Objective 4: The team will recognize and effectively prepare for risk of high blood loss.

Loss of a large volume of blood, especially when associated with haemodynamic instability, has been clearly associated with poor surgical outcome (*1*). Controlling haemorrhage and mitigating its clinical effects by appropriate fluid resuscitation are important components of intraoperative care. Clinical knowledge of resuscitation in the setting of haemorrhagic hypovolaemia was initially based on field observations of soldiers injured in battle (*2*). Rapid accumulation of scientific knowledge of the physiology of shock came during the twentieth century with controlled experiments in animal models (*3*). This work conclusively demonstrated that fluid resuscitation is essential to reverse the signs and symptoms of shock from hypovolaemia (*4*).

In advanced trauma care systems, standard practice dictates early initiation of intravenous access and fluid administration to victims of trauma. In epidemiological studies, haemorrhage has been shown to be the major cause of death of trauma victims (*5*). The Advanced Trauma Life Support course directed by the American College of Surgeons mandates the insertion of two large-bore intravenous lines for all traumatically injured patients as soon as possible, including before hospitalization (*6*). This allows the administration of fluid and medications before arrival at the hospital and minimizes delays once the patients have arrived at a facility capable of delivering care. Early attempts at manual pressure control of external haemorrhage are also important.

Table II.4.1 – Classification of hypovolaemic shock associated with acute blood loss (in adults)

	Class I	*Class II*	*Class III*	*Class IV*
Blood loss	≤ 750 ml	750–1500 ml	1500–2000 ml	> 2000 ml
% of blood volume lost	15%	15–30%	30–40%	> 40%
Pulse rate	< 100	> 100	> 120	> 140
Blood pressure	Normal	Normal to decreased	Decreased	Markedly decreased
Mental status	Normal to slightly anxious	Mildly anxious	Anxious and confused	Confused or lethargic
Urine output	Normal	Reduced	Minimal	Nil
Fluid replacement	Crystalloid	Crystalloid	Crystalloid and blood	Crystalloid and blood

From American College of Surgeons Advanced Trauma Life Support manual (*6*)

Shock can be categorized clinically by the magnitude of blood loss (Table II.4.1). Up to 15% of the circulating volume can be lost without obvious clinical symptoms, particularly in healthy individuals. By the time 30% of the circulating volume is lost, however, patients usually begin to display the early signs of shock:

tachycardia, hypotension and anxiety. With a volume loss greater than 30%, hypotension, sustained increases in heart rate and confusion are clearly present. Blood loss exceeding 40% of the total body circulating volume is immediately life-threatening and manifests as a mentally altered, hypotensive and oliguric patient. While the changes in pulse rate listed for the different classes of shock usually hold true, massive rapid uncompensated blood loss can paradoxically result in relative bradycardia (*7,8*). In addition, the absence of tachycardia does not reliably rule out severe blood loss (*9–12*). Other important caveats to the characteristics of different classes of shock are that the blood pressure of young patients (particularly children) can remain fairly high even after profound haemorrhage and that blood pressure and heart rate can be unreliable indicators in patients receiving beta-blockers or other medications with cardiovascular effects. Therefore, the clinical picture of shock might not manifest exactly as depicted in text books. Nonetheless, severe haemorrhage is an immediate threat to life and must be managed immediately.

The aggressiveness of fluid resuscitation during prehospital management is still the subject of much debate. Conflicting reports of increased mortality associated with fluid resuscitation during uncontrolled and ongoing blood loss has led some to advocate fluid restriction until definitive care begins (*13,14*). The type of fluid is also the subject of discussion, and the usefulness of various types of crystalloid solutions in prehospital management continues to be evaluated (*15*). Nevertheless, there is no debate on the mandatory need for fluid support during definitive intervention for hypovolaemic patients.

Hypovolaemia can have disastrous consequences for surgical patients and has been recognized as a major contributor to avoidable mortality and morbidity. Identifying current or potential hypovolaemia and instituting a resuscitation plan are essential for reducing surgical morbidity and mortality. Preparation for instability in a patient with hypovolaemia includes understanding the degree of and reason for the hypovolaemia, establishing appropriate intravenous access, ensuring adequate supplies of fluids for resuscitation, confirming the availability of blood products where appropriate, and coordinating resuscitation with the operating team. As blood loss is a major contributor to hypovolaemia, control of haemorrhage must be coupled with a well-thought-out plan for resuscitation to optimize the patient's outcome. Dehydration also contributes to preoperative hypovolaemia. It can be due to inadequate fluid intake by an ill patient, excess fluid loss (through e.g. diarrhoea or vomiting) or redistribution of fluid volume out of the circulation (as in e.g. bowel obstruction or peritonitis). Additionally, vasodilation due to sepsis or spinal cord injury can result in a relative hypovolaemic state. Accurate identification of these situations allows timely, targeted therapy and can reduce mortality (*16*).

Intraoperative care differs from prehospital resuscitation in that intraoperative manoeuvres can be both the cause and the treatment of continuing blood loss. Therefore, adequate preoperative preparation is essential to mitigate or avoid the physiological derangements of intraoperative hypovolaemia caused by excessive blood loss or other physiological events, such as decreased sympathetic tone due to anaesthetic agents or third spacing of fluids. When loss of a large volume of blood is either expected or a major risk, placement of adequate intravenous access before skin incision will help the team to keep the volume status adequate.

Resuscitation of hypovolaemic patients

Patients who present for surgery in a volume-depleted state should be resuscitated before surgery whenever possible. Intravenous access should be obtained promptly and resuscitation begun in an efficient fashion to minimize delays in performing the operation. Fluid deficits should be remedied by infusion of crystalloid solutions. In certain circumstances, some of the fluid deficit can be replaced by oral intake; however, this is often undesirable in gastrointestinal conditions, impending general anaesthetic or other clinical concerns. Monitoring of fluid status should be instituted wherever feasible, should be tailored to the specific clinical situation and should include regular evaluation of haemodynamic parameters, such as pulse rate and blood pressure (see Objective 2). It may also include urinary catheterization, central venous cannulation and other invasive monitoring. Communication among the clinicians caring for the patient in the pre-, intra- and postoperative periods will improve resuscitation and allow for appropriate timing of the operation.

Prevention of blood loss

Some procedures, such as caesarean section or major vascular surgery, inevitably involve heavy blood loss. Other circumstances can also predispose a patient to unusually heavy bleeding during an operation, such as reoperation or dissections known to be difficult. The first step in mitigating blood loss during an operation is prevention. Known coagulation deficits should be corrected before surgery whenever clinically possible. The surgical, anaesthetic and nursing personnel involved in an operation should all be aware of the potential for major blood loss before the procedure and be prepared for it.

Ensuring appropriate intravenous access is a critical step and allows the anaesthetist to respond to fluctuations in blood pressure (*17*). Access may take the form of large-bore peripheral lines, central venous catheters or some combination of the two. If the expected blood loss is greater than 500 ml for an adult or 7 ml/kg in children, the observed standard of practice dictates the insertion of two wide-bore intravenous lines or a central venous catheter (also preferably large-bore) to allow for adequate resuscitation. When the need for a blood transfusion is anticipated, operating teams should communicate early with the blood bank to ensure prompt availability of cross-matched blood products. When the patient is bleeding before surgery, it is imperative that all members of the operating team be aware of the source and estimated volume of blood loss.

Management of blood loss

If surgery is undertaken in an emergency or urgently for haemorrhage, complete preoperative resuscitation is often neither practical nor desirable, and resuscitation must be coupled with surgery to stem the haemorrhage. Again, large-bore intravenous access must be obtained and resuscitative measures instituted as soon as possible before operation. Volume resuscitation includes infusion of crystalloid solutions and transfusion of blood products or other volume expanders. Evidence is accumulating for the effectiveness of transfusing fresh-frozen plasma, when available, for each one or two units of packed red blood cells to combat coagulopathy (*18–21*). While increasing the amount of fresh-frozen plasma used, this may decrease the overall use of blood products by decreasing the amount of packed red blood cells required. Where appropriate and available, mechanisms to collect and re-transfuse shed blood may be used. In some situations, temporizing measures should be taken to control bleeding in order to allow fluid resuscitation to catch up with accumulated blood loss before definitive surgical management. In other situations, intra-abdominal packing to temporize bleeding is prudent and may allow for correction of coagulopathy, hypothermia and acidosis. In such 'damage control' surgery, abdominal re-exploration follows 24–72 hours after the initial surgical exploration (*22–24*). The team of anaesthetists, surgeons and nurses must all be aware of the plan for resuscitation so that they can take appropriate measures to reduce the morbidity of haemorrhage.

Hypovolaemia represents a situation in which clear, unhindered communication is essential to optimize patient care. Coordination of care during resuscitation and the operation combined with an anaesthetic plan based on the patient's physiological state can make a profound difference in intraoperative management.

Recommendations

Highly recommended:

- Before inducing anaesthesia, the anaesthetist should consider the possibility of large-volume blood loss, and, if it is a significant risk, should prepare appropriately. If the risk is unknown, the anaesthetist should communicate with the surgeon regarding its potential occurrence.
- Before skin incision, the team should discuss the risk for large-volume blood loss and, if it is significant, ensure that appropriate intravenous access is established.

Recommended:

- A member of the team should confirm the availability of blood products if needed for the operation.

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