



Comprehensive Management of Hemorrhage in Trauma Care: A Multidisciplinary Approach

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Abstract

Background: Hemorrhage remains a critical clinical challenge, particularly in trauma care, where it is a leading cause of morbidity and mortality. Rapid identification of hemorrhage severity and timely intervention are crucial for improving patient outcomes. The management of hemorrhage involves a multifaceted approach, including early detection, accurate diagnostic tools, and collaboration among healthcare professionals in emergency and trauma settings. Pharmacists, nurses, and emergency providers all play essential roles in optimizing hemorrhage care. **Methods:** This review examines the current trends in hemorrhage management, focusing on trauma and cerebrovascular hemorrhage. We analyze the severity classification system used to guide clinical decision-making, from Class I (minimal intervention) to Class IV (aggressive resuscitation). The role of diagnostic imaging, including non-contrast CT and FAST scans, in detecting hemorrhage is also discussed. Additionally, the involvement of pharmacists in managing coagulopathies and ensuring appropriate drug therapy is highlighted. Clinical outcomes are evaluated in the context of balanced transfusion protocols, including the 1:1:1 ratio of packed red blood cells, fresh frozen plasma, and platelets.

Significance | Effective hemorrhage management through early detection, timely intervention, and collaborative care improves survival rates and optimizes trauma outcomes.

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Editor Md Shamsuddin sultan khan And accepted by the Editorial Board January 15, 2024 (received for review October 04, 2023)

Results: A collaborative, multidisciplinary approach involving emergency providers, pharmacists, and nursing staff is essential for the effective management of hemorrhage. Early detection through diagnostic tools like CT scans and ultrasound leads to timely interventions such as surgical exploration and transfusions. The application of the 1:1:1 transfusion protocol has been shown to improve survival rates in trauma patients. In addition, the use of tourniquets and direct pressure has been proven effective in reducing mortality from hemorrhagic shock. The role of pharmacists in managing drug therapy, including blood products and medications for coagulopathies, significantly impacts patient outcomes. **Conclusion:** Effective hemorrhage management in trauma care requires a well-coordinated, multidisciplinary approach to ensure rapid diagnosis and intervention. Timely recognition of hemorrhage severity, accurate diagnostic imaging, and the implementation of transfusion protocols are critical components of trauma care. Pharmacists and nurses play crucial roles in optimizing treatment, while early interventions such as fluid resuscitation and hemorrhage control measures can dramatically improve patient survival. The findings underscore the importance of teamwork, specialized expertise, and systematic approaches to managing hemorrhage in trauma settings.

Keywords: hemorrhage, trauma care, early recognition, multidisciplinary approach, hemorrhagic shock.

Introduction

Hemorrhage, defined as the acute loss of blood from ruptured

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Please Cite This:

Alajery, M. A., Almalki, F. H., Khormi, A. A., Farshan, S. M. A., Qahtani, A. M., Nashar, R. M., Alazmiy, B. S., Aljarallah, M. K., Aloula, A. S. A., Jaafari, A. A., Alanazi, A. J., Alhomod, K. A., Alhamed, A. A., Alhizan, K. A., Alharbi, K. K., Harbi, S. H. A. (2024). "Comprehensive Management of Hemorrhage in Trauma Care: A Multidisciplinary Approach", *Journal of Angiotherapy*, 8(1),1-10,10096.

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(<https://publishing.emanresearch.org>).

or damaged blood vessels, presents a significant challenge in clinical care. Its severity ranges from minor instances such as petechiae and ecchymosis due to superficial vessel damage to life-threatening cases involving major physiological derangements, including alterations in vital signs and mental status (Lee et al., 2020). Hemorrhage is generally categorized into external and internal types. External bleeding is often visible and originates from body openings or traumatic wounds, making it easier to detect. In contrast, internal bleeding is more insidious and demands a high level of clinical suspicion for diagnosis. Detecting internal hemorrhage typically involves a thorough patient history, physical examination, laboratory investigations, imaging modalities, and continuous monitoring of vital signs (Gross et al., 2019). Prompt identification and intervention are crucial as untreated internal bleeding can escalate rapidly, leading to hypovolemic shock and organ failure.

Traumatic hemorrhage is one of the leading causes of preventable mortality, particularly in high-risk environments such as motor vehicle accidents or combat zones (Kauvar et al., 2006). Trauma-induced blood loss is associated with significant morbidity, underscoring the need for rapid assessment and effective management strategies (Carmichael et al., 2019). In emergency and trauma settings, early recognition and appropriate classification of hemorrhage are critical to inform treatment priorities and optimize patient outcomes. Clinical frameworks often categorize hemorrhage severity into four classes, ranging from mild (Class I) to life-threatening (Class IV), which necessitates aggressive resuscitation measures (Vulliamy et al., 2019). These classifications guide healthcare providers in the timely implementation of life-saving interventions such as fluid resuscitation, blood transfusions, and surgical control of bleeding.

The etiology of hemorrhage is diverse and varies depending on the anatomical site of bleeding. Intracranial hemorrhage, for example, occurs due to the rupture of blood vessels within the brain, leading to blood leakage into or around brain tissues. This condition is commonly associated with chronic hypertension, trauma, advanced age, or substance abuse (Agarwal et al., 2019). Intracranial hemorrhages can manifest in various forms, including subarachnoid hemorrhage (SAH), subdural hematoma, epidural hematoma, and intraparenchymal hemorrhage. Among these, SAH often results from ruptured aneurysms or arteriovenous malformations and is characterized by the sudden onset of a severe headache, often described as a "thunderclap headache" (Matano et al., 2019).

In the thoracic cavity, hemothorax—accumulation of blood between the visceral and parietal pleura—is a common consequence of trauma, metastatic cancer, or coagulopathies. Hemothorax restricts lung expansion and impairs gas exchange, presenting symptoms such as chest pain, shortness of breath, and

dizziness (Aboudara & Maldonado, 2019). In severe cases, tension hemothorax can occur, causing increased intrathoracic pressure and compromised cardiac return, necessitating immediate intervention.

Abdominal hemorrhage, another critical condition, often requires imaging for definitive diagnosis due to its nonspecific clinical presentation. Causes include trauma to organs such as the liver, spleen, or kidneys, vascular injuries, and complications arising from gynecological conditions like ectopic pregnancy or cyst rupture (Pontius & Vieth, 2019). Retroperitoneal bleeding, frequently associated with pelvic fractures, can involve injuries to major blood vessels or surrounding anatomical zones, each presenting unique diagnostic and management challenges (Baekgaard et al., 2019). For example, Zone 1 injuries often involve the pancreaticoduodenal region or the aorta, while Zone 3 injuries are commonly linked to pelvic trauma or vascular access procedures.

Long bone fractures, particularly of the femur, are another significant source of hemorrhage. The vascular nature of bone marrow and the associated blood vessels make these fractures capable of leading to rapid and substantial blood loss, contributing to hypovolemic shock if not promptly addressed (Lazarev et al., 2019). Hemorrhage management in such cases often involves stabilizing the fracture, fluid resuscitation, and surgical intervention if necessary.

The effective management of hemorrhage relies on a multidisciplinary approach. Emergency physicians, nurses, pharmacists, and surgeons play pivotal roles in ensuring timely and coordinated care. Diagnostic tools such as computed tomography (CT) scans and focused assessment with sonography for trauma (FAST) are instrumental in identifying bleeding sources and guiding treatment decisions (Rubano et al., 2013). Pharmacists contribute by managing blood products and anticoagulant therapies, while nurses monitor vital signs and provide critical bedside care (Dhakal et al., 2019). Evidence-based protocols, such as balanced transfusion strategies using a 1:1:1 ratio of packed red blood cells, fresh frozen plasma, and platelets, have been shown to improve survival outcomes in trauma patients (Palmer, 2017).

Hemorrhage remains a significant clinical challenge requiring rapid diagnosis, prompt intervention, and collaborative care. Advances in diagnostic techniques, treatment protocols, and multidisciplinary coordination continue to improve patient outcomes, emphasizing the critical importance of timely and effective hemorrhage management in trauma care.

2. Etiology of Hemorrhage

Hemorrhage presents clinically in ways that vary based on the anatomical location of bleeding (Figure 1). Acute trauma-induced hemorrhage can be classified into external wounds, bleeding within the skull, chest cavity, abdominal cavity, retroperitoneum, or long

bone fractures. An accurate diagnosis depends on a detailed medical history and thorough physical examination.

2.1 Intracranial Hemorrhage

Intracranial hemorrhage occurs when a blood vessel within the brain ruptures, causing blood to leak into or around the brain. The clinical manifestations depend on the specific location of the bleeding. Chronic hypertension is a leading cause of weakened arterial walls and intracranial hemorrhage. Symptoms typically include unilateral weakness, headache, nausea, vomiting, and altered mental status (Lee et al., 2020). Other contributing factors include chronic alcohol consumption, prolonged tobacco use, advanced age, and drug abuse (Gross et al., 2019). Trauma is another major cause of intracranial bleeding.

One specific type of intracranial hemorrhage is subarachnoid hemorrhage (SAH), which results from the rupture of a bridging cortical vein. This allows blood to accumulate between the arachnoid mater and pia mater, irritating the meninges and causing severe pain. The hallmark of SAH is a sudden, severe headache often described as the "worst headache of one's life" or a "thunderclap headache." The primary causes of SAH are ruptured aneurysms, trauma, or arteriovenous malformations (Agarwal et al., 2019). Other intracranial bleeding types include intraparenchymal hemorrhage, subdural hematoma, and epidural hematoma, often involving more than one type of bleeding in trauma cases.

2.2 Hemothorax

Bleeding within the pleural cavity is termed hemothorax, wherein blood accumulates in the space between the visceral and parietal pleura. This restricts lung expansion, impairing gas exchange in the alveoli. Hemothorax is commonly caused by traumatic injuries, metastatic cancer, clotting disorders, or rarely, spontaneous occurrences. Clinical presentations include dizziness, shortness of breath, and chest pain. If untreated, hemothorax may progress to shock or death. Tension hemothorax, characterized by increased chest pressure and reduced cardiac blood return, can be fatal without prompt intervention (Kauvar et al., 2006).

2.3 Abdominal Hemorrhage

Traumatic abdominal hemorrhage necessitates high clinical suspicion, as symptoms are often nonspecific. Imaging is crucial for confirmation. Clinical signs include abdominal pain, hematemesis, hematuria, melena, and bruising. Severe cases may lead to hemorrhagic shock and death (Figure 2). Common causes include trauma to organs such as the liver, spleen, or kidneys; vascular injuries; gynecological or obstetric complications; and coagulopathies. Among women of childbearing age, ectopic pregnancy and cyst rupture are frequent causes (Pontius & Vieth, 2019).

2.4 Retroperitoneal Hemorrhage

The retroperitoneum, housing critical visceral and vascular structures, is vulnerable to injury from abdominal or pelvic trauma. Retroperitoneal hematomas are classified anatomically: Zone 1 includes central injuries involving the pancreaticoduodenal region or major vessels such as the renal artery and aorta. Zone 2 encompasses the flanks and perinephric areas, while Zone 3 corresponds to the pelvic region, often affected by pelvic fractures or femoral vascular access injuries (Baekgaard et al., 2019). Symptoms include abdominal, back, or flank pain; urinary disturbances; and femoral nerve palsy. Clinical signs may include Grey Turner sign, characterized by bruising over the flanks.

2.5 Hemorrhage in Long Bone Fractures

Long bone fractures can lead to rapid and life-threatening hemorrhage due to the high vascularization of the bone marrow. The most vascular bones include the humerus, radius, ulna, femur, fibula, pelvis, and vertebrae. The femur alone can hold 1–2 liters of blood. Hemorrhage arises from both the bone itself and associated blood vessels, particularly during trauma or surgical interventions (Lazarev et al., 2019).

Hemorrhage presents a spectrum of clinical challenges based on the site and severity of bleeding. Accurate diagnosis and timely intervention are crucial to prevent life-threatening complications.

2.6 Epidemiology

Trauma-induced hemorrhage is a leading cause of death among individuals aged 46 years and younger in the United States, underscoring its significant impact on public health (Kauvar et al., 2006). The etiologies of hemorrhage are multifaceted, influenced by lifestyle factors, socioeconomic conditions, and environmental determinants. Globally, injuries account for approximately 9% of all deaths, contributing to 12% of the disease burden, as reported by the World Health Organization (WHO) in 2000. Notably, 90% of these injuries occur in low- and middle-income countries where access to trauma care is often limited, amplifying the risk of fatal outcomes due to inadequate healthcare resources (Kauvar et al., 2006).

Traffic accidents are among the primary causes of blunt trauma, while violence—both intentional and unintentional—also plays a substantial role in trauma-related hemorrhagic events (Carmichael et al., 2019). The high mortality associated with these causes emphasizes the urgent need for effective preventive measures and robust healthcare systems to mitigate trauma-related deaths. Early detection and rapid management of hemorrhage remain critical, particularly in resource-limited settings.

3. Pathophysiology

In adults, the total circulating blood volume ranges between 4.5 and 5.5 liters (approximately 70–90 ml/kg). The human body can typically compensate for a blood loss of up to 14% without significant physiological alterations. The classification of

hemorrhage severity is based on the percentage of blood volume lost:

Class I Hemorrhage: Blood loss up to 15%, usually asymptomatic with stable vital signs.

Class II Hemorrhage: Blood loss between 15% and 30%, presenting with nausea, fatigue, pallor, and cool extremities. Tachycardia (100–120 bpm) and a mild increase in respiratory rate (20–24 breaths/min) are common.

Class III Hemorrhage: Blood loss between 30% and 40%, associated with delayed capillary refill, altered mental status, systolic blood pressure below 90 mmHg, and tachycardia exceeding 120 bpm. These signs reflect the body's compensatory vasoconstriction to maintain vital organ perfusion.

Class IV Hemorrhage: Blood loss exceeding 40%, characterized by profound hypotension, absent peripheral pulses, and minimal or no urine output (Foucher & Tubben, 2023).

Severe hemorrhage may lead to hemorrhagic shock, where oxygen delivery to tissues is compromised. This condition induces anaerobic metabolism and metabolic acidosis, which, if untreated, can result in organ failure, coma, and death (Foucher & Tubben, 2023).

4. History and Physical Examination

A detailed medical history and physical examination are pivotal in identifying the source of hemorrhage. The primary survey in trauma care emphasizes circulation, including the evaluation and control of significant bleeding. During the assessment, clinicians should investigate five critical regions prone to life-threatening hemorrhage: external wounds, thoracic cavity, abdominal cavity, retroperitoneum, and the thighs.

A patient's history should include questions about anticoagulant or antiplatelet medication use, bleeding disorders, recent trauma, or invasive medical procedures. Specific symptoms, such as hematemesis, melena, hematuria, or hemoptysis, may point to gastrointestinal or pulmonary sources of bleeding. Intracranial hemorrhage may manifest with headache, focal neurological deficits, or altered mental status, often necessitating imaging for definitive diagnosis.

Non-traumatic hemorrhagic presentations, such as tachycardia, hypotension, or evidence of bleeding from a bodily orifice, demand thorough investigation to identify the underlying etiology.

5. Evaluation

The evaluation of hemorrhage incorporates both clinical and diagnostic approaches:

Intracranial Hemorrhage: Non-contrast CT is the gold standard within six hours of symptom onset for accurate diagnosis (Mackenzie et al., 2017). After this window, MRI may be more sensitive (Kim et al., 2013). Lumbar puncture can identify red blood

cells or xanthochromia in cerebrospinal fluid, confirming subarachnoid hemorrhage.

Thoracic Hemorrhage: Chest X-ray, ultrasound, or CT imaging aids in detecting hemothorax. For hemodynamically unstable patients, bedside evaluations are prioritized. Chest tube placement and surgical intervention may be indicated if blood output exceeds 1,500 mL initially or 200 mL/hour post-placement (Aboudara & Maldonado, 2019).

Abdominal Hemorrhage: The focused assessment with sonography for trauma (FAST) scan is an essential bedside tool for diagnosing intra-abdominal bleeding (Rubano et al., 2013). CT imaging may be used in hemodynamically stable patients. Surgical exploration is warranted in cases of peritoneal irritation, hemodynamic instability, or positive FAST findings.

Retroperitoneal Hemorrhage: Retroperitoneal bleeding is evaluated through CT and ultrasound. In patients with significant pelvic trauma, angiography may be necessary to locate and manage vascular injuries (Baekgaard et al., 2019).

Gastrointestinal Hemorrhage: Endoscopic evaluations, including esophagogastroduodenoscopy (EGD), colonoscopy, bronchoscopy, or cystoscopy, are critical for identifying bleeding sources in relevant anatomical sites.

Diagnostic tests often include a complete blood count, coagulation profile, and cross-matching for transfusion. Serial monitoring of hemoglobin levels and coagulation parameters provides insight into the progression of hemorrhage and guides therapeutic decisions.

Trauma-induced hemorrhage represents a significant global health challenge, with a substantial burden in low- and middle-income countries. The classification of hemorrhage based on blood loss percentage allows for targeted management strategies to stabilize patients and prevent complications. Rapid diagnosis using advanced imaging modalities, alongside a thorough history and physical examination, is critical for optimizing patient outcomes. Future efforts should focus on improving access to trauma care and enhancing preventive measures to mitigate the impact of hemorrhage-related morbidity and mortality.

6. Treatment/Management of Hemorrhage

The management of hemorrhage is primarily determined by factors such as the anatomic location of the injury, the severity of blood loss, the clinical presentation, and the available medical resources. Effective treatment requires prompt resuscitation, restoration of intravascular volume, and precise monitoring of physiological parameters to prevent secondary complications. Early recognition and timely intervention play significant roles in improving patient outcomes and minimizing the risk of mortality.

Initial resuscitation typically involves intravenous (IV) fluid administration, particularly when signs of hypovolemia are evident. Basic fluid resuscitation may involve normal saline or lactated

Ringer's solution through two large-bore IV lines. Simultaneously, a transfusion protocol should be initiated, employing a balanced ratio of packed red blood cells (PRBCs), fresh frozen plasma (FFP), and platelets (1:1:1), with adjustments made according to clinical needs and the patient's condition. Close monitoring for hypothermia is essential during transfusions, as it can exacerbate coagulopathy, especially in trauma patients (Lee et al., 2020).

The primary objectives of hemorrhage treatment are to restore intravascular volume and ensure adequate oxygen delivery to tissues until the underlying source of bleeding is identified and controlled. In general, a target mean arterial pressure (MAP) of greater than 65 mm Hg is recommended. However, this target may be adjusted based on the type of trauma. For penetrating injuries, maintaining a systolic blood pressure above 90 mm Hg is vital. In patients with traumatic brain injuries, the MAP should exceed 105 mm Hg, and systolic blood pressure should be kept above 120 mm Hg to prevent secondary brain injury (Gross, Jankowitz, & Friedlander, 2019). Furthermore, clinicians must carefully monitor lactic acid levels and the progression of metabolic acidosis, as these may signal the onset of peripheral vasodilation, which can lead to cardiovascular collapse.

In cases of traumatic external wounds, direct pressure is the first line of management. The application of tourniquets proximal to the hemorrhage site can significantly reduce mortality rates by controlling arterial blood flow (Agarwal, Zhou, & Frontera, 2019). These interventions should be performed rapidly to stabilize the patient while preparing for further interventions or surgical management if necessary.

6.1 Differential Diagnosis

The accurate identification of hemorrhage requires a methodical and vigilant clinical approach. Clinicians must conduct a thorough history and physical examination to assess potential causes of bleeding and initiate the correct treatment regimen. Hemorrhage often presents as hypovolemic shock, which must be differentiated from other shock syndromes, including cardiogenic, septic, and neurogenic shock. Special attention should be given to neurological hemorrhages, such as intracranial bleeds, which present with a higher risk of rapid deterioration due to the limited space within the cranium. Elevated intracranial pressure can quickly induce changes in mental status and neurological function.

Differential diagnoses for hemorrhage include conditions such as migraine headaches, meningitis, encephalitis, brain tumors, electrolyte imbalances, strokes, myocardial infarctions, and intoxication or poisoning. These conditions can present with similar symptoms, including altered mental status, nausea, vomiting, and changes in vital signs, necessitating careful diagnostic workup to differentiate hemorrhage from other critical conditions (Pontius & Vieth, 2019).

6.2 Prognosis

The prognosis of hemorrhage largely depends on the timing of diagnosis and the rapidity of medical intervention. Early identification and management of hemorrhage are crucial in improving survival rates, particularly in cases of traumatic hemorrhagic shock. Delayed treatment significantly increases the risk of mortality and morbidity, as uncontrolled bleeding leads to irreversible tissue damage and multi-organ failure (Kauvar, Lefering, & Wade, 2006). In contrast, patients who receive prompt resuscitation and hemorrhage control are more likely to recover with fewer long-term complications.

Physicians must focus on stabilizing the patient by ensuring adequate oxygenation and managing bleeding. Tissue hypoxia must be prevented, as prolonged oxygen deprivation to vital organs, particularly the brain, heart, and kidneys, can lead to irreversible damage. The early correction of hypovolemia, monitoring of blood pressure, and management of blood gas abnormalities are pivotal in supporting organ function and improving long-term recovery (Carmichael et al., 2019).

The prognosis is generally more favorable in cases where hemorrhage is controlled, oxygen delivery is restored, and tissue perfusion is maintained. Studies have shown that early interventions to optimize blood pressure and oxygenation correlate with better recovery outcomes and decreased mortality rates (Foucher & Tubben, 2023). Delays in managing bleeding, on the other hand, can lead to complications such as multi-organ failure, sepsis, and shock, which significantly worsen the prognosis.

6.3 Complications

Hemorrhage can lead to several complications, especially if bleeding is not effectively controlled. The most common complications arise from inadequate blood flow to vital organs, resulting in tissue hypoxia. Organ failure may occur, particularly in the kidneys, liver, and brain. Prolonged oxygen deprivation in the brain can result in cerebral infarction and long-lasting neurological deficits, including cognitive impairment and motor dysfunction (Lazarev, Golokhvast, & Borozda, 2019).

In patients who survive initial hemorrhagic shock, there is a risk of re-bleeding, which can worsen the clinical condition and require additional interventions. For example, subarachnoid hemorrhage (SAH) may lead to cerebral vasospasm during the post-hemorrhagic phase, exacerbating neurological deterioration and increasing the risk of stroke (Matano et al., 2019). Moreover, hospital-acquired complications such as deep vein thrombosis (DVT) and infections are frequent concerns, particularly in patients requiring prolonged hospitalization. DVT prevention, often through the use of mechanical devices or pharmacological anticoagulation, is critical for reducing the risk of venous thromboembolism (Dhakal et al., 2019). Infection control measures are also essential, particularly for patients with surgical wounds or central lines.

The occurrence of these complications can significantly delay recovery and hinder rehabilitation, ultimately affecting long-term outcomes. Therefore, managing the risk of secondary complications is just as critical as controlling the initial hemorrhage. Regular monitoring, early intervention, and prevention strategies should be implemented to mitigate these risks and optimize patient recovery.

7. Patient Education

Patient education is a crucial aspect of post-hemorrhage care, helping patients and their families manage the recovery process and reduce the likelihood of recurrence. Research indicates that many patients who survive hemorrhage do not meet their rehabilitation goals due to inadequate access to rehabilitation resources or a lack of awareness of their condition's long-term implications (Vulliamy, Thaventhiran, & Davenport, 2019). Thus, it is essential for healthcare providers to engage patients and their families early in the recovery process to establish realistic rehabilitation goals and identify available support systems.

Education should cover various aspects of recovery, including potential physical and emotional challenges, as well as the financial demands of rehabilitation. Clear communication about the recovery process ensures that patients are prepared for the difficulties ahead and helps manage expectations. Furthermore, providing information on community resources, social support services, and financial assistance can alleviate stress and improve overall recovery outcomes (Hegvik et al., 2017).

By equipping patients with the knowledge and resources needed for rehabilitation, healthcare providers can enhance both the physical and psychological aspects of recovery. This comprehensive approach not only improves rehabilitation outcomes but also helps prevent future hemorrhagic events by encouraging lifestyle modifications and adherence to prescribed treatments.

7.1 Role of Pharmacists, Emergency Providers, and Nursing in Hemorrhage Management

The management of hemorrhage, particularly in emergency settings, requires a multidisciplinary approach to stabilize patients promptly and effectively. Pharmacists, emergency providers, and nurses each contribute critical expertise in addressing the physiological, pharmacological, and supportive care needs of hemorrhaging patients. Collaboration among these professionals is essential for optimizing outcomes during a hemorrhagic crisis.

7.2 Pharmacists' Role in Hemorrhage Management

Pharmacists are integral members of the healthcare team in hemorrhage management, with a primary focus on pharmacological interventions. They provide expert guidance on the selection, dosing, and administration of medications and blood products, ensuring that these interventions are both effective and safe. In trauma and surgical hemorrhages, pharmacists play a key

role in managing the administration of blood products such as packed red blood cells (PRBCs), fresh frozen plasma (FFP), and platelets. They are responsible for ensuring the compatibility of blood products and monitoring potential transfusion reactions (Kauvar, Lefering, & Wade, 2006).

Pharmacists also manage medications designed to control hemorrhage and its complications. For example, procoagulant agents such as tranexamic acid are commonly used in trauma and surgical hemorrhages to reduce blood loss (Gross, Jankowitz, & Friedlander, 2019). Additionally, pharmacists are involved in managing anticoagulant therapy, particularly when hemorrhage is complicated by the use of anticoagulants. They assess the patient's medication history to identify drugs that may increase bleeding risk, such as anticoagulants or antiplatelet medications, and collaborate with the healthcare team to adjust these therapies accordingly (Pontius & Vieth, 2019).

In hemorrhagic shock, pharmacists contribute by recommending appropriate vasopressors, such as norepinephrine and epinephrine, to support blood pressure and tissue perfusion. Given the potential to exacerbate hemorrhage by increasing peripheral vascular resistance, careful dosing and monitoring of these medications are essential (Baekgaard et al., 2019). Pharmacists' expertise in drug interactions is invaluable, especially when managing complex cases where multiple medications could impact bleeding risk or interfere with the effectiveness of other interventions.

8. Emergency Providers' Role in Hemorrhage Management

Emergency providers, including emergency physicians, trauma surgeons, and paramedics, are often the first responders to hemorrhaging patients. Their role is crucial in the immediate assessment, stabilization, and management of hemorrhagic patients. The primary goal of emergency providers is to assess the extent of blood loss and initiate life-saving interventions to prevent hypovolemic shock, organ failure, and death.

Initial management involves rapid assessment and intervention based on the ABCs (Airway, Breathing, Circulation) approach. Emergency providers use physical examination and imaging to quickly identify the source of hemorrhage and implement hemodynamic support strategies, including fluid resuscitation with intravenous (IV) fluids such as normal saline or lactated Ringer's solution to restore circulating volume (Carmichael et al., 2019). In severe hemorrhage cases, blood transfusions are initiated using a 1:1:1 ratio of packed red blood cells, fresh frozen plasma, and platelets to maintain oxygen-carrying capacity and prevent clotting disorders (Lee et al., 2020).

Control of active bleeding is another critical intervention. Depending on the location and severity, emergency providers use various techniques such as direct pressure, tourniquets, or hemostatic dressings for external bleeding. For internal hemorrhage, surgical interventions or advanced imaging

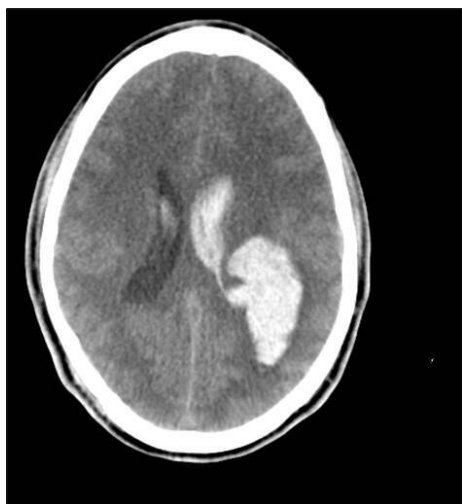


Figure 1. Hemorrhage.

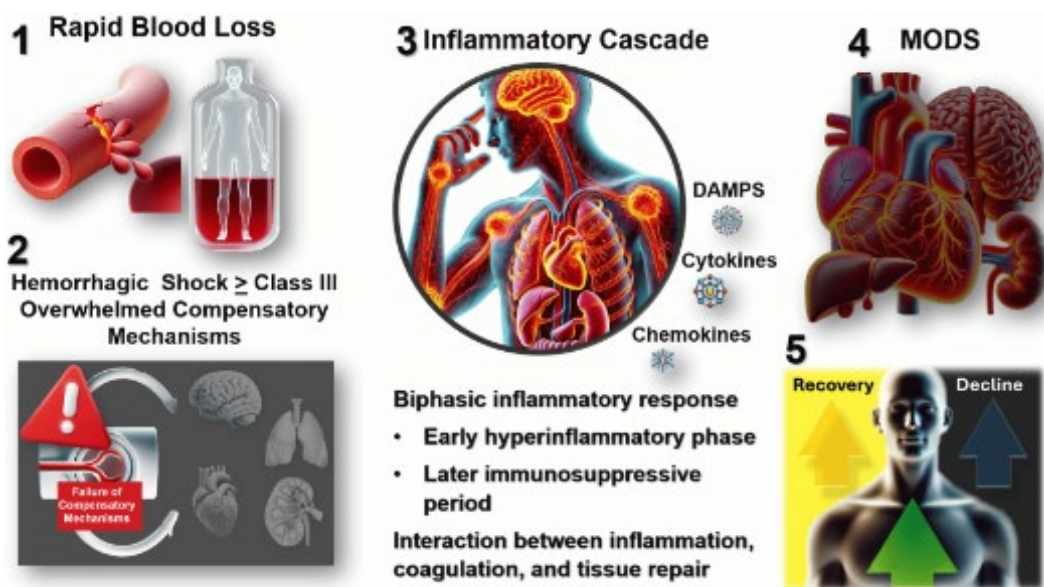


Figure 2. Pathophysiological Progression of Hemorrhagic Shock and Its Systemic Impact.

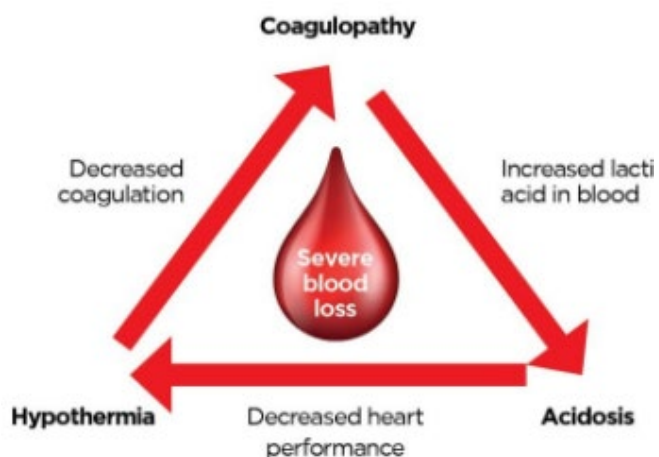


Figure 3. Trauma nursing

techniques like CT scans or ultrasound may be necessary to locate the bleeding source (Lazarev, Golokhvast, & Borozda, 2019). Emergency providers are trained to recognize the signs of hemorrhagic shock and initiate early interventions to prevent further deterioration, such as close monitoring of vital signs and laboratory values (Foucher & Tubben, 2023).

8.1 . Nursing's Role in Hemorrhage Management

Nurses play a pivotal role in hemorrhage management by providing ongoing patient monitoring, administering medications and fluids, and supporting the physical and emotional well-being of the patient. They are integral in assessing and documenting vital signs, which helps to guide treatment decisions. Nurses also assist in the administration of prescribed medications and blood products, ensuring that the patient receives the correct interventions as ordered by the healthcare team.

In addition to their clinical responsibilities, nurses act as patient advocates, offering education and emotional support to patients and families during a traumatic experience. They collaborate with pharmacists and emergency providers to ensure the patient receives comprehensive care and that any changes in condition are promptly addressed (Vulliamy, Thaventhiran, & Davenport, 2019).

The management of hemorrhage in emergency settings demands a collaborative, multidisciplinary approach to ensure the best possible outcomes for the patient. Pharmacists, emergency providers, and nurses each contribute distinct but complementary expertise, from pharmacological interventions and hemodynamic support to ongoing monitoring and patient care. Effective communication and teamwork among these professionals are essential to optimize hemorrhage management, reduce complications, and improve survival rates.

8.2 Nursing Role in Hemorrhage Management

Nurses are critical to the ongoing monitoring, assessment, and management of patients experiencing hemorrhage. They are often the healthcare professionals who spend the most time with patients, offering continuous surveillance and support. Nurses have the responsibility to monitor vital signs, assess the patient's physical condition, and provide early interventions based on changes in clinical status. These interventions include timely administration of intravenous (IV) fluids and blood products, which are essential for stabilizing hemorrhaging patients. Nurses ensure that these fluids are delivered according to physician orders and observe the patient's response to these treatments. They must also be vigilant for signs of adverse reactions to blood transfusions, such as fever, chills, or allergic responses, and act quickly to manage these complications (Kauvar et al., 2006).

An essential role of nurses in hemorrhage management is pain management. Trauma-induced pain can be overwhelming, and it is crucial for nurses to administer analgesics and sedatives as prescribed to help alleviate discomfort. This contributes to the

overall well-being of the patient during a traumatic experience. Furthermore, nurses provide psychological support, assisting patients and families in coping with the distress and anxiety that often accompany hemorrhagic conditions. Nurses often serve as a bridge between the medical team and patients, offering emotional comfort and clear communication about the recovery process and potential complications (Baekgaard et al., 2019).

Education is another key responsibility for nurses. They educate patients and their families on the recovery process, including wound care, medication adherence, and recognizing early warning signs of complications. This education extends to discharge planning, ensuring that patients are well-prepared to manage their care at home following their treatment for hemorrhage (Lee et al., 2020). This comprehensive patient education promotes a smoother recovery and reduces the risk of further complications.

Collaboration with the multidisciplinary healthcare team is vital to nursing care in hemorrhage management. Nurses work closely with physicians, pharmacists, and other healthcare providers to ensure holistic care. They provide valuable feedback regarding the patient's responses to treatments, including any changes observed in the patient's condition. By participating in multidisciplinary rounds, nurses contribute critical insights that aid in adjusting care plans to optimize patient outcomes (Kauvar et al., 2006).

Nurses also play an integral role in the direct control of hemorrhage. While physicians and surgeons may perform surgical interventions, nurses often assist in managing bleeding through techniques like applying pressure or dressing wounds, and they are frequently the first responders to bleeding events in emergency situations (Pontius & Vieth, 2019). Their timely actions, including applying hemostatic dressings or assisting with tourniquet application, can be life-saving (Figure 3).

Nurses are central to the care of hemorrhaging patients, providing critical monitoring, education, emotional support, and collaboration with other healthcare professionals. Their continuous involvement with patients and proactive interventions make them indispensable in hemorrhage management, ensuring that patients receive comprehensive, compassionate, and effective care. Effective hemorrhage control requires a coordinated, team-based approach, with nurses playing a pivotal role in optimizing patient outcomes (Jones, 2006; Carmichael et al., 2019).

9. Perspective on Hemorrhage Management in Trauma Care

Hemorrhage remains a pervasive clinical challenge, particularly in trauma care, where it is the leading cause of death. Its management requires not only speed but also precision, as timely interventions can mean the difference between life and death. Early recognition of hemorrhage severity is paramount, as it guides clinical decisions and ensures appropriate interventions are initiated without delay. The categorization of hemorrhage severity, from Class I to Class IV,

provides a framework for healthcare providers to make rapid, evidence-based decisions that optimize patient outcomes. Class I hemorrhage may require minimal intervention, while Class IV hemorrhage demands aggressive resuscitation. In emergency departments and trauma centers, healthcare professionals must be adept at recognizing the symptoms and signs of hemorrhage through comprehensive assessment, including history-taking and physical examination,

in combination with advanced diagnostic tools like CT scans and FAST scans. These diagnostic steps are critical in confirming the presence of hemorrhage and determining the necessary course of action.

Additionally, the role of multidisciplinary collaboration in hemorrhage management cannot be overstated. Emergency providers, pharmacists, and nurses all contribute their specialized expertise to the care of hemorrhagic patients. Emergency physicians and trauma specialists make rapid decisions regarding stabilization, employing tools like chest tubes or surgical exploration as required. Pharmacists ensure the correct administration of blood products and medications that manage coagulopathies, preventing further complications. Nurses, who play an integral role in the ongoing monitoring and resuscitation of patients, are crucial in tracking vital signs and responding promptly to changes in the patient's condition. This teamwork allows for the prompt and effective management of hemorrhage, which significantly influences patient survival rates.

10. Conclusion

In conclusion, hemorrhage remains a critical and often life-threatening condition, particularly in trauma care, where its management requires swift, coordinated efforts from a multidisciplinary healthcare team. The timely recognition of hemorrhage severity through effective assessment tools and diagnostic interventions is essential for determining the appropriate course of action. Emergency providers, pharmacists, and nurses all have distinct yet complementary roles in ensuring that hemorrhage is effectively managed. Early interventions such as fluid resuscitation, blood product transfusion, and direct pressure application, alongside ongoing monitoring, significantly improve survival rates. A collaborative, team-based approach is crucial in mitigating the risks associated with hemorrhage and optimizing patient outcomes. By leveraging the combined expertise of healthcare professionals and employing well-established treatment protocols, we can enhance the chances of survival and recovery for trauma patients suffering from hemorrhage. Ultimately, the success of hemorrhage management hinges on the seamless integration of diagnostic, clinical, and therapeutic interventions provided by a well-coordinated team

Author contributions

All authors contributed equally to the conceptualization, design, data collection, analysis, and interpretation of the study. M.A.A., F.H.A., A.A.K., S.M.A.F., A.M.Q., R.M.N., B.S.A., M.K.A., A.S.A., A.A.J., A.J.A., K.A.A., A.A.A., K.A.A., K.K.A., and S.H.A. participated in drafting and revising the manuscript. S.H.A. served as the corresponding author, overseeing the coordination and final approval of the manuscript.

Acknowledgment

The authors were grateful to their department.

Competing financial interests

The authors have no conflict of interest.

References

- Aboudara, M., & Maldonado, F. (2019). Update in the management of pleural effusions. *Medical Clinics of North America*, 103(3), 475-485. <https://doi.org/10.1016/j.mcna.2019.01.003>
- Agarwal, S., Zhou, T., & Frontera, J. (2019). Journal club: Association between aspirin dose and subarachnoid hemorrhage from saccular aneurysms: A case-control study. *Neurology*, 92(19), 920-922. <https://doi.org/10.1212/WNL.0000000000007230>
- Baekgaard, J. S., Eskesen, T. G., Lee, J. M., Yeh, D. D., Kaafarani, H. M. A., Fagenholz, P. J., Avery, L., Saillant, N., King, D. R., & Velmahos, G. C. (2019). Spontaneous retroperitoneal and rectus sheath hemorrhage—Management, risk factors, and outcomes. *World Journal of Surgery*, 43(8), 1890-1897. <https://doi.org/10.1007/s00268-019-05044-2>
- Carmichael, H., Steward, L., Peltz, E. D., Wright, F. L., & Velopulos, C. G. (2019). Preventable death and interpersonal violence in the United States: Who can be saved? *Journal of Trauma and Acute Care Surgery*, 87(1), 200-204. <https://doi.org/10.1097/TA.0000000000002386>
- Dhakal, P., Wang, L., Gardiner, J., Shrotriya, S., Sharma, M., & Rayamajhi, S. (2019). Effectiveness of sequential compression devices in prevention of venous thromboembolism in medically ill hospitalized patients: A retrospective cohort study. *Turkish Journal of Haematology*, 36(3), 193-198. <https://doi.org/10.4274/tjh.2018.0287>
- Foucher, C. D., & Tubben, R. E. (2023). Lactic acidosis. *StatPearls [Internet]*. StatPearls Publishing. <https://www.statpearls.com/ArticleLibrary/viewarticle/24598>
- Gross, B. A., Jankowitz, B. T., & Friedlander, R. M. (2019). Cerebral intraparenchymal hemorrhage: A review. *JAMA*, 321(13), 1295-1303. <https://doi.org/10.1001/jama.2019.0851>
- Hegvik, J. R., Spilman, S. K., Olson, S. D., Gilchrist, C. A., & Sidwell, R. A. (2017). Effective hospital-wide education in hemorrhage control. *Journal of the American College of Surgeons*, 224(5), 796-799.e1. <https://doi.org/10.1016/j.jamcollsurg.2017.02.013>
- Kauvar, D. S., Lefering, R., & Wade, C. E. (2006). Impact of hemorrhage on trauma outcome: An overview of epidemiology, clinical presentations, and therapeutic

- considerations. *Journal of Trauma*, 60(6 Suppl), S3-11.
<https://doi.org/10.1097/01.ta.0000219347.77958.9e>
- Kim, D. S., Kong, M. H., Jang, S. Y., Kim, J. H., Kang, D. S., & Song, K. Y. (2013). The usefulness of brain magnetic resonance imaging with mild head injury and the negative findings of brain computed tomography. *Journal of Korean Neurosurgical Society*, 54(2), 100-106.
<https://doi.org/10.3340/jkns.2013.54.2.100>
- Lazarev, A., Golokhvast, K., & Borozda, I. (2019). Review of the problems of diagnosis of endopelvic hemorrhage, its intensity, volume, and duration, and treatment methods of circulatory injuries and surgical hemostasis after pelvic fractures. *Emergency Medicine International*, 2019, 2514146.
<https://doi.org/10.1155/2019/2514146>
- Lee, S. U., Kim, T., Kwon, O. K., Bang, J. S., Ban, S. P., Byoun, H. S., & Oh, C. W. (2020). Trends in the incidence and treatment of cerebrovascular diseases in Korea: Part I. Intracranial aneurysm, intracerebral hemorrhage, and arteriovenous malformation. *Journal of Korean Neurosurgical Society*, 63(1), 56-68.
<https://doi.org/10.3340/jkns.2019.0115>
- Mackenzie, M. J., Hiranandani, R., Wang, D., Fung, T., & Lang, E. (2017). Determinants of computed tomography head scan ordering for patients with low-risk headache in the emergency department. *Cureus*, 9(10), e1760.
<https://doi.org/10.7759/cureus.1760>
- Matano, F., Fujiki, Y., Mizunari, T., Koketsu, K., Tamaki, T., Murai, Y., Yokota, H., & Morita, A. (2019). Serum glucose and potassium ratio as risk factors for cerebral vasospasm after aneurysmal subarachnoid hemorrhage. *Journal of Stroke and Cerebrovascular Diseases*, 28(7), 1951-1957.
<https://doi.org/10.1016/j.jstrokecerebrovasdis.2019.01.036>
- Nixon, G., Blattner, K., Muirhead, J., Finnie, W., Lawrenson, R., & Kerse, N. (2018). Scope of point-of-care ultrasound practice in rural New Zealand. *Journal of Primary Health Care*, 10(3), 224-236. <https://doi.org/10.1071/HC17044>
- Palmer, L. (2017). Fluid management in patients with trauma: Restrictive versus liberal approach. *Veterinary Clinics of North America: Small Animal Practice*, 47(2), 397-410. <https://doi.org/10.1016/j.cvsm.2017.01.004>
- Pontius, E., & Vieth, J. T. (2019). Complications in early pregnancy. *Emergency Medicine Clinics of North America*, 37(2), 219-237.
<https://doi.org/10.1016/j.emc.2019.01.003>
- Rubano, E., Mehta, N., Caputo, W., Paladino, L., & Sinert, R. (2013). Systematic review: Emergency department bedside ultrasonography for diagnosing suspected abdominal aortic aneurysm. *Academic Emergency Medicine*, 20(2), 128-138.
<https://doi.org/10.1111/acem.12032>
- Vulliamy, P., Thaventhiran, A. J., & Davenport, R. A. (2019). What's new for trauma hemorrhage management? *British Journal of Hospital Medicine (London)*, 80(5), 268-273. <https://doi.org/10.12968/hmed.2019.80.5.268>