Standards for continuous cardiac monitoring in-hospital (telemetry)

1.Introduction

This document has been produced by arrhythmia specialists and approved by the British Heart Rhythm Society [BHRS]. The driver to produce this guidance came from the national patient safety team at NHS England and Improvement, as a result of patient safety incidents reported to the National Reporting and Learning System (NRLS) that were identified, reviewed and escalated to BHRS.

The goal of continuous cardiac monitoring with electrocardiogram (ECG), is to aid in immediate recognition of cardiac arrest to improve time to defibrillation, recognise deteriorating conditions such as non-sustained arrhythmias that may lead to life-threatening arrhythmia, diagnose and facilitate management of arrhythmias or aid in identifying the cause of symptoms.

Since the introduction of continuous cardiac monitoring in hospitals, the use has been applied to critically ill and non-critically ill patients. Some hospitals have a limited capacity for monitoring, dictated by bed or technology availability. The American College of Cardiology and the American Heart Association guide inpatient use of continuous cardiac monitoring and make recommendations based on the likelihood of patient benefit. These are primarily based on expert opinion as rigorous clinical trial data is unavailable (1-4).

Because of the high sensitivity but low specificity with continuous cardiac monitoring, use in low-risk patients without indications increases the risk of misinterpreting false-positive findings as clinically significant. This can lead to errors in management including over-testing (1). Despite advances in the technology of continuous cardiac monitoring e.g. enhanced computerised arrhythmia detection algorithms, noise reduction, multi-lead monitoring and ST-segment monitoring software, the need for human oversight in the interpretation of ECG monitoring data remains important. Indications for monitoring have evolved in light of developments in electrophysiological interventions. Complex device technology requires health professionals with the expertise, to analyse ECG monitoring data relating to for example, device malfunction. Furthermore, patients are at risk from prescribed and self-administered medicines (and toxins) which prolong ventricular repolarisation so QT monitoring can be indicated.

There is evidence to suggest that if guideline-based continuous cardiac monitoring is adhered to, the overuse of this technology is minimised (5-7). Decreasing inappropriate initiation and facilitation of discontinuation of cardiac monitoring, are proven to increase compliance with guidelines and limit overuse (8).

1.1 Human factors

Unnecessary monitoring can prolong hospital admission, and reduce hospital capacity, as well as inconvenience the patient. Furthermore, there is a risk of "alarm fatigue" where alarms are a constant source of noise leading to real emergencies being overlooked. Human factors significantly contribute to the diagnostic outcome. Between 72 to 99% of telemetry findings would not influence management (3). Alarm fatigue due to desensitisation to alarms by clinical staff may further reduce sensitivity with potentially dangerous consequences. False alarms due to artefacts may be reduced by attention to skin preparation, electrode placement (over bones) or defined protocols for alarm adjustment. This is particularly pertinent to non-ICU setting with a higher proportion of low risk patients and lower patient to nurse ratios. It is recommended that ECG electrodes are applied to bony areas to reduce artefact (e.g. brushing teeth). Avoidance of the left upper chest is advisable, as electrodes may leave adhesive on the skin which is best avoided as patients may later be found to require a pacemaker.

2. Definitions

Cardiac monitoring describes the continuous monitoring of an ECG which is then displayed by the patient bed side, usually with a duplicate display at a central nurses' station. Telemetry describes cardiac monitoring using a wireless transmitter that allows display of the patient's ECG at a central nurses' station but may not display it at the patient's bed side. Telemetry allows more freedom of patient movement and is used more frequently in step-down areas. Telemetry is therefore used in areas where the nurse - patient ratios are lower, and the patient may not be visible to staff (in bathroom) and so appropriate supervision and oversight of telemetry systems may be more important than conventional cardiac monitoring. For the purposes of this document, cardiac monitoring refers to all types of ECG monitoring including telemetry. Telemetry refers solely to systems that provide wireless transmission of the ECG to a monitor/monitoring station .

3. Requirements for cardiac monitoring (telemetry)

Based on expert guidelines (1-4), patients with primary cardiac diagnoses including acute coronary syndrome, post-cardiac surgery and arrhythmia, are the most likely to benefit from cardiac monitoring (2, 5). In practice, continuous cardiac monitoring has been used to detect signs of haemodynamic instability but there are no data to support this as a safe or equivalent to close clinical evaluation and frequent vital sign measurement.

3.1 Prescription for inpatient continuous cardiac monitoring

It is recommended that monitoring is prescribed rather than automatic, with a duration of monitoring indicated on the prescription. These are suggestions for patients who benefit from monitoring. Monitoring should be stopped as soon as the treating physician is satisfied with the clinical stability of the patient, arrhythmia control or upon reaching a therapeutic endpoint, such as following successful implantation of a pacemaker.

Ischaemic Heart disease	STEMI – post procedure for 12-24h after reperfusion. 24-48hrs if continuing ischaemic, haemodynamic or electrical instability	Up to 48 hours after stable
	NSTEMI – high risk 24-48hrs	UUCT
	Unstable angina + 1. Dynamic ECG changes 2. On-going CP –within 24h revascularisation	UUCT
	Any ACS with haemodynamic compromise	UUCT
	Patients resuscitated following cardiac arrest or unstable VT associated with ischaemia/MI	Up to 48 hours after stable

Structural heart disease	Severe AS with syncope	Until treated unless ongoing conduction disease suspected
	Patients resuscitated following cardiac arrest or unstable VT	Until ICD
	Mitral valve prolapse with syncope	Until diagnosis made or diagnostic plan in place
	Congenital heart disease patients with persistent arrhythmias or episodic symptoms	Until stable
	Type A Aortic dissection	UUCT
	Open heart surgery	For 48 hours after stable
	TAVI with abnormal peri-procedural conduction	Until stable or treated (e.g. pacemaker)
	Post transcatheter closure of VSD,	

Arrhythmia	Broad complex tachycardia > 7beats until specialist advice	
	Recurrent ICD therapy	Until stable
	WPW with AF and rapid ventricular response	UUCT
	Symptomatic brady arrhythmia	UUCT
	Post structural VT ablation	Until ICD
	Persistent Narrow complex tachycardia above 130bpm	UUCT
	Targeted temperature management	

Other	Electrolyte K+ disturbance (< 3 or >6)	Until stable
	Risk factors for TdP: sudden bradycardia, hypokalaemia or hypomagnesaemia, drug induced prolongation of QTc >500ms, congenital LQTS	Unstable stable
	Brugada syndrome and uncontrolled pyrexia	Until stable
	Inherited arrhythmia syndromes (LQTS, Brugada, CPVT,	Until stable

	ARVC) with syncope	
	Poisoning with arrhythmic potential	Up to 48 hrs
	Stroke if cryptogenic stroke or AF is suspected	Up to 72 hrs or until diagnostic plan in place
	Syncope if a cardiac cause is suspected	Up to 72 hrs or until diagnostic plan in place

Monitoring not indicated in the following:

1. Patients fitted with a functioning device such as loop recorder, ICD, PPM, CRT-P/D. Exception is patients being treated for VT storm.
2. Pulmonary emboli patients – the risk of ventricular arrhythmia is low, cardiac arrest can occur due to pulseless electrical activity so appropriate patients will require haemodynamic monitoring in an appropriate environment rather than continuous cardiac monitoring
3. Patient with treatment escalation plan [TEP] where a do not resuscitate [DNAR] is in place because of significant co-morbidity or frailty
4. Orthostatic hypotension, POTS, Epilepsy, TIA, uncomplicated Faint/vasovagal syncope, ENT related dizziness.
5. When non-cardiac patients are stable enough to be transferred from an ICU / critical care environment.
6. Mild to moderate alcohol withdrawal.
7. Syncope if the precipitating cause of loss of consciousness is unknown but presumed benign (e.g. neurocardiogenic).

Congenital heart disease

▪ In the congenital heart disease population, normally benign arrhythmia can lead to haemodynamic collapse and symptoms may be nonspecific but highly intrusive (9).

▪ Increasing the number of monitored leads from 3 to 6, or even 12 leads continuous cardiac monitoring is valuable in the diagnosis of episodic arrhythmias in structural heart disease including congenital heart disease, particularly when there are pre-existing underlying ECG abnormalities (e.g. bundle branch block). In congenital heart disease patients it can be challenging to distinguish sinus rhythm from paroxysmal atrial arrhythmias due to low amplitude waveforms and propensity to right atrial substrate. Multi-electrode telemetry can be useful to determine the optimal management plan.

▪ Congenital heart disease patients with single ventricle physiology or systemic right ventricle often remain very symptomatic in persistent atrial tachycardia despite satisfactory ventricular rate control. Hence continuing monitoring with multiple electrodes can help to determine the target ventricular rate or need to restore sinus rhythm (9).

▪ The quality of telemetry is important for all patients, particularly complex congenital patients. The ability to record or print out ECG tracings from telemetry with multiple leads in transferring centres

could be invaluable to eventual arrhythmia diagnosis and management planning in specialist centres.

Other special scenarios.

▪ Following ablation of ventricular tachycardias (VTs) in patients with structural heart disease, telemetry helps to confirm the success of the procedure and guide the use of antiarrhythmic drugs. VTs in this setting can be slower than implantable cardioverter defibrillator (ICD) detection zones or nominal telemetry alarm thresholds. An examination of recent heart rate trends and QRS morphologies on telemetry can be valuable for diagnosis of recurrent VT.

▪ For drug induced prolongation of QTc ≥500 ms, the responsible medication should be discontinued, and cardiac monitoring maintained with repeated 12-lead ECGs every few hours until QTc normalises (10).

▪ Cardiac monitoring may be stopped as the treating physician is satisfied with the clinical stability of the patient, arrhythmia control or upon reaching a therapeutic endpoint, such as following successful restoration of normal rhythm by cardioversion or catheter ablation.

3. Recording and documentation

A 12 lead ECG should be available prior to connecting continuous cardiac monitoring (or obtained as soon as is practical), for reference. Telemetry systems allow more patient mobility but fatalities have resulted from staff missing cardiac events because of flat batteries in telemetry transmitters, so a system should be in place to ensure that monitoring telemetry system batteries are regularly checked and sufficiently charged. Battery life should be checked at each shift handover of telemetry monitoring (e.g. 12 hourly if this is the shift pattern adopted). Batteries should be renewed before battery life has depleted. Telemetry transmitters with short battery lives should be marked and taken out of service immediately.

A cardiac monitoring system should have the following minimum requirements:

1) An alarm system with both audible and visual alerts with the capability to set normal ranges for the patient and a programmable default alarm settings to suit the environment the monitor is used in (e.g. the default settings on a paediatric CCU will be different from an adult ITU).
2) A display that is in the direct line of site of the nurses usual working location. This may be a remote station and/or by the patients bedside if 1:1 nursing care is the norm.
3) A memory system capable of storing at least 24 hours of alarm data for review later.
4) A system for either printing or uploading ECG data to an electronic health record.

Monitoring systems not capable of delivering any one of these essential requirements should be decommissioned. Monitors that cannot achieve these requirements may give the staff the false belief that they are adequately monitoring the patient and therefore such a system is potentially more dangerous than no system at all because it may lead to lower levels of direct supervision by staff.

Human surveillance is important with continuous cardiac monitoring, despite developments with computerised monitoring systems. Alarms should be acted on by a health professional with suitable knowledge of ECG rhythm interpretation, and in a timely fashion. Relevant parameters should be documented at baseline and then at regular intervals as with the other vital sign recordings. If events occur, these must also be documented and the responsible health professional informed. Where the ability exists to integrate ECGs into an electronic health record, this should be utilised. Where paper copies exist, these should be maintained in an appropriate manner whereby they are secure and scanned into the patient's records (where possible).

It is necessary for the allocated health professional to be able to observe the ECG monitoring with enough time and attention required. It is common that this role is also given in conjunction with a responsibility to care for patients. It is recommended that staffing and responsibility allocation is adequate to allow the concentration and action necessary for continuous cardiac monitored patients.

4.1 Duration of monitoring and discontinuation

Recommendations generally refer to time limited monitoring e.g. unexplained syncope, or to a therapeutic based recommendation e.g. pacemaker implantation for high-grade AV block (1). Duration is ultimately the responsibility of the health professional, but patients and the corresponding ECG monitoring data should be reviewed on a regular basis to inform this decision accurately. The durations suggested in this document offers guidance only and decisions regarding monitoring and duration should be considered for the individual patient. It is important to remember that withdrawing monitoring in a timely fashion is as important as instituting it. Excessive monitoring increases the workload of the clinical staff, and reduces the value of monitoring leading to missed critical events.

5. Audit

Evidence exists that demonstrates where services have utilised a recommendation proforma (e.g. prescription in this document), continuous cardiac monitoring has been utilised more appropriately in terms of patient selection and subsequent discontinuation (5-8).

It is recommended that sites offering continuous cardiac monitoring, audit their use relating to:

- Adherence of criteria for utilising a continuous cardiac monitoring system,
- The availability of a 12 lead ECG
- Frequency of review
- Checking telemetry system functioning and batteries
- Appropriate discontinuation of monitoring
- Alarm set up and appropriate management of alarms
- Workforce e.g. dedicated monitor watcher or nurse responsibility whilst caring for patient
- Any adverse events of serious incidents

6.Planned review date

This document will be reviewed in two years.

7.References

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