Patient- and Doctor-Induced Emergencies

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Anesthesiologists are involved in managing both patient and doctor-induced emergencies, such as massive hemorrhage, increased intracranial pressure, cardiac disease, drug-related errors, and surgical errors. This article is a brief introduction to managing these conditions.

Patient-Induced Emergencies

A patient-induced emergency is defined as a patient presenting to the emergency room because of a severe illness or injury.

Massive hemorrhage is a major cause of preventable mortality. The leading causes of massive hemorrhage include:

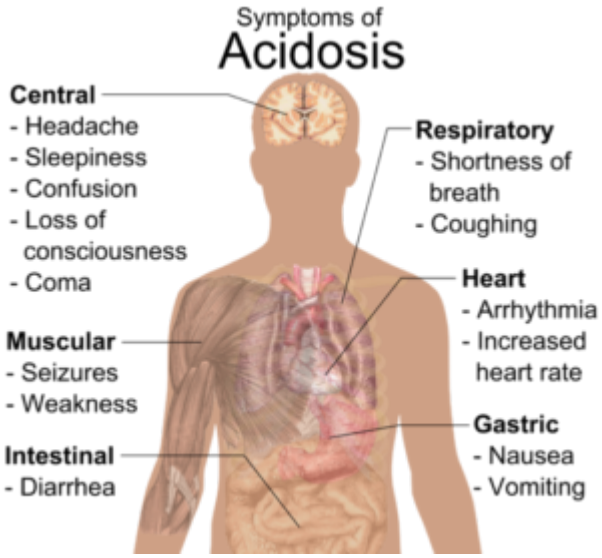
- **Trauma or assault**: the coagulopathy that occurs in a trauma setting is unique in its pathogenesis, aided by tissue injury factors. It can occur in the absence of significant fluid administration, clotting factor depletion, or hypothermia
- **Vascular disease,** such as a ruptured aneurysm; while rare, the sudden loss of blood volume in such situations makes them potentially lethal
- **Genetic bleeding disease,** such as hemophilia
- **Postpartum hemorrhage**: evidence suggests that an acquired fibrinogen deficiency state contributes to the condition, complicated by dilutional coagulopathy and exaggerated fibrinolysis

- **Drug-induced hemorrhage**: this is a known complication of blood thinners and anti-platelet drugs, as well as an adverse effect of some drugs, such as gastrointestinal hemorrhage secondary to NSAIDs.

Hemorrhage during surgery is classified as anticipated or unanticipated:

Situations in which hemorrhage	
can be anticipated	is unanticipated
• Cardiac surgery • Vascular surgery • Spine surgery	A bleeding disorder that was unknown or unreported prior to surgery

Massive Transfusion Protocol



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The Massive Transfusion Protocol (MBT) calls for rapid, judicious use of blood and blood derivatives to manage a massive hemorrhage and ensure an improved outcome. MBTs have developed as a collaborative effort between anesthesiologists, surgeons, transfusion medicine physicians, emergency physicians, and intensivists.

Currently, the MBT includes:

- Replacement of one entire blood volume within 24 hours
- Transfusion of >10 units of packed red blood cells (PRBCs) in 24 hours
- Transfusion of >4 units of PRBCs in one hour when the on-going need is foreseeable
- Replacement of 50% of total blood volume (TBV) within three hours.

Once MTP is initiated, a batch of 5 red blood cells, 5 platelets, and 2 fresh frozen plasma (FFP) are dispatched continuously until no longer required.

The pre-requisites for a successful MTP include:

Intravenous access: Large bore peripheral intravenous access is at the heart of any successful resuscitation. Special insertion sheaths in neck veins may be used, subject to

accessibility and the team's expertise.

Temperature control: warming devices, surface warmers, and core temperature monitors. With the transfusion of two or more blood products, it is of crucial importance to warm blood products gradually, "thawing" them to body temperature, prior to transfusion, to prevent complications secondary to a massive infusion of stored blood products, such as "**Disseminated Intravascular Coagulation (DIC).**"

Central venous pressure monitoring.

Onsite testing, such as **arterial blood gas** and **thromboelastography,** is highly desirable.

Increasing the use of blood thinners, especially in the elderly population, has led to increased transient coagulopathy-like states during surgery.

Ideally, **warfarin** and similar **vitamin K antagonists** should be stopped 5-7 days before any surgical intervention, bridging the gap with **heparin**. **PT/INR** should be monitored, and heparin is to be stopped a day before the procedure.

In case of an emergency, **prothrombin plasma concentrates (PCC)** can reverse warfarin effects.

P**rotamine sulfate** is a heparin antidote. However, newer, fractionated, low molecular weight heparin formulations are difficult to reverse.

Antiplatelet agents, such as aspirin and clopidogrel, are withheld (with the consent of the treating physician) and replaced with heparin when appropriate.

Low dose aspirin leads to minimal, if any, increase in bleeding tendency.

Alternative strategies:

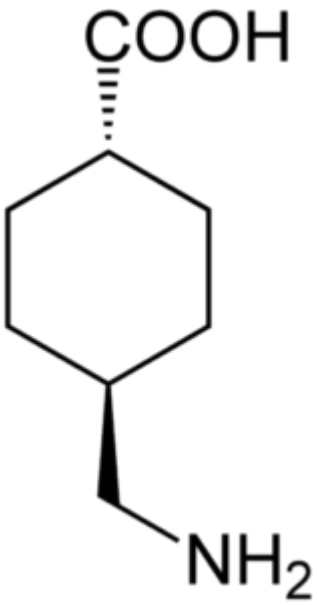

Image: "Structural Formula of Tranexamic Acid." by Jü – Own Work. License: Public Domain

Activated factor VII: beneficial for uncontrolled bleeding that is unresponsive to standard hemostatic therapy.

Antifibrinolytic agents: early administration of drugs, such as **tranexamic acid,** has a mortality benefit in trauma and obstetric hemorrhages.

Cell salvage: used for patients with rare blood groups and unexpected massive hemorrhages, it is feasible in aseptic environments, such as operating suites. However, cell savage carries a potential risk of **malignant cell dissemination and contamination**.

MTP complications include **overzealous rapid correction** without due central venous pressure monitoring, which can lead to circulatory overload, interstitial edema, and pulmonary edema. There is usually a drop in oxygen saturation, indicating pulmonary edema, which is associated with high morbidity and mortality. Aggressive diuretic use with curtailed intravenous fluid administration is critical.

Other complications are outlined below:

Immediate complication	Intermediate complication	Long term complication
Acidosis	TRALI (transfusion-related acute lung injury)	Renal failure
Hypomagnesemia	Cardiac toxicity is secondary to hypocalcemia, hyperkalemia, and other factors.	Respiratory failure
Hyperkalemia	Disseminated intravascular coagulation (consumptive coagulopathy)	SIRS (systemic inflammatory response syndrome)
Citrate toxicity	Interstitial edema	Thrombotic complications
Hypothermia	Transfusion-related circulatory overload	Sepsis
Hypocalcemia	Pulmonary edema	
Dilutional coagulopathy		

Limitations of Massive Transfusion Protocols

Inappropriate initiation of MTP leads to a waste of energy and resources. Protocols vary from institution to institution.

Raised Intracranial Pressure

The skull is a rigid, non-compressible limiting element for the intracranial contents. The intracranial space of about 1700 ml is distributed as follows: Brain parenchyma 1400 ml, blood 150 ml, and CSF about 150 ml. These intracranial elements are all in a balanced, yet flexible, dynamic state of equilibrium. If anyone of these elements changes, the others compensate for the change. This principle has been formally addressed as the **Monro-Kellie doctrine**. However, decompensation of this balance, leading to raised intracranial pressure, such as in cases of space-occupying lesions, hydrocephalus (increase in CSF component), and extra-axial blood aggregation, as in trauma and brain hemorrhage, has abysmal effects on cerebral perfusion, leading to ischemia and parenchymal damage.

In normal circumstances, **cerebral blood flow autoregulation** ensures adequate cerebral perfusion over a wide range of intracranial pressure. Autoregulation is often

impaired if there are intracranial space-occupying lesions, trauma, or infection.

Clinical reflection of raised intracranial pressure is the **Cushing's triad**: hypertension, bradycardia, and irregular respiration. Cushing's triad refers to the brain's effort to maintain cerebral perfusion during increasing cerebral edema. Increased intracranial pressure in these circumstances leads to the invariably fatal complication of **herniation**. The herniation of the posterior fossa contents, brain stem, and cerebellar tonsils through the foramen magnum causes compression of the critical medullary cardiovascular regulatory centers.

Raised intracranial pressure calls for rapid emergent co-ordinated management.

Intubation: The first traditional step in resuscitation is to control the airway and avoid hypoxia. However, subtle stimulation of the vocal cords can lead to a raised intracranial pressure, tachycardia, and hypertension.

Anesthesia drugs have variable effects on intracranial pressure. In the face of impaired autoregulation, some analgesics and sedatives can also lead to major changes in intracranial pressure, cerebral blood flow, and cerebral metabolism. Inappropriate naïve use of these drugs can lead to clinical deterioration.

Decongestant drugs, which ameliorate intracranial pressure, are prone to reducing cerebral blood flow below critical levels with resultant cerebral hypoperfusion and elevated risk of **ischemic hypoxic encephalopathy** and brain damage. Therefore, these agents must be used very cautiously to try to achieve a balance between intracranial pressure and cerebral perfusion. Various drugs and their effects are summarized below.

Drug	Effect
Hypnotic agents: propofol	Reduced cerebral blood flow, decreased cerebral metabolism, decreased ICP, decreased cerebral perfusion pressure
Benzodiazepines: lorazepam, diazepam	Reduced cerebral blood flow, decreased cerebral metabolism, decreased ICP, decreased cerebral perfusion pressure
Opioids: fentanyl, sufentanil	Reduced cerebral blood flow, decreased cerebral metabolism, no change in ICP; increased blood volume that can lead to a secondary increase in ICP.
Alpha-2 adrenergic agonists: clonidine	Reduced cerebral blood flow, no change in cerebral metabolism, no change in ICP; occasional transient decrease in ICP with low dose
Ketamine	Region-specific variable response of blood flow, the variable response of cerebral metabolism, increases ICP
Diuretics: furosemide, mannitol	Reduced ICP, reduced cerebral blood flow, decreased cerebral perfusion pressure

Cardiac Disease

Cardiovascular diseases are the leading cause of mortality. Cardiac disease, such as ischemic heart disease and arrhythmias, and severe vascular diseases like aortic stenosis, can lead to heart failure and eventually cardiac arrest.

Cardiac arrest can also be the culmination of pulmonary embolism, tension pneumothorax, cardiac tamponade, or hypovolemic shock.

The Advanced Cardiac Life Support (ACLS) guidelines published in 2015 (valid through 2020), provide a protocol to initiate resuscitation. In the OR, the surgeon is responsible for initiating CPR (**cardio-pulmonary resuscitation**), and the anesthesiologist will manage drug administration and patient monitoring. The latter includes interpreting ECG, monitoring oxygen saturation and end-tidal carbon dioxide, and checking for signs of airway obstruction and respiratory issues.

Ventricular arrhythmias, like pulseless ventricular tachycardia and ventricular fibrillation, call for the use of defibrillation.

Atrial arrhythmias are common, usually benign, and often managed without resorting to cardiac arrest management.

Some salient features of ACLS pertinent to anesthesiology are as follows:

- Low-end tidal CO2 (ETCO2 < 10mm Hg) after 20 minutes of CPR, in conjunction with other parameters, helps determine when to terminate resuscitation
- Extracorporeal CPR can prolong viability if implemented soon after cardiac arrest
- Avoiding immediate correction of hypotension is recommended during post-cardiac arrest care
- Without hypoxia or respiratory distress, oxygen administration should be withheld in cases of acute coronary syndrome
- Patients in cardiac arrest with no definite pulse are to be given focused high-quality CPR with naloxone

Doctor-Induced Emergencies

Wrong Drug and Wrong Dose Errors

A medication error is defined as “any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional, patient, or consumer.” There are different types of medication errors:

- **Prescribing faults**: over and under-prescribing
- **Prescription errors**: the fault in writing prescriptions, illegibility, wrong drugs
- **Manufacturing errors**: adulterants
- **Dispensing errors**: wrong drug, wrong formulation
- **Administering errors**: wrong dosage, wrong access, and wrong frequency

Medication errors may occur during anesthesia. Timely recognition helps correct untoward hemodynamic changes and avoid an adverse event. Measures to prevent medication errors for anesthesiologists include:

- All syringes are labeled with the drug name and concentration
- No syringe to be used in more than one patient
- Careful monitoring of the use of controlled drugs

Computerized physician order entry system: These computer-generated programs have built-in warnings about possible drug interactions, duplication of orders, incorrect dose, and patient allergies.

Constant vigilance is needed to minimize errors, including careful prescription administration and expert observation after administration to avoid potential complications.

Surgical Errors

Surgical care is an indispensable part of medical care.

Surgical errors include:

Wrong side surgery (operating on the incorrect side of the patient)

Inadvertent opening of cavities, such as inadvertent bowel perforation, leading to contamination and peritonitis.

Blood vessel damage leading to hemorrhage is a potential cause of intra-operative blood loss.

While addressing the safety of surgical care, WHO, in 2007, took up the challenge of reinforcing “Safe Surgery Saves Lives”. At the heart of this WHO, the initiative is the **WHO Safe Surgery Checklist**. Three phases of the surgical procedure are addressed in this checklist:

- Before induction of anesthesia: “Sign in”
- Before incision of the skin: “Time out”
- Before the patient leaves the operating room: “Sign out”

In each phase, a checklist coordinator checks various points to ensure complete surgical safety. A few salient points are as follows:

- Confirm patient identity
- Confirm the surgical site whenever applicable and mark the site
- Complete instrument and sponge count

All anticipated complications are to be listed beforehand to avoid unpleasant surprises intra-operatively.

The aim is to follow a few critical steps and thus to avoid infrequent, yet persistent, mishaps that may endanger the well-being of surgical patients.

Summary

Patient-induced emergencies include massive hemorrhage, increased intracranial pressure, and cardiac disease.

Doctor-induced emergencies comprise of the wrong drug, wrong dose administration, and surgical errors.

A massive hemorrhage demands objective MTP-based rapid judicious management to revive the patient and avoid inherent risks.

Anesthetic drugs must be used wisely in situations with increased intracranial pressure to ensure adequate cerebral perfusion with decreased intracranial tension.

Cardiac disease constitutes common emergencies and must be managed per **ACLS guidelines**.

With expert emergent, conscious, careful management, doctor-induced errors can be corrected to avoid patient harm.

References

Patil V, Shetmahajan M. Massive transfusion and massive transfusion protocol. Indian J Anaesth. 2014 Sep-Oct; 58(5): 590–595.

ACLS guidelines, 2015

Velo G, Minuz P. Medication errors: prescribing faults and prescription errors. Br J Clin Pharmacol. 2009 Jun; 67(6): 624–628.

Aronson JK. Balanced prescribing – principles and challenges. Br J Clin Pharmacol. 2012 Oct; 74(4):566-72.

Werner C. Effects of analgesia and sedation on cerebrovascular circulation, cerebral blood volume, cerebral metabolism and intracranial pressure. Anaesthesist. 1995 Dec;44 Suppl 3:S566-72.

Aronson JK. Medication errors: what they are, how they happen, and how to avoid them. QJM. 2009 Aug; 102(8):513-21

WHO surgical safety checklist and implementation manual, 2008

Notes