. Conflict of interests

Authors declare that there was no conflict of inters involved..

6. Etical Considerations

Written informed consent was obtained from the patient for publication of this case report and accompanying images.

7. Funding

The study sis not involve any external funding,

8. Authors' Contribution

1. AFF: Conceptualization, Clinical data collection, Writing – original draft.

2. RWS: Supervision, review and editing, guidance in study design, Manuscript validation, Final approval of manuscript

3. BR: Supervision, review and editing, guidance in study design, Manuscript validation, Final approval of manuscript

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