Guideline Title  Cardiac Monitoring in ICU

Summary: All patients in the ICU will have cardiac monitoring in place unless they have been cleared for transfer to the ward and are stable. For patients with a pre-existing cardiac history, ECG monitoring is to continue until transfer into the ward bed. When patients are transferred to other areas for investigative purposes, ECG monitoring will continue.

Approved by: ICU Director Dr Michael Parr
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Replaces Existing Guideline: Cardiac Monitoring 2011

1. Background Information: ¹
Cardiac monitoring in ICU patients forms an essential part of hemodynamic assessment. It includes rhythm and ST segment monitoring off a single or double lead and 12-lead ECG monitoring when clinically indicated. Electrocardiography (ECG) is a pictorial representation of electrical conduction and myocardial excitation in the heart. As action potentials move through the heart they generate a positive current (depolarisation) that is immediately followed by a wave of negative current (repolarisation). It is these currents that the ECG detects and records. Placement of the leads can give you positive or negative deflections and shows different areas of the heart. “LEAD” in ECG refers to the tracing of the voltage difference between two of the electrodes and is actually what is produced by the ECG machine.

2. Introduction:
The risk addressed by this policy:
Patient Safety.

The Aims / Expected Outcome of this policy:
To provide information about cardiac monitoring so that RN’s can assess and manage patients who are at risk of cardiac and haemodynamic instability in the ICU.

Related Standards or Legislation
NSQHS Standard 1 Governance
3. 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.
- All electrodes must be of the same type to prevent artefact. Electrodes are replaced daily, unless otherwise specified by the product information, and the skin inspected for any reaction. If a reaction has occurred an electrode with a different tape will be used.
- The patient’s monitoring electrodes are checked and replaced if the ECG trace is of poor quality or there is artefact.
- Alarm limits are set for the individual patient and checked each shift. The limits must be adjusted when there is a change in the patient's clinical status.
- Alarms should be **ON AT ALL TIMES**, if they are temporarily suspended, careful continuous assessment of the patient is necessary.
- When patients are paced the pacing alternative should be turned “**ON**” in the pacing screen.

4. Principles / Guidelines

**Equipment**

- Philips IntelliVue monitor model M8007A and the portable Philips IntelliVue monitor model M3002A.
- ECG cable and attachment for 5 lead and 12 lead ECG monitoring and appropriate electrodes.

**Procedure**

a) **Indications for cardiac monitoring**
All patients in ICU will require cardiac monitoring.

b) **Indications for 12-lead ECG**
- A 12 lead ECG is attended when a rhythm change is detected or there is a change in ST segments > 2mm.
- A 12 lead ECG is attended daily or more frequently when the patient is receiving a vasoactive infusion (inotropes), cardiac supporting drugs and/or patients who have cardiac instability.
- A 12 lead ECG is attended daily for all post cardiac surgery patients.
- A 12 lead ECG is taken on admission of all patients to the ICU via the Philips monitor and printed. Alternatively a portable ECG machine can be utilised.

c) Patient Preparation
- Select sites away from large muscle groups
- Choose areas that are flat with intact skin
- Clip hair from sites as necessary, with appropriate patient education/information.
- Wash sites thoroughly with soap and water, rinse well, dry well.

d) Lead Placement for standard 5-lead rhythm strip analysis

**ECG - Standard 5-Lead Placement:**

- **RA placement**: directly below the clavicle and near the right shoulder
- **LA placement**: directly below the clavicle and near the left shoulder
- **RL placement**: on the right lower abdomen
- **LL placement**: on the left lower abdomen
- **V placement**: on the chest, the position depends on your required lead selection

**Electrodes:**
- Replace daily, after skin inspection and more frequently, as required; unless specifically stated otherwise by the company product information.
- Electrode choice may include use of hypoallergenic tape, diaphoresis products etc.
- All electrodes should be of the same type to prevent artefact.
- The patient’s monitoring electrodes are checked and replaced if the ECG trace is of poor quality or there is artefact.

e) Connecting the leads to patient and ECG cable to monitor
- Attach the clips or snaps to the electrodes before placing them.
- Place the electrodes on the patient according to the lead placement chosen.
- Attach the electrode cable to the patient cable.
- Plug the patient cable into the white ECG connector.
- An ECG waveform and numeric value appears on the monitor display.

f) Monitor set up
Choose the most appropriate monitor profile after ensuring the patient has been admitted to the monitor. Available profiles include:
- Advanced PA/PiCCO
- Sepsis PA/PiCCO
Ventilator
Neurosurg / Trauma
Cardiothoracic
Cardiac Basic
Cardiac Advanced
Rehabilitation

Set Alarm limits:
- Ensure they are set appropriately - preset safety limits are already set in each profile but may need to be individualised to each patient.
- Alarms should be ON AT ALL TIMES, if they are temporarily suspended, careful continuous assessment of the patient is necessary.

Paced mode:
- To set “Paced Mode”, go to the Setup ECG menu, select Paced and toggle between Yes and No.
- Alternately you can select little heart to paced or non paced at top of monitor profile.

PHILIPS INTELLIVUE MANUAL

ST Segment monitoring
Routine ECG monitoring can be used to detect ST changes which may be ischaemic episodes. When monitoring indicates ST changes and potential ischaemic activity, a diagnostic 12-lead ECG is commonly performed to confirm and record the episode.
- Measured from the end of the QRS complex to the onset of the ST
- Normally isoelectric
- Is the region between the end of the S-wave, also called the J-point, and the beginning of the T-wave.
- Normal duration is 0.24 - 0.32
- ST segment depression occurs with myocardial ischaemia and elevation with acute myocardial infarction.

Choose the 2 ECG waveforms that show the greatest ST segment deviation

Indications of ST Segment Monitoring
- Early detection of ST elevation may indicate myocardial infarction.
- Assessment and monitoring of ischemia post myocardial infarction
- Patients with known or suspected coronary artery disease.
- To assess reperfusion after thrombolytic therapy.
- Assess for re-occlusion post-angioplasty.
Assess and monitor for intra- and post-operative ischemia for cardiac and high risk surgical procedures.

To start ST Segment Monitoring:

1. Turn on the ST Analysis
   - Press on HR numeric on monitor
   - Screen “set up ST analysis” appears
   - Press ST analysis “on”

2. Select the leads for monitoring.
   - The total number of ST measurements available depends on the ECG lead-set used for monitoring.
   - Using a 5-Lead cable with electrodes placed in Standard lead placement, will allow up to seven ECG leads for ST analysis.
   - Using a 5-Lead cable with electrodes placed in EASI lead placement, will allow 12 derived ECG leads for ST analysis.
   - Using a 6-Lead cable with electrodes placed in Standard lead placement, will allow up to eight ECG leads for ST analysis.
   - Using a 10-Lead cable with electrodes will allow 12-ECG leads for ST analysis.
   - You can select which leads to monitor ST changes by using the Setup ST Leads menu.

   This opens the Setup ST Leads pop-up window. Leads chosen for ST monitoring are listed here.
Select the Add key at the bottom of the Setup ST Leads window.
This opens the Choices pop-up window.
If all leads selected the Add key will be greyed out.
To delete a lead select, select the lead and then select delete.

3. Adjust the measurement points.
   - ST point can be positioned either relative to the J point or by directly selecting the position for the ST point
   - Enter the Setup ST Analysis menu.
   - Select Adjust ST Points. This opens the Adjust ST Points window with pop-up keys.
   - Select a suitable ECG lead for ST measurement, with a visible J-point and a visible P wave.
   - Use the up and down arrow keys to scroll through the ST snippets for the other ECG leads.
   - Use the Select Point pop-up key to scroll through the points and activate the point you need to adjust.
   - Use the left and right arrow keys to move the measurement point.
   - Each point is highlighted while active.

4. Adjust alarms.
   **ST Alarm Mode**
   - The ST monitoring measurement supports the detection of ST alarm conditions for each lead separately.
When Single Lead alarm mode is selected, only one ST lead value must exceed the alarm limit for four consecutive 15-second time periods (1 minute) before an alarm is declared.

When multi-lead ST alarm is selected, two or more ST leads must exceed a defined set of lead limits for four consecutive 15-second time periods (1 minute) before an alarm is declared.

To switch between Single-lead and Multi-lead ST alarming

- In the Setup ST Analysis menu, select ST Alarm mode.
- Select either Single ST or Multi ST from the popup menu.

Changing the ST Alarm Limits

- High and low ST alarm limits can be set individually for each ECG lead.
- Alarms limits can also be set separately for single-lead and multi-lead ST monitoring.
- Limits are set at +1.0 mm or -1.0 mm from the patients’ ST
- In the Setup ST Analysis menu, select lead alarm to be adjusted.
- Select the appropriate setting.

**h) 12-Lead ECG**

On admission to the Unit, record a 12 lead ECG and again when there is a rhythm change detected or there is a change in ST segments > 2mm.

- Placement of the leads for performing a 12-lead ECG can give you positive or negative deflections and shows different areas of the heart
- ‘LEAD’ in ECG refers to the tracing of the voltage difference between two of the electrodes and is actually what is produced by the ECG machine
- **Unipolar vs. bipolar leads:** There are two types of leads: unipolar and bipolar.
  - Bipolar leads have one positive and one negative pole. In a 12-lead ECG, the limb leads (I, II and III) are bipolar leads.
  - Unipolar leads also have two poles, as a voltage is measured; however, the negative pole is a composite pole made up of signals from lots of other electrodes. In a 12-lead ECG, all leads besides the limb leads are unipolar (aVR, aVL, aVF, V_1, V_2, V_3, V_4, V_5, and V_6).

**Types of Leads**

- Standard limb leads
- Augmented leads
- Precordial leads
**Standard leads**
Form the points as what is known as Einthoven’s triangle

**Lead I:**
- The positive lead is above the left breast or on the left arm
- The negative lead is on the right arm.
- Records the difference of potential between the Left arm and Right arm.

**Lead II:**
- The positive lead is on the left abdomen or left leg
- Negative lead is also on the right arm.
- Records the difference of potential between the left leg and the right arm

**Lead III:**
- The positive lead is also on the left abdomen or left leg
- The negative lead is on the left arm.
- Records the difference of potential between the left leg and the right arm

**Augmented leads**
- **aVR:** unipolar lead positive (exploring) terminal is the right arm
  - This lead looks at the heart from the right upper surface of the heart.
  - Nearly always negative, as it looks down onto the heart, thus the P wave, QRS and T waves are normally negative.
- **aVL:** the positive (exploring) terminal is on the left arm
  - looks at the left lateral aspect of the heart
  - looks at the lateral wall from an angle of approx 30° whereas lead I, looks at the lateral wall on a horizontal plane
- **aVF:** the positive (exploring) terminal is the left leg lead
  - Looks at the inferior aspect of the heart

**Augmented limb leads (aVR, aVL, aVF)**
**Precordial Leads**
- Exploring lead is the chest lead that is normally placed on one of six positions on the chest wall.
- Records potential in the horizontal plane.
- Each lead is positive.
- The major forces of depolarisation move from right to left.
- V1 and V2 are negative deflections.
- V3, V4, V5 and V6 become more positive (peak positive is V3 or V4).
- V1 - fourth intercostal, right sternal border.
- V2 - fourth intercostal, left sternal border.
- V3 - equal distance between V2 and V4.
- V4 - fifth intercostal left mid clavicular line.
- V5 - anterior axillary line, same level with V4.
- V6 - mid axillary line, same level with V4 and V5.

**Conventional 12 Lead Placements**

**Limb Electrodes**
- Place arm electrodes on the inside of each arm, between the wrist and the elbow.
- Place leg electrodes inside of each calf, between the knee and the ankle.

**Chest Electrodes**

Positioning:
- V1 at the 4th intercostal space, right sternal border
- V2 at the 4th intercostal space, left sternal border
- V3 midway between V2 and V4 electrode positions
- V4 at the 5th intercostal space, left midclavicular line
- V5 on the left anterior axillary line, horizontal with the V4 electrode position
- V6 on the left midaxillary line, horizontal with the V4 electrode position
12 Lead ECG Modified Lead Placement (Mason-Likar)
In the modified (Mason-Likar) electrode configuration, limb electrodes are placed on the torso according to the standard continuous ECG monitoring.
- Arm electrodes are placed below the clavicle near the shoulders.
- Leg electrodes are placed on the lower abdomen.
- Chest (precordial) electrodes are placed in the same positions as conventional 12-lead placement.

Advantages of Modified Electrode Placement
There is reduced susceptibility to movement artefact (as limb electrodes are on the torso). And increased patient comfort as leg-limb placement is not required.

EASI electrode placement
- Using a standard 5-electrode set in EASI lead placement you can monitor up to 12 standard ECG leads simultaneously and continuously at the bedside.
- EASI provides a monitoring method for trending ST-segment changes that can provide an early indication of ischemia.
- EASI-derived 12-lead ECGs and their measurements are approximations to conventional 12-lead ECGs. As the 12-lead ECG derived with EASI is not exactly identical to the 12-lead conventional ECG obtained from an electrocardiograph, it should not be used for diagnostic interpretations.

You must enable either standard lead placement or EASI lead placement. In the Setup ECG menu, select Lead Placement and then Standard or EASI.
Capturing 12 Lead ECG via the Philips IntelliVue monitor
- Press on HR and select 12 lead ECG
- Press capture ECG and Print
- ECG will print out at main Philips monitor at nurse’s station

To print an ECG from the Philips monitor at nurse’s station
- Go to the main Phillips monitor
- Select the Patient Window
- Select the 12 Lead Review key
- Select the ECG you wish to print
- Select the Print key

The results of the 12-lead ECG should be reviewed with the ICU medical officer.

Surfaces of heart

**Inferior**
Inferior leads II, III and aVF look at the heart from the perspective of the inferior surface (bottom)

**Lateral**
Lateral Leads I, aVL, V₅ and V₆ look at the heart from the perspective of the lateral wall of the ventricle.
V₅ is closer to the left posterolateral wall.
V₆ is actually closer to the left high lateral wall

**Septal**
Septal leads V₁ and V₂ look at the ventricular septal wall

**Anterior**
Anterior leads V₃ and V₄ look at the anterior surface (front).
Definitions

- **ECG**: Electrocardiography is a pictorial representation of electrical conduction and myocardial excitation in the heart
- **ST segment**: is the region between the end of the S-wave, also called the J-point, and the beginning of the T-wave

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

6. References / Links
1. ECG interpretation learn books. 2012. Manny Mortel
14. Critical Care Nurse. Clinical Usefulness of the EASI 12-Lead Continuous Monitoring system. Mary Jahrsdoerfer, Karen Giuliano and Dean Stephens

Author: P.Nekic ICU CNE
Reviewers: ICU CNC, CNE’s, NUM’s, CNS’s & Staff Specialists, Cardiothoracic Surgeons

Endorsed by: ICU Medical Director – Dr. Michael Parr