Invasive Monitoring

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Learning Outcomes

• Gain an understanding of need to invasively monitor critically ill patients
• Explore basic waveform analysis
• Discuss potential complications of invasive monitoring
• Refresh knowledge of nursing care of patients with invasive lines
How Invasive Monitoring Works

- Cannula/line
- Non-compliant manometer tubing
- Transducer (turns a pressure into an electrical signal)
- Pressurised flush bag & flush solution
- Monitor
The Phlebostatic Axis

- Right side 4th intercostal space, mid axillar
- This is roughly level with the R atrium
- The transducer should be level
- Monitoring ‘zeroed’ once per shift minimum
Arterial Lines

Insertion sites:
• Radial
• Brachial
• Femoral
• Dorsalis Pedis
Why Invasive Monitoring?

• Arterial Lines
  – Allow continuous monitoring of blood pressure, good for assessment and titration of vasoactive drugs (inotropes, vasopressors etc)
  – Useful to have continuous monitoring on unstable patients
  – Unable to obtain NIBP due to severe burns, polytrauma etc
  – Multiple ABG samples required (NIV, invasive ventilation)
  – Arguably gives greater accuracy
Allen’s Test

• The importance of performing Allen’s test prior to insertion

https://youtu.be/D1tJO0RW9UM
Arterial Blood Pressure

- The pressure exerted on the arterial wall
- \( BP = (SV \times HR) \times SVR \)
- \( SV \times HR = CO \) (litres/min)
- MAP more accurate for gauging perfusion
- \( MAP = CO \times SVR \) or \( MAP = P_{dias} + \frac{1}{3}(P_{sys} - P_{dias}) \)
Arterial Waveform

- Anacrotic limb (or Systolic upstroke)
- Anacrotic notch (or Systolic Peak Pressure)
- Dicrotic notch
- Dicrotic limb (or Diastolic Runoff)
Abnormal Waveforms

Overdamped/Blunted waveform:

- Air bubbles
- Positioning/kinking/clots in line
- Pressure bag not at pressure
- Aortic stenosis
- Vasodilation
- Cardiogenic shock
- Hypovolaemia

- Underestimates SBP, overestimates DBP
Abnormal Waveforms

Underdamped/Spiking

- Artherosclerosis
- Vasoconstriction
- Aortic Regurgitation
- Arrhythmia

- Overestimates SBP, underestimates DBP
Complications

- Infection
- Occlusion
- Disconnection
- Air embolus
- User error
  - Wrong fluid put up in monitoring lines
  - Injecting drugs into arterial line
  - System not at right pressure
- Not an exhaustive list
Central Venous Catheters

Insertion Points:
- Internal Jugular
- Subclavian
- Femoral
- PICC lines in the arm
Why Invasive Monitoring?

• Central Lines:
  – Multiple infusions via one lumen (does NOT give faster flow due to Hagen-Poiseuille equation – flow of fluid is inversely proportional to length of cannula)
  – Measuring CVP (Can give a guide on efficacy of fluid resuscitation, circulating blood volume, monitoring circulatory failure)
  – Useful for multiple blood samples
Central Venous Pressure

Central Venous Pressure (CVP) is the blood pressure in the vena cava near the right atrium.

Factors that increase CVP include:

- Cardiac tamponade
- Decreased cardiac output
- Forced exhalation
- Heart failure
- Hypervolemia

- Pulmonary hypertension
- Tension pneumothorax
- Mechanical ventilation and the application of positive end-expiratory pressure (PEEP)
Central Venous Pressure

Factors that decrease CVP include:

- Deep inhalation
- Distributive shock
- Hypovolemia
The CVP Waveform

• ‘A’ wave due to Atrial Contraction
• ‘C’ wave due to Tricuspid Closure and ventricular Contraction
• ‘V’ wave due Venous filling of the atrium
Complications

- Malposition of catheter
- Haematoma
- Arterial puncture
- Pneumothorax
- Haemorrhage
- Air embolus
- Infection/Sepsis

- Catheter embolism
- Thrombosis
- Haemothorax
- Cardiac tamponade
- Cardiac arrhythmias (especially during insertion)
- Occlusion
- User errors
Nursing Care Considerations for Invasive Monitoring Lines

- Ensure the insertion site is visible at all times (not possible with femoral lines, but frequent checks required)
- All connections secured
- Ensure the cannula is covered with appropriate occlusive dressing
- Ensure arterial and central lines are labelled as such next to 3 way tap (in addition to being clearly colour coded)
- Never inject anything into arterial cannula or line.
- Monitor colour & temperature of limb distal to arterial line
- Maintain the transducer level with the patient's phlebostatic axis/Right atrium
Nursing Care Considerations for Invasive Monitoring Lines

- Ensure flush bag has adequate fluid
- Observe for and remove air bubbles
- Monitor and display the waveform at all times
- Re-zero transducer once per shift and after movement from the axis.
- Explain to patient and relatives what the purpose of this equipment
- Change transducer set every 96 hours or if new line inserted (follow local guidelines)
Questions?