Guideline Title: PiCCO

Summary:
This guideline outlines the use of Pulse Contour Cardiac Output (PiCCO) in patients who require advanced volumetric and haemodynamic monitoring.

Approved by: ICU Director
Publication (Issue) Date: December 2015
Next Review Date: December 2018
Replaces Existing Guideline: PiCCO Plus Machine Pulsion Medical Systems 2004

Contents:
1. Background
2. Policy statement
3. Principles/guidelines
4. Performance measures
5. References

1. Background Information:
- PiCCO is intended for monitoring of haemodynamic variables to aid cardiovascular management and support in critically ill patients with circulatory compromise.\(^6\)
- The PiCCO system continually estimates the stroke volume from the arterial waveform, using the arterial catheter\(^6\), following an initial calibration process using thermodilution.
- The initial transpulmonary thermodilution calibrates the parameters & the algorithm is then capable of computing each single stroke volume.
- Provides continuous beat by beat parameters which are obtained from the shape of the arterial pressure wave.
- The area under the arterial curve during systole, minus the background diastolic area, is assumed to be proportional to the stroke volume. Cardiac output is then derived from the stroke volume and heart rate.
- PiCCO measures volume status by calculating Intrathoracic Blood Volume (ITBV) and extravascular lung water (EVLW) through transpulmonary thermodilution.\(^6\)
- An added advantage of PiCCO is the ability to measure EVLW and alert clinicians to early development of pulmonary oedema.\(^6\)
- Clinical data obtained from PiCCO is used to guide clinical management of the patient through volume loading, volume reduction and use of inotropes/vasopressors.\(^6\)

The risk addressed by this policy:

Patient Safety

LH_ICU2015_Guidelines_Systems/Cardiovascular_PiCCO
The Aims / Expected Outcome of this policy:

Clinical Staff will have the knowledge and skills to be able to manage patients with haemodynamic and volumetric instability by interpreting the calculations obtained from PiCCO.

Related Policies

LH_PD2014_C03.16 Central Venous Access Devices (CVAD): Care and Management
- ICU Guideline_Clinical Guidelines_Arterial_Monitoring_and_Management

2. Policy Statement:

- All care provided within Liverpool Hospital will be in accordance with infection prevention/control, manual handling and minimisation and management of aggression guidelines.
- Care for a patient with PiCCO should only be undertaken by staff accredited by CNE via the PiCCO competency assessment.
- Nurses caring for a patient with a PiCCO in situ will be accredited for this care.
- Staff will be familiar with the setting up of the catheter and transducer set, and measure successfully relevant haemodynamic parameters through thermodilution in accordance with the patient’s needs.
- Clean, non-touch technique must be employed during all thermodilution procedures.
- Accurate documentation is necessary for trend analysis and acute changes.
- Calibration of the machine will be performed every 8 hours, or as clinically indicated (e.g. significant changes in blood pressure or cardiac output).

3. Principles / Guidelines

Equipment:
- Philips pressure module or port on MMS
- Philips Orange CCO module
- Philips Orange end CCO cable
- PiCCO arterial line
- White Phillips pressure cable
- PiCCO transducer monitoring kit including in-line sensor
- Pressure bag & 500ml 0.9% sodium chloride
- Phillips blue end thermistor cable
- Central Venous Access Device
- CVP line with transducer set
- 20ml syringe x 3
- Cold 0.9% sodium chloride <8°C
- Two 3 way taps

Set up:
- Ensure that arterial pressure port for PiCCO is labelled ABP not ART
- Zero and level ABP & CVP to phlebostatic axis
- Press Change Screen - PiCCO Screen
- Access Admit/Discharge Window
- Admit the patient
- Enter the patient’s Height and Weight
- Enter patients Gender Press Confirm
- Press Cardiac Output Module hard key or Main Setup and select Measurement and CO Method
- This will be automatically detected. Ensure CO is turned on.
- Adjust temp alarms as required
• Select Alarms ON or as per policy
• Press CCO
• Choose where alarms from either CCO or CCI
• Adjust alarm limits
• CCO from ABP
• Ensure CCO is on
• Select cardiac output

Procedure:
• Press CathCt & change number as required- CathCt is detected automatically or found on red hub or catheter package
• Press Inj Vol and change volume to 15 or 20mls
• Must be cold 0.9% sodium chloride
• Wait for screen to say ‘Ready for new measurement’
• Press Start C.O for each injection
• Wait for screen to say: ‘Stable baseline Inject Now’
• Perform 2-3 thermodilution measurements. These measurements should only be selected if they are within ± 15%, if not, keep going until you get triplicate measurements in that range. Ideally you want ±10% but this might take a few more measurements. The more precise calibration, the better the guidance provided by the monitor.
• Select curves to be deleted (using the criteria above to decide which ones to keep and which to delete). The ones to be deleted will turn red. Measurement curves to be kept and used for calculations will be green.
• Press Save CO & CCO
• This will determine CCO continuously
• Press Hemo Calc
• Ensure CVP is correct. There should be no other infusions running through the lumen at the time of obtaining the CVP measurement. Ensure the transducer is positioned at the phlebostatic axis and has been re-zeroed prior to obtaining reading.
• Press Perform Calc
• Print results

Clinical Issues:
• Clinical interventions using PiCCO should be guided by ICU medical team and the decision tree tool in context to the patients’ global clinical assessment.  

• The PiCCO decision tree tool can be used to guide clinical decisions.

• Preferred access for CVC is internal jugular or subclavian veins
  ▪ Venous injection port should be placed in the central cardiopulmonary circulation, within or directly proximal to the right atrium.
  ▪ Placement of CVP in the femoral vein will result in significant over-estimation on intrathoracic volumetric measurements however trans-cardiopulmonary thermodilution measurements of CO may still be reliable.

• Preferred access for Arterial line
  • The femoral artery is the most common site of cannulation, however the brachial/axillary sites may also be considered. Always assess vessel calibre and flow with ultrasound Doppler first and seek senior input if any concerns.

• Calibration of PiCCO by transpulmonary thermodilution
  ▪ The accuracy of the CCO relies on calibration by thermodilution
  ▪ Injection volume 15-20mls depending on patients IDEAL body weight
  ▪ Injection fluid of 0.9% sodium chloride must be cold.
  ▪ Optimal fluid temperature is below 8°C.
  ▪ A probe attached to the central venous catheter measures the initial temperature of the injectate, and the resulting change is measured in the proprietary arterial line
  ▪ There must be a difference in temperature of at least 0.125 for the thermodilution measurement to be recognized
  ▪ There must be three separate injections within 5-minutes period performed by the same person at the same speed. These measurements should only be selected if they are within ± 15%, if not, keep going until you get triplicate measurements in that range. Ideally you want ±10% but this might take a few more measurements. The more precise calibration, the better the guidance provided by the monitor.
  ▪ Calibration should be repeated every 8 hours or following a major change in the patients clinical condition such as giving volume or changing inotropes
  ▪ Extreme changes in heart rate, blood pressure or systemic vascular resistance will require recalibration to determine cause for change
The CCO monitoring relies on the accuracy of the arterial waveform. Therefore the Arterial trace needs to be:
- Calibrated, levelled to the phlebostatic axis, re-zeroed and checked each shift
- Continually monitored
- Check arterial line and transducer tubing for kinks

The CVP reading is also required for accurate CO monitoring therefore it should be:
- Re-zeroed and checked each shift
- Ensuring a correct CVP reading is critical before performing haemocalculation

For Patients on Continuous Renal Replacement Therapy (CRRT):
- Readings are accurate as long as the Vascath is not placed in the same site.
- If CVAD and vascath are in the internal jugular and subclavian veins the CRRT will need to be paused while doing the thermodilutions
- Warming of blood temp may lead to baseline drift or instability. Wait until stable blood temperature (read from the PICCO) has again been achieved before starting CCO if the PRISMA has been stopped/started

For patients on Intra-abdominal balloon pump (IABP):
- The use of intra-aortic balloon pump will not alter the thermodilution variable; however PICCO will not be able to read the continuous cardiac output due to IABP changing the shape of the arterial waveform.

**Indications:**
- Shock
- Cardiac Dysfunction
- Sepsis
- Acute Respiratory distress syndrome
- Patients who require hemodynamic and volumetric monitoring
- Parameters continuously estimated by transpulmonary thermodilution:
  - Pulse Contour Cardiac Output
  - Arterial Blood Pressure
  - Heart Rate
  - Stroke Volume
  - Stroke Volume Variation
  - Systemic Vascular Resistance
  - Index of Left Ventricular Contractility
- Parameters quantified by pulse contour analysis
  - Cardiac Output
  - Intrathoracic Blood Volume
  - Global End-diastolic Volume
  - Cardiac Function Index
  - Extravascular Lung Water

**Contraindications:**
- Patients with contraindications for femoral, axillary arterial cannulation e.g. patients with grafts or severe burns.
- PICCO may derive inaccurate thermodilution parameters in patients with
  - Intra-cardiac Shunts
  - Aortic Aneurysm
  - Aortic Stenosis
  - Pneumonectomy
  - Macro Lung Embolism
  - Extracorporeal Circulation
4. **Performance Measures**

All incidents are documented using the hospital electronic reporting system: IIMS and managed appropriately by the NUM and staff as directed.

5. **References / Links**

3. Pulsion Medical Systems 2008

**Author:** ICU CNE (P.Nekic), Reviewed by ICU CNE (Y.McManus)

**Reviewers:** ICU Staff Specialists, NM, NUM’s ICU – CNC, ICU-CNE’s, CNS’s,

**Endorsed by:** ICU Medical Director – Prof Michael Parr