Hypotension

A decrease in BP > 20% baseline or SBP<90 mm Hg or MAP < 60 mm Hg. Requires simultaneous diagnosis and treatment. Potentially life threatening emergency!

ANESTHETIC CONSIDERATIONS:

- **Etiology**
  - Preload – decreased
  - Contractility – decreased
  - Afterload – decreased
- **Prevention**
  - Careful pre-operative checks
  - Anesthetic plan to prevent hypotension
  - Ensure euvolemia prior to induction
  - Possible pretreatment with small doses of vasopressors (bolus or infusion) at induction (depends greatly on situation)
- **Manifestations**
  - Hypotension – NIBP or invasive pressure
  - Tachycardia
  - Arrhythmias
  - Decreased ETCO2
  - Hypoxemia/poor SpO2 tracing
  - Cardiac arrest/PEA
- **Management**
  - Possible emergency situation, simultaneous diagnosis and treatment
  - Increase FiO2 to 100%, notify surgical team, ask for help
  - Recycle NIBP and reevaluate vitals
  - Treat suspected underlying cause while ruling out other possibilities
  - Algorithmic approach from machine to patient / patient to machine, excluding possible causes

ANESTHETIC GOALS:

- Simultaneously diagnose and treat a potentially life threatening emergency.
- Prevention and detection of early manifestations and sequelae

ETIOLOGY

E. Decreased preload
- Hypovolemia
- Vasodilation
- Restricted venous return
- Increased intrathoracic pressure/PPV
- Patient positioning
- Tamponade
- PE
- Tension pneumothorax

F. Decreased contractility
- Myocardial depressants (induction agents/volatiles)
- Arrhythmias (electrolytes, etc.)
- Cardiomyopathy/CHF
- MI/ACS (O2 supply-demand balance)
- Valvular etiology
- Abrupt increase in afterload
- Hypoxemia
- Sepsis

G. Decreased afterload/SVR
- Vasodilation (regional techniques)
- Drugs
- Sepsis
- Anaphylaxis
- Endocrine (adrenal insufficiency, hypothyroidism, hypoglycemia, etc.)

OTHER CLASSIFICATION (I.E. SHOCK)

- Distributive
  - Sepsis
  - Anaphylactic
  - Neurogenic
  - Adrenal insufficiency
- Obstructive
  - Tension PTX
  - Massive PE/VAE/AFE/Fat emboli, etc.
  - Tamponade
  - Mediastinal mass
- Hypovolemic
  - Hemorrhagic

- Cardiogenic
    - Cardiomyopathy (Right or left sided heart failure)
    - Arrhythmia
    - Ischemia
    - Valvular

TYPICAL SITUATIONS

- Pre-induction with sick patients
- At induction / intubation (PPV, PEEP) / neuraxial activation
- Following position change
- Failure to displace uterus in parturient
- Change in surgical conditions (abdo insufflation, etc.)
- Insufficient fluid replacement
- Intraoperative blood loss/surgical misadventure
- Release of arterial cross-clamps or tourniquets
- Medication error

HISTORY AND PHYSICAL

- Check for tachycardia, orthostatic hypotension
- Pre-op hematocrit
- Skin turgor (mucous membranes, cap refill in peds)
- CVP if available
- Manifest as:
    - Fall in BP
    - Mental status changes
    - Nausea/vomiting in conscious patients
    - Arrhythmias
    - Weak thready/pulses
    - Inability to get adequate SpO_2/NIBP
    - Decreased $ETCO_2$, SpO_2
    - Decreased U/O
    - Decreased heart sounds

MANAGEMENT

Pre-op

- Ensure adequate volume expansion
- Correlate art line with NIBP early
- Be judicious with LA dosing for neuraxial
- Plan to administer drugs slowly if known hypotensive effect

Intraop

- Monitor surgical activities (e.g. undo x-clamp, tourniquet release) and monitor blood loss
- Ensure adequate oxygenation/ventilation
    - Switch to 100% FiO_2 if severe hypotension
- Verify true hypotension
    - Palpate pulses
    - Do NIBP measurement
- Examine patient (rule out bronchospasm, pneumothorax, etc.)
- Turn off vasodilators
- Expand blood volume
    - Crystalloid, colloid, blood
    - Change patient position
    - Ensure large-bore IV if ongoing replacement
- Treat with pressors/tropes (ephedrine, phenylephrine, epi, vasopressin, norepi)
- Correct underlying cause
    - ABG for acidosis, electrolyte abnormalities, anemia, etc.; ECG for arrhythmia or ischemia; consider TEE

Postop

Differential Diagnosis of Hypotension in the PACU (Table 85-9)

- Intravascular volume depletion
    - Persistent fluid losses
    - Ongoing third spacing of fluid
    - Bowel preparation
    - Gastrointestinal losses
    - Surgical bleeding
- Increased capillary permeability
    - Sepsis
    - Burns
    - Transfusion-related acute lung injury
- Decreased cardiac output
    - Myocardial ischemia/infarction
    - Cardiomyopathy
    - Valvular disease
    - Pericardial disease
    - Cardiac tamponade
    - Cardiac dysrhythmias
    - Pulmonary embolus
    - Tension pneumothorax

    - Drug induced (β-blockers, calcium channel blockers)
- Decreased vascular tone
    - Sepsis
    - Allergic reactions (anaphylactic, anaphylactoid)
    - Neurogenic shock (cord injury, iatrogenic high spinal)
    - Adrenal insufficiency

COMPLICATIONS

- CHF/pulm edema from excessive fluid resuscitation
- Hypertension from treatment of artifact
- MI
- Cerebral ischemia
- Renal insufficiency

NOTES

Significant multivariate predictors of hypotension 0-10 min after anesthetic induction include:

1. ASA III-V
2. baseline MAP <70 mm Hg
3. age > or =50 yr
4. the use of propofol for induction of anesthesia
5. increasing induction dosage of fentanyl

Reich DL et al. Predictors of hypotension after induction of general anesthesia. A&A 2005

-Afterload = wall stress during LV ejection (wall stress = tension applied a cross-sectional area; therefore, units are force per unit area)

- Laplace law
    - $\text{Wall stress} = (\text{pressure} \times \text{radius})/(2 \times \text{wall thickness})$

-Measurements of afterload are: wall stress (Law of Laplace), impedance, effective arterial elastance, systolic intraventricular pressure, systemic vascular resistance, pulmonary vascular resistance

-Artifacts: motion with NIBP, wrong NIBP cuff size, faulty ABP transducer, transducer height too high

REFERENCES

- *Crisis Management in Anesthesiology*, Ventilatory Crises During Anaesthesia, Curr. Anaesthesia & Critical Care (2003)
- Miller 7th, Kaplan 5th