Anesthesia for hemodynamically unstable patient coming for emergency surgery

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Hemodynamic instability can be defined as a state where the circulatory system is not able to provide for perfusion of the tissues. This could be due to various causes but broadly the causes can be enumerated as

1. Hypovolemic
2. Distributive
3. Cardiogenic
4. Obstructive

Anesthesiologists can be called in to give anesthesia for such patients for emergency surgeries. The source of such patients are usually from **the emergency department** where patients with multiple injuries who are in shock requiring emergency procedures to resuscitate them. Critically ill patients in the **intensive care unit** can also come to the operating room for emergency procedures. These patients mostly will be suffering from hemodynamic instability due to sepsis, a distributive kind of instability. There are a group of patients who present with primarily a pump failure for example a post myocardial infarct patient requiring a emergency procedure to stabilize the cardiac function which falls in the domain of a cardiac anesthesiologist. Lastly a patient may present with features of obstructive shock for example from a pulmonary embolus blocking the right ventricular outflow that needs an emergency embolectomy. Though the mechanisms are different the management of these patients depends on certain fundamental principle which will be detailed in this presentation keeping the most common cause for hemodynamic instability that is patients with Hypovolemic shock due to blood loss.

Initial assessment and resuscitation:

Patients who present for emergency procedures following a hemorrhagic shock following trauma usually require the surgery to stop the bleeding, for decontamination and stabilization of fractures and probably neurosurgical procedures for decompression of brain. The pre anesthetic assessment needs to be very quick and should follow a set pattern. The vital functions are assessed and necessary interventions are made immediately. This is essentially termed as Primary Survey. The sequence of this assessment is

1. Airway with cervical spine control
2. Breathing with ventilatory assistance
3. Circulation with hemorrhage control
4. Neurological assessment with prevention of secondary damage

5. Exposure with environmental control

In any trauma patient who presents for an emergency procedure the airway needs to be assessed for patency and for accessibility for endotracheal intubation. If there is evidence of respiratory obstruction it needs to be cleared by simple airway maneuvers like chin lift, jaw thrust and finger sweep. Simple adjuncts like oropharyngeal or nasopharyngeal airway can also be used as the situation demands. But if the airway is not secure or is unprotected or the patient needs to be anesthetized immediately for some intervention either for diagnostic or therapeutic purpose then an endotracheal intubation needs to be done. When assessing for airway one can use the LEMON scoring for difficult emergency airway where L stands for Look, E stands for evaluate, M for Mallampatti, O for obstruction, n for neck mobility.

If the airway is unobstructed or has been relieved by simple airway maneuvers or adjuncts and patients respiratory efforts are alright then he needs to get 100% oxygen by anesthetic breathing system. Incase there is need for ventilatory assistance the same can be given by bag and mask till endotracheal intubation. In a hemodynamically compromised patient one needs to clinically diagnose life threatening problems associated with ventilation namely *tension pneumothorax, massive hemothorax, open pneumothorax, flail chest* and *cardiac tamponade.*

Arresting of bleeding takes priority in any hypovolemic patient. The goal should be to restrict the fluid resuscitation to provide only for vital organ perfusion without increasing the blood pressure to levels which will dislodge the clots and increase the bleeding. Priority should be given to shifting the patient to the operating room or to interventional radiology suite to intervene and stop the bleeding. In exanguinating hemorrhage one may need to give O-ve packed cells to keep the patient alive and later when available to transfuse with the group specific blood when available. Applying direct compression, tourniquets for limb trauma, external stabilizers for pelvic fractures are temporary measures which will reduce blood loss till permanent surgical control can be attained. Hence during the primary survey the patient may need to undergo an emergency surgery to arrest bleeding for example an laparotomy for a splenic rupture before proceeding to the next step namely assessment of the neurological status.

Neurological assessment is usually done by GCS. It is a simple measurement with less inter observer variability and a prognostic indicator of neurological outcome. A GCS of less than 8 indicates a need for endotracheal intubation. In patients with traumatic brain injury adequate precautions to prevent secondary neurological damage like preventing hypotension, hypoxia and hypercapnia needs to be taken.

In any emergency patient it would be inappropriate to wait for lab investigations for taking up a patient for an emergency surgery. But it would be advisable to send blood for baseline parameters including a complete blood count, blood urea, sugar and serum

lactate. Blood also is sent for grouping and cross matching and this is usually done when the cannulae are put on arrival.
Radiological examination is restricted to only Chest, pelvis and c spine in an unstable patient. Some times a patient may need to taken up even before the radiological investigations. In may not be appropriate to shift a patient for CT scans when they are Hemodynamically unstable except for life saving interventions like therapeutic embolisation in a pelvic fracture patient.

Ultrasonography has a role in locating bleeding. A focused assessment by ultrasonography for trauma (FAST) will tell us whether there is blood in the peritoneal cavity, pericardial or pleural cavity. Some times it may need to be repeated even if the initial FAST was negative.

Shifting the patient to the operating room

- Needs to be done very quickly but meticulously
- In patients who have been intubated care needs to be taken not to have inadvertent extubations or pulling out of IV cannulae, chest tubes or urinary catheters.
- Oxygen cylinders, batteries of transport ventilators need to be checked before shifting the patient out of the resuscitation suite. One should never shift the patient thinking that "it is only across the corridor".
- Not all the fractures would have been splinted and hence extreme care should be taken to prevent undue damage to unnoticed injuries in an anesthetized patient.
- While receiving the patient in the OT there should be adequate transfer of information regarding what all treatment he had received so far.

Shifting the patient on to the operating table.

- The same precautions will hold good here also
- All the lines have been placed with a purpose, so they should be accessible to the anesthesiologist
- It may be prudent to use the same monitors and cables till the time the patient achieves reasonable hemodynamic stability instead of trying to change the ECG cables , SPO2 cables , Temperature Probes

Monitoring:

Routine monitoring like ECG, SpO2, Non invasive blood pressure monitors should be connected.

Radial artery cannulation to get an continuous arterial blood pressure is very useful but at no point of time should the surgery be delayed for sake of arterial line. It can be done as the surgery is proceeding. It is a very useful monitor to have when one expects lot of hemodynamic instability.

Central venous lines are useful when all other venous access fail. It is also useful to give inotropes and vasopressors if used. Central venous pressure can be used to monitor the left ventricular filling pressure though it can be grossly inadequate. Monitoring ***central venous oxygen saturation*** is a useful in identifying ongoing bleeding and also in assessing the adequacy of tissue perfusion. ***Pulse Pressure Variation*** during respiratory cycle indicates a relative hypovolemia and predicts that the patient will respond to fluid administration. Most monitors with invasive blood pressure monitors can freeze the arterial trace and quantify the PPV. When there is no PPV there will not be any increase in cardiac output no matter how much fluid is given..

Induction of Anesthesia:

Hemodynamically unstable may need to be induced as part of the primary survey itself when the airway needs to be taken care of and / or the ventilation needs to be assisted. Points to be taken care of in all patients is

- All induction agents cause severe hypotension in Hypovolemic Hemodynamically unstable patients.
- Ketamine and Etomidate can be used in unstable patients keeping in mind that patients in extremis may not with stand these induction agents also.
- Patients in extremis or impending arrest may not need any drugs or muscle relaxants alone.
- In patients with hypotension but conscious with systolic pressures of around 80 mmHg will require induction agents and ketamine and etomidate will be drugs of choice.
- Ketamine can cause myocardial depression in sympathetically exhausted patients
- Etomidate can cause adrenocortical suppression but clinical significance of this is yet to be ascertained.
- In severely Hypovolemic patients the blood supply to the brain itself is reduced and the incidence of awareness may not be as high as we think when induction agents are not used.
- Fentanyl and midazolam can also cause circulatory depression in unstable patients.

Muscle relaxants of choice

Suxamethonium is the drug of choice. Even in major crush injuries, spine injuries and in patients with burns suxamethonium can be used safely in the first 24 hours post injury. After 24 hours the chances of hyperkalemia increases in these patients. In patients with penetrating globe injuries use of suxamethonium is relatively contraindicated for the fear

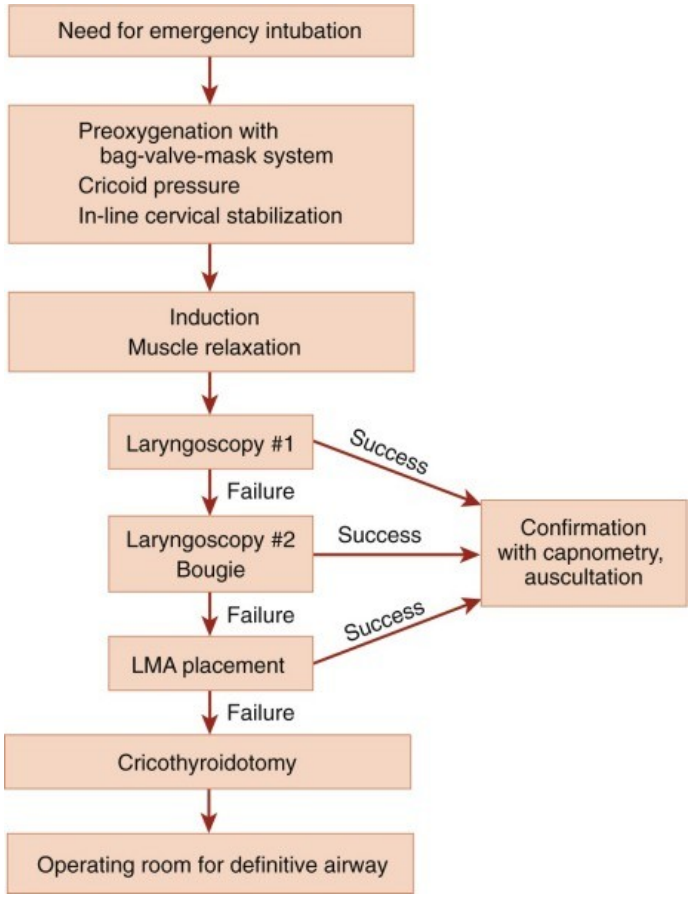
of increase in extrusion of globe contents. In case suxamethonium is contraindicated rocuronium bromide at 1.2 mg/kg will be the drug of choice.

Intubation:

Modified rapid sequence intubation is used for patients with hemodynamic instability coming for emergency surgery. The sequence will be

- Manual in line stabilization – in all trauma patients
- Preoxygenation (if patient is conscious and fit enough)
- Injection of the calculated dose (as per the hemodynamic status of the patient) of induction agent (etomidate or thiopentone).
- Application of cricoid pressure
- Injection of calculated dose of suxamethonium or rocuronium bromide
- Gentle Ventilation with 100% oxygen
- Laryngoscopy and intubation with a cuffed endotracheal tube
- Inflation of cuff
- Confirm tracheal placement
- Remove the cricoid pressure

Incase of difficulty in intubation help can be attained. One attempt with intubation over a gum elastic bougie will definitely be useful. Incase of difficulty one can enter into the ASA difficult airway algorithm which has been modified in emergency situations where the option of waking up the patient and postponing the surgery is not there. Incase of CICV (Cannot intubate or cannot ventilate) one needs to have a very low threshold to decide for a surgical airway (cricothyroidotomy)



Fluid management:

Priority is given to control of bleeding in a hemodynamically unstable patient due to blood loss. Once the bleeding is controlled then fluid resuscitation is continued till the volume status and metabolic status is restored (ie) the organ perfusion is normalized.

The Goals of fluid resuscitation in the Early Phase (that is till the bleeding is controlled) is to maintain organ perfusion and this can be achieved by

- Maintain systolic blood pressure at 80 mm Hg (prevents clot dislodgement)
- Maintain hematocrit at 25% to 30%
- Maintain the prothrombin time and partial thromboplastin time in normal ranges
- Maintain the platelet count at greater than 50,000 per high-power field
- Maintain normal serum ionized calcium
- Maintain core temperature higher than 35°C
- Prevent an increase in serum lactate

- Prevent acidosis from worsening
- Achieve adequate anesthesia and analgesia

Once the bleeding is achieved the goals of resuscitation will be

- Maintain systolic blood pressure higher than 100 mm Hg
- Maintain hematocrit above individual transfusion threshold
- Normalize coagulation status
- Normalize body temperature
- Restore normal urine output
- Maximize cardiac output by invasive or noninvasive measurement
- Reverse systemic acidosis
- Document decrease in lactate to normal range

Which fluids to use:

There is no conclusive evidence that one fluid is better than the other. The present recommendation is to use isotonic crystalloids (Normal saline, ringer lactate) in the early part of resuscitation.

Normal saline which has 155 meq of chloride can theoretically cause hyperchloremia and hence lactated ringer has been advocated in many centres. The problems with crystalloids is that they do not stay in the intravascular space for a long time and need to be given 3 – 5 times the volume of blood lost. Colloids stay in the intravascular space for a long time and can be given in 1:1 ratio. The problem with colloids is that they are expensive, can interfere with clotting and have not shown conclusive advantage in outcome of patients in hemorrhagic shock.

How much fluid to give:
Should be guided by the amount of blood lost, the hematocrit, vital signs, the filling pressures and cardiac output. When the resuscitation volume exceeds 80ml/kg/hour or when duration of crystalloid resuscitation at this rate is for more than 2 hours then the fluid resuscitation fails to maintain the perfusion of tissues due to accumulation of fluid in the interstitium.

In hypovolemic patients using vasopressors to maintain blood pressure is usually not advocated. But when the perfusion pressures are very low a bolus of vasopressor can be given to buy time to fill up the intravascular volume. In patients in whom adequately volume replacement has been done some times one may need to use circulatory support in the form of noradrenaline infusion.

Blood transfusion should be considered for patients who come with exanguinating hemorrhage very early. In patients who are on the verge of a cardiac arrest one can give uncrossmatched o-ve packed cells. Once the grouping is ready group specific uncrossmatched blood can be given. In patients who have received more than four units of O –ve packed cells it is better to give the same blood rather than giving the group specific blood.

In patients with extensive trauma who arrive in the casuality with coagulopathy even before they have been fluid resuscitated it would be advisable to start on RBCs: Plasma:platelets on 1:1:1 ratio from the beginning instead of giving plasma after transfusion of six units of packed cells which is the normal protocol in many centres. This is due to the existence of Acute Coagulopathy of trauma Shock.(ACoTS).

Modalities for Assessment of Systemic Perfusion (From Miller)

Technique	Shortcomings
Vital signs	Will not indicate occult hypoperfusion
Urine output	May be confounded by intoxication, diuretic therapy, circadian variation, or renal injury
Systemic acid-base status	Confounded by respiratory status
Lactate clearance	Requires time to obtain laboratory result
Cardiac output	Requires placement of a pulmonary artery catheter or use of noninvasive technology
Mixed venous oxygenation	Difficult to obtain, but a very accurate marker
Gastric tonometry	Requires time to equilibrate, subject to artifact

Technique	Shortcomings
Tissue oxygenation	Emerging technology, appears beneficial
Stroke volume variation	Emerging technology, requires an arterial line
Acoustic blood flow	Investigational technology, unproven

Maintenance of Anesthesia:

Goals will be to provide adequate analgesia and amnesia without causing undue hemodynamic consequences. In an unstable patient before hemorrhage control it may not be possible to provide the full dose of narcotics or the volatile agents. Both these agents if used in normal recommended doses can cause profound hypotension. Once the hemodynamic status improves slowly volatile agents can be introduced with lot of caution as the circulatory state may suddenly deteriorate as soon as the volatile agents are introduced. Similarly incremental doses of narcotics can be added. Using propofol in a patient with unstable hemodynamics need to be discouraged as it causes profound vasodilatation and hypotension.

Muscle relaxants can be used liberally in these patients as these patients will usually be ventilated electively and extubation will be planned only in the ICU. Pancuronium with its sympathomimetic and vagolytic properties will be a useful drug in hemodynamically unstable patient. In the group of patients where extubation would be tried on the table an intermediate acting relaxant like vecuronium or rocuronium can be tried.

Out of the volatile agents isoflurane is preferable as it causes less myocardial depression than the other volatile agents. The concern of coronary steal is not of much clinical significance. Halothane which is very rarely used can sensitize the heart to the circulating catecholamines which may be very high in the Hemodynamically compromised patient.

Nitrous oxide may worsen hemodynamic status in a patient in hemorrhagic shock. Also its ability to expand air filled spaces like pneuothorax, pneuomocephalus prevents its usage in trauma patients.

All patients who undergo emergency procedures need to undergo positive pressure ventilation . This will maintain adequate oxygenation and also take over the work of breathing. But in any patient with multiple injuries whenever there is an abrupt fall in

oxygen saturation during a procedure one need to keep in mind development of a pneuomothorax.

Patients who come from the intensive care may be on some particular mode of ventilation with PEEP. It would be better to use the same setting intraoperatively also.

Prevention of hypothermia.

One of the predictors of poor outcome is fall in core body temperature in an unstable patient undergoing emergency surgery. Hence body temperature be maintained by peripheral warming by using body warmers, warming IV fluids and blood, warming the fluids used to lavage body cavities especially the peritoneal cavity, keeping the ambient temperature slightly higher than usual. Monitoring of temperature is done usually by nasopharyngeal or esopghageal probes

How far to allow the surgeon to proceed in a hemodynamically unstable patient:

In any multiply injured patient who comes for an emergency procedure it is preferable to do only damage control procedures, stabilize them in the intensive care and then do the definitive procedures. Some pointers which will determine whether or not to proceed further is the presence of **coagulopathy, acidosis and hypothermia**. The presence of any of this should restrict the surgical intervention to the bare essentials. Estimation of mediators of inflammation like interleukin-6 will help in decision making.

At the end of the surgical intervention:

Most of these patients will be shifted to the intensive care, electively ventilated and extubated once they are stable. Whenever there is a doubt regarding the fitness for extubation on the table it will be better to err on the side of not extubating as it might be very difficult to reintubate these patients if needed. They would have had lot of fluid transfusion and their airway is likely to be edematous.

In cases where one expects lot of pain in the post operative period continuous regional and central neuraxis blocks can be instituted if there are no specific contraindications.

These patients would have accumulated lot of tissue oxygen debt during the period of blood loss which needs to be cleared. Some of these patients may show normal vital parameters like blood pressure, heart rate, urine output. Yet their lactate levels(indicating adequacy of tissue perfusion) may not have come down indicating that there is occult hypoperfusion of the tissues. These patients may go on to multiple organ dysfunction and death late in the post operative period. Hence continuing resuscitation in the post operative period improves outcome in these patients.

Transfer to the intensive care unit.

Care needs to be taken regarding

- Endotracheal tube
- Ventilation
- Monitors and cables
- Tubes and bags

While shifting the patients care should be taken to gently as there can be hypotension due to fluid shifts. Similarly there may be undiagnosed fractures or incompletely splinted fractures. Once shifted to the ICU details of the injuries sustained, procedures done, fluids and blood transfused, drugs given, support needed especially inotropic support need to be communicated to the attending physician. Analgesic infusions may need specific mention if continuous block catheters are in place which will help when the patients are weaned from the ventilators.

Conclusion:

The anesthetic management of patients with hemodynamic instability is a challenge that anesthesiologist need to face as the condition that leads to the instability mostly needs surgical intervention to stabilize the patient. The time available for the anesthesiologist to assess and to call for help is also very little. Unfortunately most of these patients come to the hospital at very odd hours when help at hand is also very little. .The primary objective in these patients will be to get them on to the operating theatre as soon as possible . Maintaining the vital functions during induction and performance of the emergency surgical procedure requires an experienced anesthesiologist at the head end who will be able to take decisions without wasting any time which could decide the outcome in the management of these patients.