VHA Telemetry Guidebook 2020

Department of Veterans Affairs

FEBRUARY

Published by: Specialty Care Services and Office of Nursing Services

Table of Contents

TELEMETRY GUIDEBOOK

Executive Summary

Cardiac monitoring was initially limited to hardwired monitors in operating rooms, critical care units, and emergency rooms. With the advent of enhanced portable technology, the use of cardiac monitoring was expanded to medical surgical units and other clinical areas. For our purposes, cardiac telemetry monitoring, or *telemetry* is continuous electrocardiographic monitoring and other vital physiological parameters of hospitalized patients transmitting cardiac signals which show the heart's electrical activity (rhythm) as a waveform display. These waveforms are transmitted to a remote surveillance device located at a station, in a patient's room, or both.

Analysis of the current state of Veterans Health Administration (VHA) telemetry programs reveals significant variation in telemetry practice. Contributing factors for this variation include a scarcity of rigorous, high-level evidence; a wide range in patient acuity levels; a variety of physical and technologic configurations; and inconsistent expectations for personnel education, training, and competence. We recognize development of a guidebook targeting standardization of telemetry practice in these areas will help facilitate broad adoption of the best available evidence, and reduce gaps in care, to improve the quality and safety of telemetry monitoring for our nations Veterans.

This guidebook incorporates practice standards for patient telemetry monitoring from the American College of Cardiology (ACC) and the American Heart Association (AHA). It comprises cardiac telemetry practice updates as well as the results of aggregated patient safety experiences and findings. The purpose of this guidebook is to highlight evidence-based resources designed to assist health care facilities with implementation and enhancement cardiac monitoring programs.

Disclaimers

Endorsement

The views and opinions of authors herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. Government.

Hyperlinks

Appearance of external hyperlinks does not constitute endorsement by the Department of Veterans Affairs (VA) of the linked Websites or the information, products, or services contained therein. The Department does not exercise any editorial control over the information found at these locations. All links are provided with the intent of meeting the mission of the Department and the VA Website. Please contact Dr. Richard Schofield, National Program Director for Cardiology via email address:Richard.Schofield@va.gov for any feedback on the contents of this guidebook.

Liability

With respect to documents available from this server, neither the U.S. Government nor any of its employees makes any warranty, expressed or implied, including the warranties of merchantability and fitness for a particular purpose, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately-owned rights. Reference from this website does not constitute an endorsement or recommendation by VA or any of its employees. We are not responsible for the content of any *off-site* websites referenced from the Veterans Health Administration (VHA).

Guidance

This Telemetry guidebook is a compilation of *BEST PRACTICE* resources designed to assist health care facilities with implementation and enhancement of cardiac monitoring programs in compliance with current VA/VHA policy and external regulatory standards. In accordance with VHA Directive 6330, *Directives Management System*, official policy documents include: VHA Directives, which carry the authority to mandate Department or Administration-wide policies.

Acronyms and Definitions

Acronym	Definition
ASD	Atrial Septal Defect
B/P:	Blood Pressure
ECG or EKG:	Electrocardiogram
EHR:	Electronic Health Record
ER:	Emergency Room
FDA:	Food and Drug Administration
HFMEA:	Healthcare Failure Mode Effect and Analysis
HR:	Heart Rate
ICU:	Intensive Care Unit
IFU:	Instruction of Use
Li-ion:	Lithium Ion
NCPS:	National Center for Patient Safety
NTTF:	National Telemetry Task Force
NiCd:	Nickel Cadmium
NiMh:	Nickel Metal Hydride
ONS:	Office of Nursing Services
OR:	Operating Room
PCI:	Percutaneous Coronary Intervention
PVC:	Premature Ventricular Contraction
RR:	Respiratory Rate
SOP:	Standard Operating Procedure

TAVR:	Transcatheter Aortic Valve Replacement
TMP:	Telemetry Monitoring Personnel
VHA:	Veteran Health Administration
VSD:	Ventricular Septal Defect
WMTS:	Wireless Medical Telemetry Service

Chapter 1 Introduction and Historical Overview:

Introduction

Increased availability of wireless technology has brought cardiac monitoring from *hardwired* monitoring with limited use in healthcare settings, such as ORs, ERs or ICUs, to enhanced portable monitoring technology and expansion on inpatient medical-surgical units and other clinical settings with less restrictions on mobility. Cardiac telemetry enables viewing cardiac arrhythmias and other vital physiologic parameters in *real time* which can provide crucial clinical information that may impact a patient's plan of care. However, the integrity of the data telemetry provides is dependent on the competence, vigilance, reliability, and safe practice of the personnel who monitor telemetry patients and maintain the equipment.

Regional variations in telemetry practice exist. The National Telemetry Task Force (NTTF) has compiled this guidebook for maintaining telemetry safety and ensuring consistency in all clinical settings. This guidebook incorporates telemetry monitoring practice standards from the ACC and AHA and is a product of Veterans Health Administration (VHA). VHA facilities providing telemetry monitoring should be prepared to demonstrate enhanced quality of care and patient safety monitoring as a life safety system utilizing best practices.

Therefore, the NTTF recommends each VHA with cardiac telemetry monitoring should have:

- Evidence-based, standardized practices for initiating, monitoring, and discontinuing telemetry
- Education plans to ensure staff competency
- Key individuals with clearly designated roles
- Processes to proactively identify and remediate risks
- Enduring safety and contingency plans
- Leadership in the quality of care and resource allocation
- Plans to evaluate and implement improvements
- Guidelines for technical and consumable supplies

Historical Overview

In 2014 the VHA Office of Nursing Services-Cardiovascular Field Advisory Committee reviewed 75 telemetry-based programs within the VHA which revealed variations in delivery of telemetry services. In 2017, the VHA NCPS conducted a Telemetry Healthcare Failure Mode and Effects Analysis (HFMEA) to highlight vulnerabilities within telemetry processes. The Telemetry HFMEA reviewed 2,547 safety reports and 93 telemetry-related Root Cause Analysis (RCA) over a five-year period from April 2012 to April 2017 with significant variations in equipment, education, competencies and telemetry service delivery.

Although these practice variations are not unique to VHA, they highlight an opportunity for improvement. In order to address practice variations, a National Telemetry Taskforce convened and the NTTF Guidebook was compiled using evidence-based literature and best practices to promote standards which VHA facilities might consider adopting.

Using the Guidebook

This guidebook is organized into chapters which are linked via the table of contents to quickly locate an area of interest. The chapters include:

1) *Introduction and Historical Overview*
2) *Cardiac Telemetry Monitoring Procedures*
3) Cardiac Telemetry Monitoring Indications
4) Education and Competency
5) Reducing Risks Associated with Cardiac Telemetry Monitoring
6) Communication and Contingency Planning
7) Resource Allocation
8) Technology and Consumable Supplies.

The content in the guidebook was assembled by the National Telemetry Task Force.

Chapter 2 Telemetry Monitoring Procedures

Objectives

- Overview of roles and responsibilities
- Describe procedural considerations for telemetry monitoring
- Define patient transport opportunities
- Outline telemetry alarm communication strategies

Roles and Responsibilities:

(Please see Appendix D Interdisciplinary Team Approach to Caring for Cardiac Telemetry Patients crosswalk of roles and responsibilities)

The following individuals and groups are considered essential to VHA inpatient telemetry monitoring programs:

a. National Program Director for VHA Cardiology: To provide national leadership as an advisor and consultant in collaboration with VISN and VHA medical facility Cardiology Services
b. Veterans Integrated Service Network (VISN) Director (or Designee): To ensure that each VISN facility provides telemetry services which are consistent with VHA Directives and standards of quality
c. VHA Medical Facility Director (or Designee): To ensure that the facility has the appropriate resources to support telemetry life safety system services
d. Medical Care Provider: To prescribe inpatient cardiac monitoring using appropriate guidelines for indications, monitoring duration, and alarm customization
e. Nurse Manager (or Designee): To ensure that life safety monitoring is provided in an environment of care that is supported with needed resources and is provided by competent staff
f. Nursing Staff: To initiate provider's orders for cardiac monitoring, along with ensuring that rhythms, rates, measurements, and alarms are being documented and reported per facility policies
g. Central Telemetry Monitoring Personnel: To provide continuous observation of patient heart rate, correct interpret rhythms, and accurate measurement

intervals. Communicate directly with nursing staff regarding changes, arrhythmias, loss of connectivity, or concerns related to patient status

h. Clinical Biomedical Engineering Personnel: To provide technical support in addressing telemetry issues such as system maintenance, functionality, and equipment outages

Performance and Quality Improvement

Continuous quality and performance improvement are essential with remote telemetry monitoring to align with the Institute of Medicine's key quality aims of safe, timely, effective, efficient, equitable, and patient centered-care. The measure of performance and quality improvement measures specific to remote telemetry monitoring include yet are not limited to such items as: staff education, appropriate lead selection and placement, skin preparation, alarm response, interpretation and documentation, telemetry utilization, re-useable medical equipment procedures, hospital failure mode analysis, and process adherence (See Appendix C).

A pre and post assessment for quality improvement (See Appendix C)

Procedures for Telemetry Monitoring

Recommendations and standards attributed to the joint AHA/ACC/AACN (Sandau, K.E., et. al. 2017) specific criteria for remote cardiac telemetry monitoring

1. Obtain provider order for telemetry monitoring; to include IV access
   a. All patients on telemetry monitoring will be *evaluated at least every 24 hours by a provider* for continued monitoring needs
   b. Unless renewed, telemetry monitoring *will be* discontinued after 24 hours
   c. Order renewals will specify guideline category which applies (See Chapter 3)
2. In the event a patient requires telemetry monitoring and there are no available transmitters, follow facility policy for course of action.

Principles to guide the local policies include:

a. Consideration of patient safety and acuity when allocating telemetry resources
b. Use AHA guidelines to identify patients at highest need for telemetry monitoring

    c. Include telemetry resource optimization during facility-wide, interprofessional, environment of care rounds
3. Use correct skin preparation and electrode placement
    a. Assess for skin breakdown, medication patches, etc. and document altered sites
    b. Avoid bony surfaces or implantable devices and document altered sites
    c. Large breasted or obese patients, place chest electrodes under breast or over breast in correct anatomical position
    d. Clip, *do not shave* hair
4. Place electrodes in anatomically correct positions (See Chapter 4)
5. Use telemetry lead that best transmits waveform specific to patient rhythm
   NOTE: The intent of monitoring, paired with the need to differentiate specific morphologies determines lead(s) selection
6. Connect lead wires to electrodes *before* connecting to patient.
7. Ensure electrodes are stored sealed, in their package, until ready for use as per manufacturer's recommendations
8. Make a stress-loop or assure adequate wire length if placing telemetry transmitter (box) in patient's gown or pajama pocket (instruct patient of importance)
9. Facilities should clearly identify how often rhythm strips are to be routinely assessed and documented to align with patient's condition, standards of care, and guidelines
10. Notify TMP to admit patient to the central monitor
11. TMP will print baseline telemetry strip
    a. Baseline strip will be reviewed, measured, interpreted and documented
    b. Minimum documentation will include atrial and ventricular rate(s), PRI, QRS duration, QT/QTc; any ST deviations and overall rhythm interpretation
12. TMP assigned to the central monitor station will:
    a. Assess patients' rhythms and notify of any alterations that may impact the patient's physiological status
    b. Sets and maintains alarm parameters per provider orders
    c. Assures alarms are visible and audible while patient on telemetry
13. TMP will report malfunctioning of the monitoring system or transmitters to biomedical engineering in a timely manner as identified by facility policy (See Chapter 7)
14. Team will individualize alarms to the patient's clinical status
15. Provide and document patient and family education related to cardiac

monitoring

16. A shift handoff will occur *among all personnel* who care for patients on remote telemetry monitoring
17. Nursing staff must respond immediately to STAT calls or requests from the central monitor station personnel. (See Appendix E)
18. Only individuals with documented, up-to-date TMP education and central monitor station equipment competency, rhythm interpretation, and processes should relieve central monitor station personnel
19. Facility has a process for patients refusing telemetry
20. Facility policies must address storage and cleaning of telemetry transmitters (boxes) and equipment

A quick reference grid can be found in Appendix D

Patient Transport

- Transportation of telemetry monitored patients *must be* with continuous electrocardiographic monitoring via a portable monitor and a defibrillator-pacemaker monitor with pacer and defibrillator capabilities
- Transporting telemetry monitored patients will be with a healthcare provider skilled in use of the equipment, electrocardiographic interpretation, and skilled in Basic Life Support (BLS) at a minimum
- Temporary suspension of telemetry monitoring is not acceptable
- Clinicians will exercise clinical judgement regarding indications for telemetry

Alarm Communication

The rapid communication of alarms from the telemetry monitoring personnel to the nurse caring for the patient is imperative for safe care of patients. Facilities should have a plan that clearly delineates the communication process. An Alarm Algorithm sample can be found in Appendix E.

An effective communication plan should include:

1. How the communication for all emergent or lethal patient rhythm changes to the nurses will occur (telemetry-designated telephones or other compatible phone or pager system)

2. The escalation process if the telemetry monitoring personnel are unable to communicate with a nurse via the designated communication device. For example:
    a. Contact the charge nurse via a telemetry-designated telephone
    b. Communication Badge (ie.,Vocera) Urgent Broadcast to the assigned unit to alert all nursing staff (**NOTE:** not available at all sites)
    c. Communication to the Patient Care Coordinator (PCC) or nurse manager or supervisor as designated by facility
    d. Initiate Rapid Response Team if indicated
    e. Initiate Code Team if indicated
3. Telemetry Monitoring Personnel should call a code if a lethal arrythmia is noted

Sample Alarm Algorithm may be found in Appendix E.

Reducing Monitor Alarm Fatigue

AHA Practice Standards recognize the role of arrhythmia monitoring in early recognition of clinical deterioration which could *prevent or mitigate the effects of cardiac arrest* (Sandau et. al., 2017, p. e291-e314). However, telemetry alarms which occur frequently but don't require immediate action (*warning* or *low* priority levels), tend to get inappropriately silenced, then get *tuned out* altogether when more serious alarms occur.

In 2014, The Joint Commission National Patient Safety Goal 06.01.01 recognized that clinical alarms were a safety concern. *Nuisance* alarms that are ignored rather than set to levels to alert care givers of clinical deterioration have been implicated in adverse patient events. Alarms that go off repeatedly, or *alarm floods*, cause desensitization and reduce vigilance or, *alarm fatigue*. The numbers of alarms can be mitigated by:

a. Identifying Appropriate Alarm Ranges: Facilities providing cardiac telemetry monitoring should have a Clinical Alarms Committee to address issues related to alarm safety and ensure alarms are clinically actionable and do not promote alarm fatigue. Data analysis related to frequent alarms has been successfully determined using *the average number of patient alarms per bed per day as a key metric* (AAMI Foundation, 2012). The Committee can then use the data to determine what the most appropriate alarm parameters and advisories should be for each specific unit.

b. Customization of Alarms: Unit default alarm levels are not universally appropriate for all patients. When nuisance alarms occur, providers should order customized parameters based on the appropriate actionable levels to meet the clinical needs of the patient (Cvach, et al. 2017).

Chapter 3: Cardiac Telemetry Monitoring Indications

Objectives

- Delineate indications for telemetry monitoring
- Recognize and follow the AHA/ACC telemetry monitoring standards of care
- Recognize a (non-exhaustive) list of caveats after most sections
- Define telemetry order set verbiage

Embedded Caveats in this chapter are for *read only*
(This is meant for Clinical Application Coordinators when constructing Order Sets.)

The following as adapted from the AHA/ACC/AACN Update to practice (Sandau et. al., 2017, p. e291-e314)

I. QTc Monitoring:

A. Assess need for QTc monitoring

B. Indications:

1. QTc monitoring is indicated during in hospital drug initiation for:
   a) Antiarrhythmic drugs known or with the potential to prolong QTc
   b) During initiation or administration of drugs other than antiarrhythmics recognized to prolong QTc particularly among patients at high risk for QTc prolongation
   c) If QTc prolongation necessitates discontinuation of drug, continue monitoring until QTc returns to baseline
2. QTc monitoring is indicated in patients with known inherited Long QT Syndromes, or those with previous episodes of Torsades de pointes if presenting with ventricular arrhythmia or illness causing prolongation of QTc until arrhythmias resolve or QTc returns to baseline
3. QTc monitoring is indicated in cases of an inciting condition until that has resolved: e.g. moderate to severe electrolyte imbalance; drug overdose with drugs known to cause QTc prolongation or unknown drugs and in cases of targeted hypothermia treatment
4. QTc monitoring has no benefit and is not indicated during the initiation of non-antiarrhythmic drugs if no risk factor for Torsades or prior QTc prolongation

5. QTc monitoring is not indicated in absence of baseline QTc prolongation in cases of acute neurological event

C. QTc monitoring when not indicated should be turned off even if indicated arrhythmia monitoring is ongoing

Caveats:

1. Because QT/QTc dispersion may result in differential prolongation across multiple leads, 12-lead electrocardiography remains the gold standard for electrocardiographic identification of QTc prolongation
2. QTc monitoring can be accomplished by either intermittent 12-lead electrocardiography (such as post anti-arrhythmic drug dosing), or both continuous monitoring and intermittent 12-lead electrocardiography
3. In patients with appropriate indications, continuous QTc monitoring can serve as a useful adjunct to (but is not a replacement for) standard care, including 12-lead electrocardiography for the identification of changes in the QT and/or QTc interval if certain conditions can be met:
    a) A telemetry system with appropriate technology to support the diagnostic modality is in place
    b) Because QTc prolongation is associated with ventricular arrhythmias (particularly polymorphous ventricular tachycardia and ventricular fibrillation), arrhythmia monitoring should also be in place
    c) Appropriate staff training has been conducted, particularly in techniques for both arrhythmia (especially ventricular ectopy and polymorphous ventricular tachycardia recognition) monitoring thresholds for reporting alarms, selection of leads for monitoring
4. A protocol for reassessment of ongoing need for QTc monitoring is in place

II. Arrhythmia Monitoring by Specific Population

A. Coronary Artery Disease

1. Early-phase ACS (<24 hours) for intermediate- or high-risk Non-ST-elevation (NSTE), NSTE-ACS or ST-Elevation Myocardial Infarction (STEMI). Should be initiated immediately, continuing uninterrupted ≥24–48 hours (or until ruled out; negative biomarkers).
2. After Myocardial Infarction (MI), with revascularization of all ischemic lesions. Should be initiated immediately, continuing uninterrupted ≥12–24

hours after revascularization

3. After MI, without revascularization or with residual ischemic lesions
4. Should be initiated immediately, continuing uninterrupted ≥24–48 h until no evidence of ongoing modifiable ischemia or hemodynamic or electric instability
5. Vasospastic angina (i.e., Prinzmetal). Until symptoms resolved
6. Apical ballooning syndrome (stress cardiomyopathy) until symptoms resolved
7. Newly diagnosed left main coronary artery lesion until revascularized.
8. After nonurgent PCI, with complications. For ≥24 h or until complication resolved
9. Examples when monitoring is not indicated:
   a) After nonurgent PCI, without complications No further monitoring beyond femoral sheath removal and immediate post procedure area
   b) After routine diagnostic coronary angiography. No further monitoring beyond immediate post procedure area
   c) Low risk and noncardiac chest pain. If normal ECG and negative biomarker

B. Major Cardiac Intervention

1. Open heart surgery: Uncomplicated: 48–72 hours.
2. High risk for Atrial Fibrillation (AF): monitor patient until discharge from acute care unit
3. Mechanical circulatory support:
   a) Clinically significant cardiovascular or hemodynamic deterioration
   b) Immediately after implantation
4. Admitted with noncardiac problems
5. Transcatheter structural interventions
   a) After Transcatheter Aortic Valve Replacement (TAVR), particularly with peri-procedural conduction abnormalities ≥3 days after procedure and after day three
   b) Other transcatheter interventions (e.g., Ventricular Septal Defect (VSD), Atrial Septal Defect (ASD), valvuloplasty.) Duration of monitoring varies with procedure, device, and patient factors

C. Arrhythmias

1. Ventricular Tachycardia (VT) s; post resuscitation from VT/Ventricular Fibrillation (VF) cardiac arrest or hemodynamically unstable VT. Until implantable cardioverter defibrillator (ICD) implanted or underlying problem resolved
2. Non-sustained VT
3. Atrial tachyarrhythmias:
   a) New or recurrent AF: monitor until treatment strategy determined or if hemodynamically unstable or symptomatic AF
   b) Ongoing rate control management
   c) Initiation in hospital of new antiarrhythmic agent
   d) Chronic AF: Rapid ventricular rate
4. Sinus bradycardias
   a) Symptomatic
   b) Asymptomatic, significant bradycardia with negative chronotropic medications initiated
5. Atrioventricular block
   a) Symptomatic second- or third-degree atrioventricular block of any anatomic origin
   b) Asymptomatic second- or third-degree block caused by distal conduction system disease
   c) Third-degree atrioventricular block caused by intranodal disease
6. Congenital or genetic arrhythmic syndromes (e.g., Wolff-Parkinson-White (WPW), Brugada, long QT syndrome (LQTS)
7. Hemodynamically unstable, recurrent syncope, increased arrhythmia susceptibility. Until appropriate therapy is delivered
8. WPW with rapid conduction via accessory pathway during atrial arrhythmia. Until therapy such as antiarrhythmic medication or ablation is delivered
9. Congenital long QT with unstable ventricular arrhythmias or further QT prolongation induced medically or metabolically. Until stable, exacerbating cause reversed, QTc returned to baseline
10. Syncope of suspected cardiac origin. Meeting admission criteria for syncope, cause of syncope suspected to be cardiac. Monitor ≥24 hours; until cause and treatment identified; then follow indications and durations per criteria in these practice

11. Monitoring **is not indicated** in:
    a) Chronic AF: If admitted for reason other than arrhythmia or rate and patient are hemodynamically stable
    b) Sinus Bradycardia Asymptomatic, hemodynamically stable, admitted for other indication
    c) Atrioventricular block: Asymptomatic Wenckebach or transient atrioventricular block of vagal origin

D. Electrophysiologic Procedures

1. Electrophysiologic Ablation Procedure
    a) Uncomplicated SVT ablation: Immediate post procedure
    b) Complex ablation (pulmonary vein isolation) or serious comorbidities 12–24 hours
    c) Atrioventricular nodal ablation after incessant tachycardia and after chronic AF with concomitant pacemaker implantation Monitor for 12–24 hours

1. Pacemaker/Defibrillator Procedures
    a) Transcutaneous pacing pads: Monitor until pacing is no longer necessary
    b) Standard temporary transvenous pacing: Monitor until pacing is no longer necessary and the device is removed or replaced with a permanent device
    c) Semi-permanent transvenous pacing: 12-24 hours or until permanent device implanted
    d) Permanent pacemaker or ICD: Whether pacer dependent or not, patients are to be monitored in the immediate post procedure period not exceed 12-24 hours at implanting physician's discretion.

3. Pre-existing Cardiac Rhythm Device
    a) ICD shocks: During related hospitalization until precipitating event treated
    b) **Not indicated**: ICD or pacemaker and admission for unrelated indication: ***No Benefit***

c) **Not indicated**: Stable with wearable defibrillator and admission for unrelated indication: ***No Benefit***

E. Other Cardiac Conditions

1. Acute decompensated heart failure: Until clinically stable
2. Infective endocarditis: Until clinically stable

F. Noncardiac Conditions

1. Post conscious sedation: ***May be of benefit*** until patients are breathing per baseline and hemodynamically stable; consider that monitoring other than ECG may be more appropriate e.g., oximetry, end-tidal CO2
2. Noncardiac major thoracic surgery: After noncardiac major thoracic surgery to identify AF through postoperative day 2–3 and *may be helpful until discharge* from acute care
3. Noncardiac surgery: Not indicated among asymptomatic postoperative patients

G. Medical Conditions

1. Stroke: Monitor 24–48 hours
2. Moderate to severe imbalance of potassium or magnesium: Until normalization of electrolytes
3. Drug overdose: Monitor until free of the influence of the drug(s) and clinically stable
4. Hemodialysis: Efficacy is not well established for most patients receiving chronic hemodialysis unless they have another indication (e.g., hyperkalemia, arrhythmia)

Caveats:

1. Due to the intermittent nature and potential life-threatening nature of some arrhythmias and the potential for immediate action in response to them, continuous telemetric arrhythmia monitoring is critically important in the care of patients with indications for arrhythmia monitoring
2. Implementation of continuous arrhythmia monitoring should include the following:

a. A telemetry system with appropriate technology to support the diagnostic modality.
b. Appropriate staff training has been conducted, particularly in techniques for lead placement, arrhythmia recognition, monitoring, thresholds for reporting alarms, and a clear plan for closed-loop communication with the care team
c. A protocol for reassessment of ongoing need for continuous arrhythmia monitoring is in place

III. ST Segment Monitoring for Ischemia:

A. Assess need for ischemia monitoring

B. Indications:

1. Examples where monitoring for ischemia is reasonable or may be considered include:
2. Acute monitoring in acute coronary syndrome (ACS) pending or shortly after re-vascularization
3. After complicated percutaneous coronary intervention (PCI)
4. Vasospastic angina; until diagnosis is established
5. Post open heart surgery until patient is awake and able to report chest pain
6. Apical ballooning until chest pain resolves

C. Examples where ST segment monitoring is of **no benefit and may be harmful** include:

1. Patients who are awake and able to report their angina
2. Non-cardiac chest pain after uncomplicated routine coronary angiogram or PCI
3. Chronically altered repolarization; (e.g., bundle branch block, ventricular pacing, pericarditis and/or chronic digitalis use)

D. ST-T segment monitoring when not indicated; *should be turned off* even if indicated arrhythmia monitoring is ongoing

Caveats:

1. *12-lead electrocardiography remans the gold standard* for electrocardiographic identification of ischemic ECG changes
2. In-patients with appropriate indications, ST segment monitoring can serve as a useful adjunct to (but not a replacement for) standard care, including 12-lead electrocardiography if certain conditions can be met:
   a) A telemetry system with appropriate technology to support the diagnostic modality is in place
   b) Appropriate staff training has been conducted; particularly recognition of patients for whom monitoring cannot be used due to existing electrocardiographic abnormalities, techniques for monitoring, thresholds for reporting alarms, selection of leads for monitoring, and in recognition of diverse mechanisms for ST-T abnormalities
   c) A clearly established protocol for addressing false and non-actionable alarms to minimize risk of alarm fatigue
   d) A protocol for reassessment of ongoing need for ST segment monitoring is in place

Telemetry Orders

- All patients on telemetry monitoring will be evaluated at least every 24 hours by the provider to assess need for continued monitoring.
- Orders to discontinue telemetry monitoring will be automatic at 24 hours unless renewed.
- Order renewals will specify the guideline category which applies.

Order set for telemetry indications

- Maintain patent IV access while on Telemetry
  - *Call provider for:*
- HR less than [drop down] or greater than [drop down]
- Blood Pressure less than [drop down] or greater than [drop down]
- Other: [may have drop down or 250 character drop down box]
- ECG changes and obtain 12-lead ECG

Telemetry **ORDERS EXPIRE DAILY and must be reassessed and reordered if indicated****

Indications for monitoring

1. Acute Coronary Syndrome (unstable angina, NSTEMI, STEMI)
2. Vasospastic Angina (i.e., Prinzmetal)
3. Apical ballooning syndrome (stress cardiomyopathy)
4. Newly diagnosed left main coronary artery lesion (until revascularized)
5. After urgent and non-urgent PCI, with complications
6. After major cardiac interventions:
   a) Open heart surgery
   b) Mechanical Circulatory Support
   c) Transcatheter structural interventions: e.g. TAVR, Mitral Clip, Watchman, VSD, ASD, Valvuloplasty
7. Sustained or non-sustained VTs; post resuscitation from VT/VF cardiac arrest
8. Atrial arrhythmias:
   a) New or recurrent AF; especially if symptomatic, rate uncontrolled or hemodynamically unstable AF
   b) Need for ongoing rate control or initiation of anti-arrhythmic management
9. Bradycardias
   a) Symptomatic sinus bradycardias or asymptomatic, significant bradycardia with negative chronotropic medications initiated
   b) Atrioventricular block
      (1) Symptomatic and/or compromising second degree atrioventricular (AV) Block
      (2) Third-degree AV Block
10. Syncope of suspected cardiac origin, especially with high risk criteria
11. Congenital or genetic arrhythmic syndromes (e.g., Wolff-Parkinson-White (WPW), Brugada, Long QT Syndrome (LQTS); if hemodynamically or unstable arrhythmias, recurrent syncope, increased arrhythmia susceptibility, or rapid conduction related to WPW
12. QTc Monitoring: [drop down on and show indications]; or [off]

a) QTc monitoring is indicated during in hospital drug initiation for:

1) Antiarrhythmic drugs known or with the potential to prolong QTc
2) During initiation or administration of drugs other than antiarrhythmics recognized to prolong QTc particularly among patients at high risk for QTc prolongation
3) QTc monitoring *is indicated* in patients with known inherited Long QT Syndromes, or those with previous episodes of Torsades de pointes if presenting with ventricular arrhythmia or illness causing prolongation of QTc

b) QTc monitoring *is indicated* in cases of an inciting condition until that has resolved: e.g., moderate to severe electrolyte imbalance; drug overdose with drugs known to cause QTc prolongation or unknown drugs and in cases of targeted hypothermia treatment

NOTE: QTc monitoring ***has no benefit and is not indicated*** during the initiation of non-antiarrhythmic drugs if no risk factor for Torsades or prior QTc prolongation

- QTc monitoring **is not indicated** in absence of baseline QTc prolongation in cases of acute neurological event
- QTc monitoring **when not indicated should be turned off** even if indicated arrhythmia monitoring is ongoing
- Because QT/QTc dispersion may result in differential prolongation across multiple leads, *12-lead electrocardiography remains the gold standard* for electrocardiographic identification of QTc prolongation
- QTc monitoring can be accomplished by either intermittent 12-lead electrocardiography (such as post anti-arrhythmic drug dosing), or both continuous monitoring and intermittent 12-lead electrocardiography

13. ST Segment Monitoring for Ischemia [drop down with indications] or [off]

a) Acute coronary syndrome before or shortly after revascularization
b) After complicated PCI
c) Post open-heart surgery before extubating
d) Vasospastic angina, apical balloon syndrome during treatment
e) Apical ballooning

NOTE: ST segment monitoring is ***of no benefit and may be harmful*** in:

a) Patients who are awake and able to report their angina

b) Non-cardiac chest pain; after uncomplicated routine coronary angiogram or PCI

c) Chronically altered repolarization e.g., bundle branch block, ventricular pacing, pericarditis and or chronic digitalis use will not benefit and may be harmed

ST-T segment monitoring ***when not indicated should be turned off* even if indicated arrhythmia monitoring is ongoing**

14. After Electrophysiologic Procedure:
    a) Uncomplicated SVT ablation
    b) Complex ablation (pulmonary vein isolation) or serious comorbidities 12–24 hours
    c) Atrioventricular nodal ablation after incessant tachycardia and after chronic AF with concomitant pacemaker implantation
15. After Pacemaker and/or Defibrillator Procedures:
    a) Transcutaneous pacing
    b) Standard temporary transvenous pacing
    c) Permanent pacemaker or ICD including generator change
16. Pre-existing Cardiac Rhythm Device: ICD shocks: During related hospitalization
17. Other cardiac conditions:
    a) Acute decompensated heart failure
    b) Post moderate sedation: May be of benefit
    c) Infective endocarditis with hemodynamic compromise, arrhythmias or risk of AV block
    d) High risk cardiac patient undergoing non-cardiac surgery
    e) Stroke
    f) Noncardiac major thoracic surgery to identify AF
    g) Pulmonary embolism with right heart strain
    h) Hypothermia
    i) Cardiac contusion
    j) Acute myocarditis
18. Medical conditions
    a) Moderate to severe imbalance of potassium or magnesium
    b) Drug overdose

NOTE: *Patients in an intensive care unit and immediate post-procedure area (e.g. catheterization laboratory) will have continuous electrocardiographic monitoring*

Monitoring is not indicated:

This suggests that cardiac monitoring is unlikely to provide any therapeutic benefit because the risk to the patient of a serious cardiac event is very low

- After nonurgent PCI, without complications No further monitoring beyond femoral sheath removal and immediate post procedure area
- After routine diagnostic coronary angiography. No further monitoring beyond immediate post procedure area
- Low-risk and noncardiac chest pain. If normal ECG and negative biomarkers
- Chronic AF: If admitted for reasons other than arrhythmia or rate and the patient is hemodynamically stable
- Sinus Bradycardia Asymptomatic, hemodynamically stable, admitted for other indication
- Atrioventricular Block: Asymptomatic Wenckebach or transient atrioventricular block of vagal origin
- ICD or pacemaker and admission for unrelated indication
- Stable with wearable defibrillator and admission for unrelated indication
- Noncardiac surgery, among asymptomatic postoperative patients
- Hemodialysis
- Infective endocarditis
- Drug overdose
- Moderate to severe imbalance of potassium or magnesium

Comfort focused care is the goal

CHAPTER 4 Staff Education and Competency

Objectives

- Outline minimum initial and ongoing education and training requirements for ***all*** telemetry monitoring personnel on telemetry monitored units via remote, local, or central monitoring
- Describe minimal education requirements for competency; this is not position specific

Staff Education and Competency Overview

Annual Competencies for Telemetry Monitor Personnel (TMP)

a. All TMP should demonstrate minimum knowledge, skills and ability required to ensure safe telemetry practices, continuing education initially and annually, or more frequently if indicated.

b. Annual competency demonstration specific to telemetry equipment, telemetry processes, and central monitoring station competency.

Minimum Telemetry Education Requirements

Composed of didactic content, testing, and return demonstration and required for ALL Telemetry Monitor Personnel. These requirements are not position specific; all staff levels are required to have the same *initial and annual* education requirements for watching telemetry monitors.

The following are attributed to Funk, M., et. al. (2010, 2017)

Specific ECG Abnormalities

A. Normal rhythm
   1. Sinus rhythm
   2. Sinus bradycardia
   3. Sinus arrhythmia
   4. Sinus tachycardia

B. Intraventricular conduction defects
   1. Right and left bundle-branch block
   2. Aberrant ventricular conduction

C. Bradyarrhythmias
    1. Inappropriate sinus bradycardia
    2. Sinus node pause or arrest
    3. Non-conducted atrial premature beats
    4. Junctional rhythm
    5. AV blocks
        a) 1st degree
        b) 2nd degree
        c) Mobitz I (Wenckebach)
        d) Mobitz II
        e) Advanced (2:1)
        f) 3rd degree (complete heart block)
    6. Asystole, pulseless electrical activity
    7. Sinoventricular rhythm (in severe hyperkalemia)

D. Tachyarrhythmias
    1. Supraventricular
        a) Paroxysmal supraventricular tachycardia (Atrial ventricular (AV) nodal re-entrant, AV reentrant)
        b) Atrial fibrillation
        c) Atrial flutter
        d) Multifocal atrial tachycardia
        e) Atrial tachycardia with 2:1 block
        f) Junctional ectopic tachycardia
    2. Ventricular
        a) Accelerated ventricular rhythm
        b) Non-sustained/sustained monomorphic ventricular tachycardia
        c) Non-sustained/sustained polymorphic ventricular tachycardia
        d) Prolonged QT interval-associated ventricular ectopy, Torsades de pointes
        e) Ventricular fibrillation

E. Premature complexes
    1. Supraventricular (atrial, junctional)
    2. Ventricula

F. Pacemaker electrocardiography
    1. Failure to capture
    2. Failure to pace (no pacer output)
    3. Failure to sense
    4. Failure to capture both ventricles in biventricular pacing
G. ECG abnormalities of acute myocardial ischemia
    1. ST-segment elevation, depression
    2. T-wave inversion
H. Muscle or other artifacts simulating arrhythmias

General Electrophysiologic Concepts

A. Automaticity
    1. Physiologic pacemakers
    2. Overdrive suppression
B. Excitation
    1. Refractory periods
C. Conduction
    1. Conduction velocity
    2. Concealed conduction
    3. Anterograde and retrograde conduction
D. Sinus node physiology
    1. Normal ranges of sinus rate with age
    2. Effects of autonomic tone
        a) Vasovagal reactions
        b) Resting/sleep
        c) Activity/exercise
    3. Effects of drugs
E. AV node physiology
    1. Effects of atrial rate
    2. Effects of autonomic tone
        a) Resting/sleep
        b) Activity/exercise
    3. Effects of drugs

F. Wide vs narrow QRS complexes

G. QT/U intervals

1. Relation to rate
2. Gender differences
3. Drug effects
4. Pause dependency

H. Observations with arrhythmias

1. Sustained vs Non-sustained
2. Monomorphic vs polymorphic
3. Hemodynamically stable vs unstable
4. Symptomatic vs asymptomatic
5. Association with heart disease vs no heart disease

I. Hemodynamic effects of arrhythmias

1. Influence of rate
2. Influence of heart disease
3. Influence of A-V synchrony
4. Influence of left ventricular synchrony

J. Implantable devices

1. Function of electronic pacemakers, including biventricular pacemakers
2. Function of automatic defibrillators

K. Acute myocardial ischemia

1. ST-elevation MI (anterior, inferior, right ventricular; ST recovery indicative of successful reperfusion; reperfusion arrhythmias; intermittent reperfusion; ECG leads related to occlusion of 3 main coronary arteries)
2. Non–ST-elevation MI
3. Transient myocardial ischemia (effects of body position changes mimicking ischemia)

L. Syncope

M. Effects of common antiarrhythmic drugs, rate control vs rhythm control

Specific Monitoring Skills

A. Operation of monitoring system used in hospital unit (arrhythmia, ST monitoring)

B. Recognition of limitations of computer algorithms

C. Proper skin preparation for applying electrodes

1. Expertise in correct application and positioning of ECG electrodes

2. Positioning electrodes placement (5 lead placement)

LIMB LEAD	**ANATOMICAL POSITION**
RA (Right Arm)	Placed in the Infraclavicular fossa close to right shoulder
LA (Left Arm)	Placed in the infraclavicular fossa close to left shoulder
LL (Left Leg)	Placed below rib cage on left side of abdomen
RL (Right Leg)	Placed on the right side of abdomen
V1*	Placed in the fourth intercostal space just to the of the sternal border
	Potential altered electrode placement secondary to skin breakdown, obesity, large breasts

D. Accurate electrode placement for system used (e.g., reduced lead sets)

E. Setting heart rate, ST alarm parameters appropriately (body position, patient baseline level)

F. Measurement of heart rate

G. Measurement of intervals (use of ECG calipers)

H. Recognition of atrial activity

I. Evaluating pauses

J. Diagnosis of specific rhythm

K. Recording of standard 12-lead ECG, landmarks for and importance of accurate lead placement (importance of marking lead location for consistent lead placement)

L. Recording from postoperative epicardial wires (including electrical safety)

M. Ability to intervene (unit protocols for responding to, reporting, and documenting)

1. Defibrillation/cardioversion
2. Patient with bradycardia
3. Patient with tachycardia
4. Patient with syncope
5. Patient with cardiorespiratory arrest
6. Patient with implanted device (new or chronic)
7. Patient with temporary transvenous pacemaker
8. Patient with transcutaneous pacemaker

N. How to reduce artifact

O. How to set alarm parameters

P. Lead Assessment

Q. Battery Assessment (link to recommendation)

R. Cable Assessment (link to recommendation)

S. Disinfection of Equipment

1. Leads, telemetry boxes, monitors etc.

T. Proper storage of electrodes

U. Proper care of the leads when placing the transmitter in the patient's gown pocket

V. Interpreting and documenting waveforms (minimum of a 6 second strip) and protocol for how often this occurs

1. Recognition of atrial activity
2. PR identification and measurement
3. QRS identification and measurement
4. QTc measurement for patients receiving medication that prolongs QT and are at risk for fatal arrythmias
5. Rate
6. Rhythm

7. Evaluation of pacemaker activity
8. T wave abnormalities
9. ST segment depression, elevation (includes identification of J point)

W. Ischemia monitoring for patients at risk for myocardial infarction
1. ST segment fluctuation assessment-utilize supine positioning as standard evaluation procedure
2. Tailoring ST alarm parameters to patient's baseline ST level
3. Consistent lead placement and monitoring

X. Clinical decision making based on the information obtained from the monitor
1. Life threatening arrhythmias
2. Non-life-threatening arrhythmias
3. Reportable arrhythmias

Y. Admission process to central monitoring station, if required

Additional Telemetry Requirements

- Clip Hair – do not shave
- Shift Handoff content
- Transport protocols for telemetry patients
- Process to report malfunction equipment
- Process to initiate and discontinue telemetry monitoring
- Process for Stat calls
- Process if the patient requires telemetry and there is no telemetry beds or transmitters available
- Process for when the patient refuses telemetry
- Basic Life Support (BLS) is a minimum requirement for TMP and/or ACLS if required for the specific position
- Process to call a CODE and when to call a CODE
- Process and procedure for telemetry system failure
  Specific operational instruction, based on manufacturer's instructions for use, for the facilities telemetry monitors and all associated equipment.

Chapter 5 Reducing Risks Associated with Telemetry Monitoring

Objectives:

Upon completion of this chapter the learner will:

- Identify three key roles responsible for the delivery of safe cardiac monitoring practice within VHAs
- Verbalize interventions to assist the life safety of telemetry patients
- Identify interdisciplinary approaches to managing safety, quality, and outcomes of monitored patients
- Define importance of alarm customization in reducing alarm fatigue

Guideline of Safe Number of Waveforms per Monitor Watcher

An in-depth review of current literature on the number of waveforms or cardiac telemetry monitor screens that can be safely viewed revealed limited evidence. The 2017 *Update to Practice Standards for Electrocardiographic Monitoring in Hospital Settings,* from the AHA states: *The number of waveforms a monitor watcher can effectively and safely observe is not known, although a recent study used simulation to compare response time of monitor watchers to VF over 5 different patient loads (16, 24, 32, 40, and 48 patients).* Segall (2015) noted as patient loads increased, response times increased significantly. Frequency of failure to meet a response time goal of <20 seconds was significantly higher in the 48-patient condition than in all other conditions. The number of waveforms observed is also dependent on the layout and location of the screens, the type of monitoring and alarm notification system in use, alarm burden, and whether the staff is expected to watch more than electrocardiographic waveforms (i.e., oxygen saturation measured by pulse oximetry [Spo2], end-tidal CO2, blood pressure).

Further, it was demonstrated (Cohen et al 2009, Wolfe 2007) that an increase in complex distracters in a visual search array increases reaction time. This is also true for airline baggage screening, it was discovered that decreased clutter leads to higher target detection sensitivity. Studies show that error rates increased, and Air Traffic Controllers performance and judgment decreased, as volume increased. Response times to harmful arrhythmias increased significantly with a patient load of greater than 48. Additionally, Monitor Watchers may also be tasked with watching other waveforms thereby adding to the complexity of an already busy visual display.

The panel of subject matter experts on the National Telemetry Task Force reviewed the literature and to improve patient safety, *the guideline is set to limit the*

number of waveforms to a total of 40 per telemetry monitor watcher. (**NOTE:** this is not 40 monitors, it is 40 waveforms; i.e. ECG, pulse oximetry, end tidal C02, blood pressure, etc.).

Staffing Fatigue and Hours Worked

Multiple studies have demonstrated that extended hours and overtime, in healthcare, contribute to fatigue and adverse events (Olds, Clarke 2010). In the 2016 published research (Funk et al 2016) *Use of Monitor Watcher in Hospitals: Characteristics, Training, and Practices,* 68% of respondents cited working a 12-hour shift. A study by Stimpfel & Aiken *(2013), Hospital Staff Nurses Shift Length Associated with Safety and Quality of Care* revealed that nurses who worked greater than 8-9 hours were associated with worse reports of patient care quality and overall safety grade. Fatigue leads to reduced response times that negatively impact detecting and reporting critical rhythms and waveforms. It is essential that monitoring staff take breaks during shifts to allow for time away from the monitoring environment and that telemetry monitoring shifts should be minimally less than 12 hours, optimally under 10 hours, and no overtime.

Telemetry Monitor Station, Human Factors and Ergonomics

In 2014 (Kohani et al) used virtual reality to simulate a telemetry monitoring station and observe the impact of monitoring station designs on TMP performance related to delayed response and communication failure. They concluded that design consideration should include: 1) *the maximum number of signals that an individual operator can monitor simultaneously without degrading human performance; 2) the recognizable tone and frequency of alerts to identify abnormalities and reduce alarm fatigue; and 3) general design principles for control panel graphical user interfaces such as color coding, signal differentiation, screen layout, and hierarchical interface interaction*.

Cleanliness of Equipment

Telemetry monitoring boxes and reusable wires are exposed to patient surfaces for extended periods. The equipment and circuitry are easily contaminated with debris or bodily fluids. The following are recommendations:

- During use the telemetry box should be kept in a disposable protective pouch to reduce damage, exposure to contaminants, and excessive soiling
- Once telemetry is discontinued, boxes should be cleaned with a manufacturer recommended solution and in accordance with the infection control practices

within the institution

- Boxes found to be damaged or extremely dirty should be referred to Biomed for appropriate handling
- Reusable lead wires should be cleaned with a manufacturer recommended solution that does not cause wire damage
- Visible debris should be removed with a soft bush
- Soaking is not recommended
- Replace wires if they are visibly damaged or have been in contact with bodily fluids
- Biomed recommendations regarding lead wire duration of use should be followed

Some institutions have opted to use disposable lead wires. An AHA Practice Standard (p. e 318) indicated that a *comparative-effectiveness study revealed disposable electrocardiographic lead wires were associated with fewer technical alarms than reusable wires*. Cost, practicality, duration of use, reliability, infection control, and environmental disposal are all to be considered by institutions contemplating whether to use disposable or non-disposable lead wires (See Chapter 9)**.**

Components of Telemetry Monitoring as a Life Safety System:

Individual VHA facilities providing cardiac telemetry monitoring report challenges. Budgeting, physical lay-out, and equipment maintenance, along with staffing concerns such as competency, staff-to-monitor ratios, communication loops, and emergency contingencies are concerns throughout the system. Variations in practices have arisen which have been identified as vulnerabilities in the delivery of care during cardiac monitoring.

The NTTF has identified the following areas as necessary life safety considerations when providing cardiac telemetry within an institution:

- Provider selection of patients for telemetry
- Review for continuation of monitoring every 24 hours
- Concise order sets for cardiac telemetry monitoring, including indications, notification parameters, duration of monitoring, and code status
- Initiation of orders for cardiac telemetry within 30 minutes of admission
- Documentation of baseline physical assessment with VS upon admission
- Minimum documentation will include atrial and ventricular rate(s), PRI, QRS duration, QT/QTc; any ST deviations and overall rhythm interpretation, and QT interval at baseline and a minimum of every 8 hours, or more frequently as

dictated by patient condition and individual institution

- Processes for alarm management, defining responsibility for maintaining alarm parameters as ordered, and, alternatively, for defining a process to customize alarms to reduce non-actionable nuisance alarms (AHA, p. e317, Cvach, et al, 2017)
- Established process for communication of code status and arrhythmia notification along with a process to identify responsibility for escalation of notifications such as activation of RRT or code blue teams
- Established process for identification of staff assignments and contact numbers each shift, along with expectation that calls from telemetry be given high priority. Staff assigned to telemetry patients are responsible for remaining accessible or having an assigned designee during inaccessibility
- Maintaining uninterrupted telemetry monitoring for the duration ordered by provider. *Orders to be off telemetry for testing or non-medical reasons are not acceptable.*
- Patients who defer ordered cardiac telemetry monitoring will have documentation of discussions addressing risk and benefit from both provider and nurse
- Maintaining monitoring during transport using a monitor with pacer and defibrillator capabilities, accompanied by minimum BLS trained personnel

Interdisciplinary Team Approach to Caring for Cardiac Telemetry Patients

Telemetry monitoring alone does not ensure that patients will be safer or observed more closely. Evidence to the contrary has shown that monitoring offers a false sense of security for the provider as well as for the staff when the patient is being monitored for an unlimited duration, and when alarms go ignored due to alarm fatigue. Best practices for telemetry monitoring stress that orders clearly state the indication, notification parameters, code status, and the duration of continuation, and be reviewed at least every 24 hours. Therefore, daily review of cardiac monitoring information is an important part of (IDR) discussions between providers, nurses, and in some cases, the monitoring room staff. See Appendix D

1. After initial orientation and training, a mandatory periodic competency evaluation of all staff should be performed to ensure continued proficiency. Continuing education to reinforce current knowledge and update staff on research findings and techniques should be encouraged and supported.
2. Periodic audits of electrode placement and rhythm strip interpretation
3. A periodic review of unit protocols, initial training, staff competency, and

ongoing education efforts should be undertaken at designated intervals to determine whether they continue to meet staff and patient needs. This analysis should include reviews of staff performance, critical events, and patient outcomes

4. Appropriateness of telemetry indication, QTc monitoring, and ST segment monitoring

Chapter 6 Communication and Contingency Planning

Objective

- Provide guidance for contingency planning
- Identify effective interdisciplinary and interdepartmental communication pathways during telemetry outages
- Describe management strategies for front-line staff
- Describe management strategies for equipment (e.g., telemetry, communication, and EHR).

Recommendations for Contingency Plan Development

The NTTF recommends a facility level Telemetry Contingency Plan Committee. Facilities may choose to include any or all the following representatives in the contingency plan development: Biomedical engineers, Nursing (staff and/or management), Telemetry Monitoring Personnel (TMP), Information Technology (IT), Administrative Officer of on Duty (AOD), Patient Safety Manager (PSM), Facility engineers, Quality Management (QM), Emergency Management Coordinator, and others deemed appropriate to develop a high-quality plan.

Facilities should prepare for events occurring during normal business hours, off-tours, weekends and holidays; this is crucial for a strong telemetry contingency plan. The NTTF strongly encourages the following:

- There is a contingency plan in place specific to cardiac telemetry monitoring
- Telemetry outages should be treated as an emergency
- Patient admissions for telemetry areas should be avoided until the outage has been resolved
- Staff can locate the contingency plan in the event of an emergency
- Simulation of cardiac telemetry downtime contingency plan should be practiced at least once a year
- A written and verbal debrief of simulated or actual event should be presented to the Telemetry Contingency Plan Committee for quality control

The telemetry contingency plan should include standard procedures by facility. These will include the following:

- Standard procedures for planned, or unplanned outages of primary telemetry systems and primary communication systems
- Contingency activation pathway (may include facility alert system; e.g., overhead

page)

- Staff roles and responsibilities during an outage
- Interdisciplinary communication plan
- Documentation of EKG strips during outage
- Plan for triaging and monitoring patients during an outage
- Identification of back up equipment and supplies (with locations)
- Up-to-date emergency contact phone numbers
- Communication algorithm for awareness of the outage (See Appendix E)
- Transfer of patients to other areas or other facilities with telemetry monitoring capabilities for extended outages
- Troubleshooting and resolution of outage

Examples of pre-defined role responsibilities during telemetry down time

The following are examples, will be facility dependent:

Telemetry Monitor Personnel:

- Reports to person with unit oversight per facility policy
- Notifies the Charge Nurse of telemetry downtime
- Notifies Nurse Supervisor of telemetry downtime
- Provides input and recommendations of patient triage prioritization of most vulnerable patients with nursing and physician or designated provider
- Request further instruction on how to proceed

Nurse Supervisor or Nurse Manager or Charge Nurse as applicable:

One clear nurse lead is imperative to decrease confusion

- Notifies and maintains communication with telemetry personnel and AOD of loss of telemetry
- Reviews task list to assign personnel roles (e.g., have MSA as runner, room assignment for observation of portable monitors, etc.)
- Awareness of most vulnerable patients
- Assists designated physician/provider and telemetry technician with triaging most vulnerable patients, open beds, availability of transfers
- Maintains contingency reference binder and/or supply box

Nursing Staff:

- Ensure the contingency plan is implemented as directed by nurse lead

- Work with nurse charge to ensure identified patients are placed on alternative (hard-wire) cardiac monitor
- Re-adjust nursing assignment to ensure monitoring is maintained
- Maintain communication with Charge Nurse
- Ensure patient safety is maintained

Administrator of the Day (AOD):

- Notifies the Biomedical Engineering department of telemetry down time during off tour and holidays
- Ensures telemetry down time protocol is in place during off tour and holidays
- Contact on-call physician/provider to assess telemetry needs during off tour and holidays

Provider Lead: (hospitalist or cardiologist)

*****One clear provider lead is imperative to decrease confusion*****

- Decides most vulnerable patients to remain on portable telemetry
- Decides least vulnerable who can come off telemetry
- Decides who may need to be transferred to another area of facility or transfer to another site if needed
- Includes telemetry personnel, AOD or appropriate level of nursing supervision with decision-making to maintain clear communications

Biomedical Engineering:

- Troubleshoots telemetry technology systems
- Contacts vendor(s) for remote access as appropriate
- Locates backup equipment

Information Technology (IT):

- Maintain communication with Nurse Lead (see above)
- Maintain phone back up capability for phone outage (e.g., should have dedicated backup lines separate from the primary phone system for contingencies)
- Ensure there will be ability to appropriately document in the electronic medical record (EMR)
- Ensure backup cardiac telemetry history is accessible
- Complete inventory assessment at regular intervals per facility policy and equipment recommendations; ensure reconciliation

Chapter 7 Resource Allocation

Objectives

- Outline electrode, battery, lead wire use
- Discuss single and multi-use lead wire
- Discuss actions if patient refuses
- Outline emergency management of cardiac telemetry patients

Routine Battery Changes

Nuisance alarms are created when electrode conductive gel dries out, and skin impedance increases due to oils dirt, and perspiration. Daily (every 24 hour) assigned electrode changes have been shown to reduce lead disconnect alarms by as much as 46% (AHA, p. e318). Skin should be cleansed, dried, lightly abraded with a cloth, and new electrodes with dates written on them placed in the correct anatomical landmarks. Routine battery changes should be completed at vendor recommended intervals or if there is a low battery alarm.

Single-Patient Use, or Multiple-Patient Use Lead Wires

1) Lead wire integrity should be evaluated every 48 hours as recommended by AHA
2) A sufficient par level of electrodes and lead wires should be maintained.

Refusal of Patients for Remote Telemetry Monitoring

When providers identify patients meeting the criteria for remote telemetry monitoring and the patient refuses monitoring, provider and nursing documentation must reflect patient education specific to dangers associated with refusal of monitoring.

Emergency Management of Patients

Telemetry policies should include a system failure or shutdown contingency plan which clearly identifies response to various types of equipment failures/events to include but not limited to planned and unplanned telemetry system or communication system outages. See contingency plan considerations (Chapter 6)

Examples for emergency management check list may include:

1. Portable (hard box) monitors with locations

2. Binder with:
    a. Written telemetry down time contingency plan
        - Located on each unit
        - Located in a central repository for administrative reference
    b. Phone tree with primary and backup methods of contact (i.e., contact information during business hours and off-tour hours)
        - Appropriate supervisors and managers
        - AOD
        - Biomedical Engineering
        - IT
        - Vendor(s) (if applicable)
    c. Supplies locations
        - Lead wires for back up equipment
        - Correct plugs for backup equipment
        - Correct electrodes for backup equipment readily available
        - Quick reference on how to switch patients from telemetry to back up monitor
        - Backup batteries charged and available
        - Back-up and/or portable communication devices (e.g., two-way radios, dedicated land lines)

Chapter 8 Technology and Consumable Supplies

Objectives

- Guidance for procurement of new telemetry equipment or systems
- Explore the pros and cons of consumable supplies
- Outline factors that can be incorporated into the daily operation and maintenance of a telemetry system.

Considerations for Telemetry Equipment

The telemetry program should ***consult with the facility Biomedical Engineering department when investigating the procurement of new or upgrades to existing telemetry systems or equipment.*** Minimum Technology Requirements should be determined by a multifaceted team including technical and clinical subject matter experts to ensure the procurement meets the needs of the medical center and staff. The procurement team shall evaluate the clinical, technical, and cost considerations when procuring equipment. The facility Biomedical Engineering department shall advise as to the most appropriate configuration of the medical equipment.

Technology, Frequency, And Antenna

- The telemetry system should incorporate digital technology with the capacity to monitor up to 64 waveforms (ECG, SaO2, BP).
- The telemetry system must utilize a WMTS frequency allocated to medical systems (e.g., 608-614 MHz, 1,395-1,400 MHz, 1429-1,432 MHz, 2.4 GHz) or Wi-Fi (802.11 a, b, g, n). Frequency/Smart hopping is acceptable.
- Antenna systems must provide coverage for all areas of the existing telemetry nursing units. Facilities may choose to expand coverage to other areas.

General Requirements

- The telemetry system must provide battery status for each patient and must alarm for low battery conditions.
- The telemetry system must be able to distinguish between pacemaker and natural rhythm.

Telemetry Transmitter

- Each telemetry channel should be capable of monitoring the following parameters and have the associated features: 5 Lead ECG, SPO2, Respiration, Pulse Rate. SPO2 may be available through an external module.
- The telemetry transmitter should be water resistant and have, at minimum, an ingress protection rating of IPX3.
- The telemetry transmitter should withstand a drop from a height proportional to its mass as defined in ANSI/AAMI ES60601-1:2005/(R)2012 (Medical electrical equipment—Part 1: General requirements for basic safety and essential performance) section 15.3.4.2.
- The telemetry transmitter should provide a patient remote record activator.
- The telemetry transmitter should use manufacturer specific rechargeable batteries or commonly available batteries such as AA, AAA or 9 volt. Rechargeable Nickel Cadmium (NiCd) and Nickel Metal Hydride (NiMH) batteries are not recommended.
- The telemetry transmitters should have a minimum battery life of 24 hours (ECG only).

Arrhythmia Detection

- The telemetry system should provide basic or life-threatening arrhythmia detection (e.g., asystole, ventricular fibrillation (v.fib), ventricular tachycardia (v. tach)).
- The telemetry system should provide comprehensive arrhythmia detection (asystole, v.fib, v. tach, premature ventricular contraction (PVC)/minute, v. bradycardia, couplet, bigeminy, trigeminy, R-on-T, Accelerated Ventricular Rhythm, Single PVC, Tachycardia + Bradycardia, atrial fibrillation).
- The telemetry system should provide ST segment analysis.
- The alarms for v. tach and v. brady should have user configurable thresholds for each patient.

Remote Display

- The remote (slave) monitor should incorporate a color display.
- The remote (slave) monitor may have Active or Interactive capabilities.
  The remote (slave) monitor should have audio.

Full Disclosure and Review

- The full disclosure and review system should be capable of storing single lead ECG, multiple lead ECG, or all waveform parameters.
- The full disclosure and review system should be capable 96 hours of continuous storage for each patient.
- The telemetry system should provide a waveform history of 96 hours.
- The full disclosure and review system should be capable of providing a Holter Report on each patient.

Central Station and Recording

- The central station monitor should incorporate a color display.
- The central station should be capable of displaying at least 4 waveforms (4 patients) to be displayed simultaneously on the screen.
- The central station should allow for alarm controls (e.g., suspend, pause, confirm).
- The central station should produce audible alarms of adjustable volume.
- The central station should provide restricted permissions for administrative configuration
- The central station should provide cross-unit visibility.
- The central station recorder should be capable of single, dual, or multiple-line recording.
- The central station recorder should be capable of recording at 5/50 mm sec speeds.
- The central station should incorporate a laser printer.

Networking Capabilities

- The telemetry monitoring system should be capable of two-way information exchange (e.g., to electronic health record, nurse charting system) using HL7 (Health Level Seven) standards.
- The telemetry monitoring system should be capable of electronic patient data transfer to remote site/monitor.
- The telemetry system should be able to be installed on a stand-alone network, isolated from the hospital enterprise network. Inter-connections between the stand-alone network and enterprise network are permitted for information

exchange (e.g., electronic health record, nurse charting) but should be minimized.
- The telemetry system may interface to communication and alarm management systems.

Data Management

- The monitoring system should incorporate a quality assurance tracking and reporting package.
- The monitoring system should be able to produce alarm history reports.
- The monitoring system should be capable of interfacing with other departments and physicians' offices.
- The monitoring system should be capable of electronic patient transfer.

Safety/Performance Standards and Regulations

The telemetry system should meet the following FDA recognized consensus standards or previous version/equivalent standards:

- **ANSI AAMI ES60601-1:2005/R2012 and A1:2012**, *Medical electrical equipment—Part 1: General requirements for basic safety and essential performance*.

- **ANSI AAMI IEC 60601-1-2:2014,** *Medical electrical equipment - Part 1-2: General requirements for basic safety and essential performance - Collateral standard: Electromagnetic disturbances - Requirements and tests.*

- **ANSI AAMI IEC 60601-2-27:2011R2016,** *Medical electrical equipment - Part 2-27: Particular requirements for the basic safety and essential performance of electrocardiographic monitoring equipment*

If the telemetry transmitter uses rechargeable batteries, it should meet the FDA recognized consensus standard **IEC 62133-1 Edition 1.0 2017-02**, *Safety Requirements for Portable Sealed Secondary Cells (alkaline, lithium-ion)*.

Compliance with following consensus standards is not a requirement but may be considered by facilities when evaluating telemetry systems

- **IEC 60601-1-6:2006**, *General requirements for basic safety and essential performance - Collateral standard: Usability*

- **IEC 60601-1-8:2006**, *General Requirements for Safety for Alarm Systems*

- **IEC 60601-2-49:2001**, *Particular Requirements for Safety for Patient Monitoring Equipment*

- **AAMI EC 13:2007**, *Performance Standard, Cardiac Monitors*

- **AAMI EC 53:1995 (R) 2001,** *ECG Cables/Leadwires (excluding 4.2.1)*

- **ANSI AAMI IEC 60601-2-47:2012/R2016,** Medical electrical equipment - Part 2-47: Particular requirements for the basic safety and essential performance of ambulatory electrocardiographic systems

  (**NOTE:** *This is only applicable if the telemetry system does not fall under ANSI AAMI IEC 60601-2-27:2011R2016)*

- **AAMI EC57** Testing and reporting performance results of cardiac rhythm and ST-segment measurement algorithms

Operational and Maintenance Requirements for Telemetry Systems

The following list provides recommended operational and maintenance considerations for a cardiac telemetry monitoring system. This should be used as a reference when developing or reviewing your telemetry program. The following recommendations are based on existing policy and the opinions of the VHA National Telemetry Taskforce:

- Telemetry coverage should be verified before, during, and after construction or renovation. Verification may include functional testing, spectrum analysis, and/or coverage mapping.
- Telemetry systems should be installed and operated in accordance with VA Medical Device Security requirements, including but not limited to:
    - VA Directive 6550: Pre-Procurement Assessment of Medical Device Systems

VA Handbook 6500: Risk Management Framework for VA Information Systems – Tier 3: VA Information Security Program

OIS Risk Based Decision Memorandum 667: Risk Based Decision connection of the installation of VHA Patient Monitoring Systems to the VA network

- VA Memorandum 2010-04-04: Isolation Architecture for Networked Medical Devices

- Telemetry system components should be connected to an uninterruptible power supply (UPS) and hospital emergency power as applicable. Facilities should also consider using redundant fail-over power supplies where possible (i.e., for server components).
- All Telemetry systems must be registered with the American Society for Healthcare Engineering (ASHE) prior to operation. This is a requirement under 47 C.F.R Part 95. The VA Telemetry registration procedure can be found in **HTM Service Bulletin:** Telemetry Registration Procedure **(**http://vaww.ceosh.med.va.gov/01BE/Pages/documents/HTMTelemetryBulletin.pdf**).**
- Telemetry systems should be maintained according to the facilities medical equipment management plan. Manufacturer's maintenance requirements, previous experience, and applicable regulations should be consulted to develop a maintenance program for telemetry systems.
- Service training should be included with the purchase of telemetry systems if the facility chooses to maintain the system in-house. It is recommended that facility staff be trained prior to the end of the warranty period.
- Facilities should have a program in place to provide telemetry system technical support after hours and on weekend shifts. Examples might include on-call support or use of partial service contracts.
- If facilities utilize manufacturer or third-party service contracts, response times and remote assistance should be negotiated to provide an appropriate and timely response by the manufacturer. Consideration should be given to after hours and weekend support.
- Facilities should have in place a defined procedure for communicating and resolving telemetry system failures in a timely fashion.

- Facilities should ensure that end users have an effective plan to communicate system failures to Biomedical Engineering (or the manufacturer) quickly in the event of a failure.
- Facilities should have in place a contingency plan to be implemented in the case of unexpected or extended telemetry system downtime. Examples might include frequent rounding, one-to-one observation, emergency land-line phones or 2-way radios, and/or use of portable monitoring equipment. See Chapter 4 for additional information on contingency planning.
  Facilities should have in place a plan to communicate any scheduled maintenance activities involving the Telemetry system to the Telemetry unit manager, including the expected impact of the maintenance activities on Telemetry operations and the expected duration.

Single-Patient Use and Multiple-Patient Use Lead Wires and Electrodes

This section describes recommendations from the NTTF pertaining to lead wires and electrodes, along with supporting information intended to assist VHA facilities in decision making. The supporting information includes key findings from literature review and a cost comparison of single-patient use versus multiple-patient use lead wires for several telemetry program scenarios.

Recommendations

The NTTF determined that there is insufficient evidence to recommend either disposable (single-patient use) or reusable (multiple-patient use) lead wires; there is not enough evidence that disposable lead wires reduce the rate of hospital acquired infections. There is some evidence that disposable lead wires may lower the number of alarms for *no telemetry*, *leads fail*, or *leads off* alarms (Albert, Murray, & Ghandi, 2014), (Healthcare, 2019) (Bena, 2015).

Disposable lead wires can cost significantly more than reusable lead wires depending on individual facility parameters. The cost difference varies greatly based on patient workload and the replacement schedule for reusable lead wires. Individual sites should weigh the costs/benefits of their situation to determine if use of disposable lead wires may be warranted.

Recommendations for all facilities, whether single-patient use, or multiple-patient use lead wires are used:

- Electrodes should be replaced every 48 hours as recommended by AHA.
- Lead wire integrity should be evaluated every 48 hours as recommended by AHA.
- Sufficient par level of electrodes and lead wires should be maintained.

Recommendations for Facilities Using Multiple-Patient Use Lead Wires:

- Institute a replacement schedule for reusable lead wires, tracking the date they are placed in service. *This schedule should be adjusted as necessary so that lead wires are replaced prior to failure.*

- *Implement a routine inspection process for reusable lead wires*, replacing any lead wires that fail the inspection. Inspection should include:
    - Visual inspection of the cable housing, strain reliefs, and pins/connectors for signs of fraying, tearing, fracture, or corrosion.
    - Tactile inspection to assess how tightly the connectors mate together. Loose fitting cables should be replaced.
    - Performance based inspection to identify warnings or error messages (missing lead wire, bad connection, no signal, etc.)
    - Reprocess reusable lead wires with a manufacturer approved cleaning agent.

Supporting Information

Review of available literature identified the following key findings pertaining to single-patient use and multiple-patient use lead wires and electrodes:

- Literature confirms that telemetry lead wires may harbor contaminants. This was described by Albert et. al (2014), Lestari, Ryll, and Kramer (2013), and Safdar et. al (2012). However, there is no statistically significant difference in the rates of blood stream infection (BSI), ventilator-associated pneumonia (VAP), or surgical site infections (SSI) between disposable and reusable lead wires (Albert et al., 2014).

- Disposable lead wires may lower the number of alarms for no telemetry, leads fail, or leads off (Albert et. al, 2015). Monitoring artifact alarm rates in disposable lead wires are statistically non-inferior to reusable leads (Albert et

al., 2015). There is no statistically significant difference between true crisis or false crisis alarms with disposable and reusable lead wires (Albert et al., 2015).

- The 2017 American Heart Association (AHA) Practice Standards for ECG Monitoring recommend evaluating lead wires every 48 hours at a minimum (Sandau et al., 2017).

- The AHA cites a study (Cvach, Biggs, Rothwell, and Charles-Hudson, 2013) in their 2017 update to telemetry practice standards which demonstrated that daily electrode replacement decreased the number of alarms per monitored bed by 46% in multiple care units (Sandau et al., 2017). The AHA further recommends Class 1, Level of Evidence C) that electrodes be replaced every 48 hours (Sandau et al., 2017).

Cost Comparison of Single-Patient Use and Multiple-Patient Use Lead Wires

Disposable (single-patient use) lead wires result in a higher cost than reusable (multiple-patient use) lead wires. Based on historical VA purchasing data, a disposable lead wire costs approximately $20 and can be used for one patient. A multiple-patient use lead wire costs approximately $127 and is expected to last between 6 - 24 months before replacement (or 30 - 70 patient uses) (Turkman, 2011).

Based on this information, expected length of stay on telemetry (3 to 5.6 days), and average number of telemetry beds in VA (48 beds), a VA telemetry facility using disposable lead wires would spend $71,700 more per year than if reusable lead wires were used. This value is the average of multiple scenarios with varying telemetry utilization, expected life of re-usable electrodes, and average length of stay on telemetry.

The actual cost increase may range from 1.4 to 20 times more per year depending on the facilities demographics. A summary of the cost comparisons for each scenario evaluated is provided in Table 1.

Table 1. Cost Comparison of Single-Patient Use vs. Multiple-Patient Use Telemetry Lead Wires per year. The cost ratio is determined by dividing the cost of single-patient use lead-wires by the cost of multiple-patient use lead wires for the same scenario.

Expected Lead Wire Life (Days)	Telemetry Bed Utilization (Percent)	Expected Length of Stay (Days)	Annual Cost of Single-Patient Use	Annual Cost Multiple-Patient Use	Cost Ratio
60	80	5.6	$ 52,075.85	$ 37,190.32	1.4
180	80	5.6	$ 52,075.85	$ 12,396.77	4.2
365	80	5.6	$ 52,075.85	$ 6,113.48	8.5
60	80	3	$ 97,208.26	$ 37,190.32	2.6
180	80	3	$ 97,208.26	$ 12,396.77	7.8
365	80	3	$ 97,208.26	$ 6,113.48	15.9
60	100	3	$ 121,510.33	$ 37,190.32	3.3
180	100	3	$ 121,510.33	$ 12,396.77	9.8
365	100	3	$ 121,510.33	$ 6,113.48	19.9
		Average	**$ 90,264.81**	**$ 18,566.86**	**4.9**
		Average Cost Difference	**$ 71,697.96**		

Disposable and Rechargeable Batteries

The following section describes recommendations pertaining to telemetry batteries, along with supporting information intended to assist VHA facilities in decision making. The supporting information includes key findings from review of technical literature and a cost comparison of disposable versus reusable batteries.

Recommendations

It was determined that universal adoption of disposable batteries throughout VHA is impractical due to the technical constraints of the telemetry transmitters currently in use in VHA and minimal performance difference between disposable alkaline and rechargeable Lithium-Ion (Li-ion) batteries. Use of rechargeable Li-ion batteries may provide a cost savings for certain scenarios without compromising battery life, however, not all telemetry manufacturers offer this technology. The following recommendations are provided:

- Facilities should check their telemetry transmitter manufacturer's instructions for use (IFU) for specific battery requirements and adhere to them. This is critical to ensure consistent battery life and accurate battery life indicators.
- Telemetry transmitters should not be used if the battery door does not securely fasten closed as batteries may not be secured in place. Safety reports have described adverse events resulting from un-secured telemetry transmitter battery doors.

- Facilities should avoid using rechargeable Nickel Cadmium (NiCd) or Nickel Metal Hydride (NiMH) batteries in telemetry transmitters. NiCd and NiMH batteries are expected to have a significantly shorter battery life and may result in an inaccurate battery life indicator or low battery alarms when used for telemetry.
- If using disposable batteries, facilities should use alkaline batteries that meet the telemetry transmitters manufacturers specifications provided in the IFU or technical documentation. Generally, facilities should use high quality alkaline batteries unless otherwise specified in the manufacturer's instructions.
- Facilities should develop a schedule for battery replacement and document it in their standard operating procedures. This schedule should consider the expected battery life of the telemetry transmitter with/without SPO2 in use. The following can be used as a starting point, and facilities should tailor the specific replacement schedule to their needs and specific telemetry technology and adjust over time, as necessary:

    - Replace telemetry transmitter batteries for every new patient or every 24 hours if operating in ECG only mode.
    - Replace telemetry transmitter batteries every 12 hours if using continuous SPO2.
    - Replace telemetry transmitter batteries any time a low battery indicator is observed. A low battery indicator may indicate as little as 30 minutes until battery depletion.
    - Always replace all batteries in a transmitter at the same time
    - The battery replacement schedule should include designation of responsible individuals.

- Facilities should always maintain a sufficient supply of batteries. Par levels for batteries should be verified daily. We recommend that batteries are provided through central supply and that the quantity should not to be changed without consultation of the telemetry manager. There are numerous safety reports describing battery shortages affecting telemetry operations in VA.

- For facilities using rechargeable batteries, we offer the following additional recommendations:

- Avoid using rechargeable NiCd or NiMH batteries as a replacement for disposable alkaline batteries.
- Replace/recharge transmitter batteries as indicated by low battery indicator or at least every 24 hours. The low battery indicator may indicate as little as 30 minutes until battery depletion.
- Replace the inventory of rechargeable batteries every 2 years (or per manufacturer recommendations).
- Have an inventory of at least 2 rechargeable batteries for each telemetry transmitter in the facility and the appropriate number of charging stations to support the inventory of rechargeable batteries.

Supporting Information

Technical literature indicates that telemetry transmitters use primarily AA, 9V, or lithium ion Li-ion type batteries. Several manufacturer instructions for use state that high quality, alkaline, AA batteries or manufacturer specific rechargeable Li-ion batteries should be used and that rechargeable NiCd or NiMH batteries should not be used (Philips Medical Systems, 2011; GE Healthcare 2008; Nihon Kohden, n.d).

The reason that specific batteries must be used is to ensure the accuracy of the battery life indicator and low battery warning indicator (Philips Medical Systems, 2011). The battery life of NiCd or NiMH rechargeable AA batteries is reported to be one-half to one-third compared to disposable alkaline AA batteries (Nihon Kohden, n.d). An alkaline AA battery has a capacity of 2500 mAh, AA reusable NiMH battery has a capacity of 1000 mAh, and AA reusable NiCd battery has a capacity of 600 mAh (Buchmann, 2001). Manufacturer provided rechargeable Li-ion batteries have a comparable battery life to disposable AA alkaline batteries (Philips Medical Systems, 2011). Table 2 below shows the expected battery life for the Philips MX-40 telemetry transmitter for disposable AA alkaline batteries and rechargeable Li-ion batteries.

Table 2: Philips MX40 telemetry transmitter expected battery performance as stated in IFU (Philips Medical Systems, 2011).

Charge	Life (Li-ion)	Life (AA Alkaline 1.5 V)
100%	>25 hours	>24 hours
50%	<13 hours	<12 hours
Low battery	<30 minutes	< 30 minutes

Table 3 below shows the expected battery life for four major telemetry manufacturers when using disposable alkaline AA batteries.

Table 3. Expected battery life of telemetry transmitters using alkaline AA batteries. Data obtained from ECRI Institute (n.d.) on 11/29/2018.

	Philips MX40	GE ApexPro/ApexPro CH	Nihon Kohden ZM 531PA	Spacelabs Aria
Battery used	3 X Alkaline AA	2 X Alkaline AA	3 X Alkaline AA	2X Alkaline AA
Battery Life (ECG Only mode)	37 hours	40/120 hours	72 hours	>120 hours
BATTERY LIFE (ECG + spo2)	22 hours	30-60 hours (external SPO2 module)	60 hours	24 hours

Cost Comparison of Disposable and Reusable Batteries

VA Purchasing data and results of a survey of VHA telemetry facilities were used to develop a cost comparison of disposable alkaline batteries vs. rechargeable Li-ion batteries for three scenarios; changing the batteries at every shift change (12 hours), every 24 hours, and every 33 hours (the average battery life expectancy of a telemetry transmitter based on Table 3).

Based on historical VA purchasing data, rechargeable Li-ion batteries cost $250.00 each while the cost per disposable battery is $0.32. NTTF estimate assumes an average of 48 telemetry beds per facility (based on survey data) and that every telemetry

transmitter requires two rechargeable batteries (due to the run time and requirement for a backup battery) or three AA disposable alkaline batteries to function. For the estimate, costs were spread over 2 years as would be practical for facilities for budgetary purposed (i.e., assume that facilities replace half of the batteries each year). The results of these simulations for disposable AA batteries vs. rechargeable Li-ion batteries are provided in Table 4. Table 4 illustrates that disposable batteries are generally more expensive to use when they are changed at intervals of 24 hours or less; rechargeable Li-ion batteries may provide a cost savings for these scenarios.

Table 4: 10-year cost comparison of reusable Li-ion batteries and disposable alkaline AA batteries replaced every 12, 24, and 33 hours. Cost ratio is determined by dividing the cost of the disposable battery estimate by the cost of the of the reusable battery estimate.

	Rechargeable Li-ion battery	Disposable Alkaline AA changed every 12 Hours	Disposable Alkaline AA changed every 24 Hours	Disposable Alkaline AA changed every 33 Hours
Year 1	$ 12,000	$ 29,265	$ 14,633	$ 10,642
Year 2	$ 24,000	$ 58,531	$ 29,265	$ 21,284
Year 3	$ 36,000	$ 87,796	$ 43,898	$ 31,926
Year 4	$ 48,000	$ 117,061	$ 58,530	$ 42,568
Year 5	$ 60,000	$ 146,327	$ 73,164	$ 53,210
Year 6	$ 72,000	$ 175,592	$ 87,796	$ 63,851
Year 7	$ 84,000	$ 204,858	$ 102,429	$ 74,494
Year 8	$ 96,000	$ 234,123	$ 117,062	$ 85,136
Year 9	$ 108,000	$ 263,389	$ 131,694	$ 95,778
Year 10	$ 120,000	$ 292,654	$ 146,327	$ 106,420
	Cost Ratio:	2.44	1.22	0.89

Appendix A Thank You

The dedicated members of this Telemetry Guidebook Development Team, The Telemetry Task Force, contributors and supporters would like to dedicate this first ever Telemetry Guidebook in honor of all of our Veterans who answered the call to serve and protect this wonderful nation. Our mission is to serve you like you have served. Thank You!

Sincerely,

Beth Ann Taylor, DHA, RN, NEA-BC
Chief Nursing Officer

Richard S. Schofield MD, FACC, FAHA
National Program Director, Cardiology
VA Office of Specialty Care

Appendix B: Glossary

Acute Coronary Syndrome (**ACS**) - is a syndrome (set of signs and symptoms) due to decreased blood flow in the coronary arteries such that part of the heart muscle is unable to function properly or dies. New-onset angina is also considered unstable angina, since it suggests a new problem in a coronary artery.

Alkaline battery - is a type of primary battery which derives its energy from the reaction between zinc metal and manganese dioxide.

American College of Cardiology (ACC) - is a nonprofit medical association which was established in 1949 to help the formulate health policy and support cardiovascular research. ACC bestows credentials upon cardiovascular specialists who meet its qualifications. ACC is an active member of the American Heart Association (AHA).

Arrhythmia - is a problem with the rate or rhythm of your heartbeat. It means that your heart beats too quickly, too slowly, or with an irregular pattern. When the heart beats faster than normal, it is called tachycardia.

Critical Care Unit- is an intensive therapy unit or intensive treatment unit or critical care unit, is a special inpatient unit that provides intensive treatment medicine.

Electrode – The patch that is placed onto the patient and attaches to the lead wire

Electrocardiographic interpretation - is the process of producing an electrocardiogram by interpreting the graph recording of voltage versus time of the heart's electrical activity using electrodes placed on the skin.

Evidenced based standard practice – means that an intervention or assessment has demonstrated meaningful and reproducible results in carefully controlled research studies. The phrase evidence-based practice (or EBP) is widely known throughout educational and health care settings.

Ischemia (ST segment) monitoring - ST-segment monitoring can detect silent ischemia, which occurs in the absence of symptoms. Although the impact of ST-segment monitoring on patient outcomes is not known, when ST-segment monitoring is used it is imperative that accurate data is obtained.

Lithium-ion batteries - Li-ion batteries use an intercalated lithium compound as one electrode material, compared to the metallic lithium used in a non-rechargeable lithium battery. The batteries have a high energy density, no memory effect (other than LFP cells) and low self-discharge.

Office of Nursing Services Cardiovascular Field Advisory Committee – Is part of the Clinical Practice Program (CPP) which was developed by the Office of Nursing Services (ONS) to support nursing practice at the point of care.

PR Interval- Often abbreviated PRI, the *PR interval* is the distance (time) between the beginning of the P wave and the beginning of the QRS complex. The *R* in *PR interval* refers to the R wave, but it is not always measured to that wave. It ends at the beginning of the first wave in the QRS complex.

QRS complex - Is the combination of three of the graphical deflections Q wave, R wave and S waves are seen on a typical electrocardiogram. It is usually the central and most visually obvious part of the tracing. QRS corresponds to the depolarization of the right and left ventricles of the human heart and contraction of the large ventricular muscles. In adults, the QRS complex normally lasts 0.06–0.10 seconds.

QT/QTc monitoring - Normal QT interval upper wave limits are determined by the heart rate; as a result, the QT corrected for heart rate, or QTc, is often used (QTc=QT/square root of the Respiration Rate (RR) interval) as a reference point. In general, the QT interval is less than 0.46 seconds, and intervals greater than this number are defined as prolonged.

Quality assurance indicators – These are select indicators which use available data collected throughout the routine health information system.

Quality Improvement - is a systematic, formal approach to the analysis of practice performance and efforts to improve performance.

Root Cause Analysis- is a systematic process for identifying underlying causes and contributing factors of problems or events and a systematic approach for correcting and eliminating vulnerabilities.

Safety reports - are detailed documents prepared by any level VHA employee describing what actual or close call (near miss) event occurred and identifies the actions taken by the unit to mitigate risk and treat the patient.

Sentinel Events - is an unexpected occurrence involving death or serious physical or psychological injury, or the risk thereof. Serious injury specifically includes loss of limb or function.

SpO2: stands for peripheral capillary oxygen saturation, an estimate of the amount of oxygen in the blood.

ST segment deviations or ST segment abnormality – ST segment deviations in the standard surface electrocardiogram (ECG) are a common finding. ST segment deviations are also associated with potentially arrhythmogenic conditions such as Brugada and early repolarization syndromes. ST segment abnormalities on the ECG can sometimes be due to a specific cause, such as ST segment elevation myocardial infarction, pericarditis or myocardial ischemia.

Transmitters - Telemetry receivers and telemetry transmitters are data acquisition components used to gather information from remote locations via wireless communication. Telemetry receivers and telemetry transmitters can be produced as separate receiver and transmitter units or combined into a device known as a transceiver.

Telemetry Monitoring Personnel (TMP) - are the different positions who carry out job functions related to telemetry monitoring.

Ventricular Bradycardia - V Brady is a very slow heart rate of less than 60 beats per minute. Bradycardia usually affects elderly people, but it may affect even the very young. It may be caused by one of two sources: The central nervous system does not signal that the heart needs to pump more, or the SA node may be damaged.

Ventricular tachycardia (V-tach or VT) - is a type of regular, fast heart rate that arises from improper electrical activity in the ventricles of the heart. Although a few seconds may not result in problems, longer periods are dangerous.

Appendix C Cardiac Telemetry Monitoring Implementation Pre-Post Assessment

The following assessment tools were designed to guide facilities in performing an initial and ongoing assessment of the cardiac telemetry program(s). The goal is to identify current capabilities and vulnerabilities and to conduct continuous quality improvements for providing safe, efficient, and patient centered-care.

Chapter 2. Telemetry Roles, Responsibilities, and Procedures	Met	Partially Met	Not Met	Comment
The facility policy for telemetry addresses:				
Provider orders for telemetry				
Requirements for patient assessment and evaluation				
Correct skin preparation and electrode placement				
Proper lead selection and process				
Minimum documentation requirements				
Responsibilities for alarm parameters				
Requirements for rhythm strip assessment and documentation				
Process for shift handoff				
Discontinuation criteria				
Patient Transport monitoring with defibrillator and minimum BLS requirements				
Alarm communication processes and expected response times				
Schedules for electrode, lead wire, and battery replacement				
Storage and cleaning of telemetry transmitters, adapters, and lead wires				
Competency requirements for central monitoring station process and equipment				
Competency requirements for telemetry monitoring personnel				
Alarm parameters and customization				
Operational plan if no telemetry beds or telemetry boxes available				
The facility has a process for patients that refuse telemetry.				

Chapter 3. Cardiac Telemetry Monitoring Indications	Met	Partially Met	Not Met	Comment
Facility order sets address telemetry monitoring indications				
Facility *monitoring parameters* are in line with AHA/ACC recommendations				
Orders to discontinue telemetry are automatic every 24 hours unless renewed				

Chapter 4. Education and Competency	Met	Partially Met	Not Met	Comment
All telemetry monitoring personnel meet the minimum telemetry education requirements (Chapter 4).				
All telemetry monitoring personnel demonstrate annually, competency specific to telemetry equipment, facility policy and processes, and central station monitoring				
All telemetry monitoring personnel are trained in Basic Life Support (BLS), **and** Advanced Cardiac Life Support (ACLS) **if** *required by the position.*				

Chapter 5. Reducing the Risks associated with Telemetry Monitoring	Met	Partially Met	Not Met	Comment
Telemetry monitoring personnel are limited to monitoring no more than ***40 waveforms*** simultaneously				
Telemetry monitoring personnel shifts are limited to no more than 10 hours				
Cleaning of telemetry transmitters, adapters, and lead wires is consistent with manufacturer's and facility reusable medical equipment recommendations				
The facility has implemented the life safety considerations provided in Chapter 5, as appropriate				
The facility reviews cardiac monitoring information at least every 24 hours as part of an interdisciplinary discussion.				

Chapter 6. Communication and Contingency Planning	Met	Partially Met	Not Met	Comment
The facility has a telemetry contingency plan for planned or unplanned downtime, addressing the considerations outlined in Chapter 6.				
The facility simulates or practices the telemetry contingency plan at least once per year with a documented follow-up debriefing.				

Chapter 7. Resource Allocation	Met	Partially Met	Not Met	Comment
The facility has a pre-determined electrode change schedule and has outlined responsibilities to ensure compliance.				
The facility has a pre-determined telemetry transmitter battery change schedule and has outlined responsibilities to ensure compliance.				
The facility has a pre-determined lead wire evaluation and change schedule and has outlined responsibilities to ensure compliance				
The facility maintains a sufficient supply of batteries, lead wires, and electrodes.				
The Facility has an emergency management plan for telemetry equipment				

Chapter 8. Technology and Consumable Supplies	Met	Partially Met	Not Met	Comment
The facility has a process in place to verify and troubleshoot telemetry infrastructure wireless coverage issues (e.g., access point issues, dead spots, signal strength) before, during, and after construction **or** renovation **and or** as needed.				
The facility's telemetry system is installed and operated in accordance with current VA Medical Device Security requirements (Chapter 8)				
Telemetry system components are connected to an uninterruptible power supply (UPS) and emergency power, as applicable.				
The facility's telemetry system is registered with the American Society for Healthcare Engineering (ASHE)				
The facility's telemetry system is included in the facility's medical equipment management plan				
The facility has a process in place for technical support outside of normal business hours				
The facility has a process in place to communicate scheduled maintenance activities to the Telemetry unit manager				
The facility uses telemetry transmitter batteries that are consistent with the manufacturer's instructions for use				

Appendix D: Interdisciplinary Team Approach to Caring for Cardiac Telemetry Patients

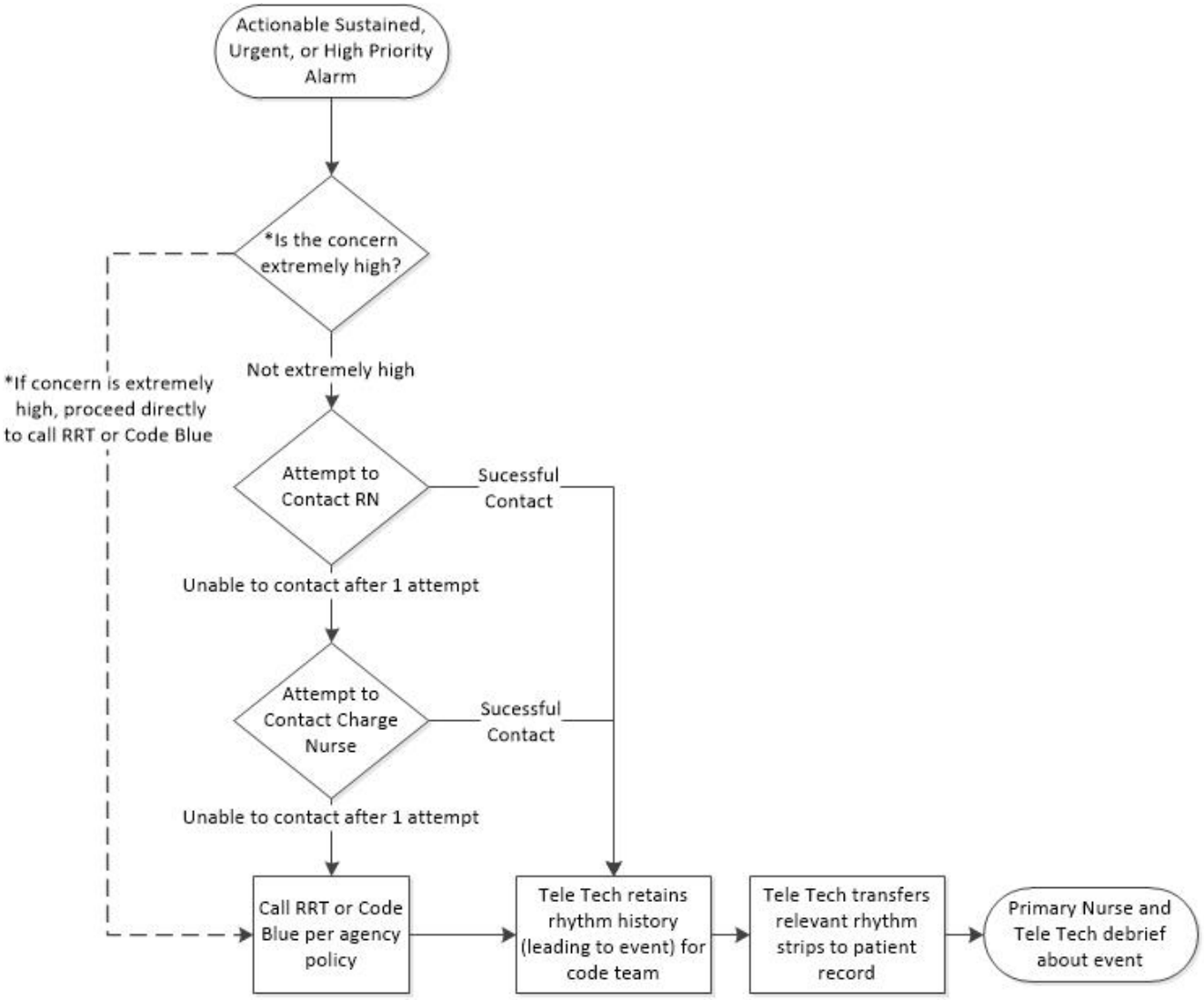
Provider	Nurse	Telemetry Monitor Personnel (TMP)
Order placed for cardiac telemetry	Receive and implement telemetry order:	
	Inform monitor room personnel of admission, code status, nurse contact information Educate patient	TMP advised of admission
	Enter patient information into telemetry system (depending on institution process)	Enter patient information into telemetry system (depending on institution process)
	Skin prep and apply patient monitoring telemetry box	Use proper skin prep and electrode locations when changing electrodes
	Document baseline assessment and Vital Signs (VS) and RN physical assessment	Obtain and document baseline rhythm strip, including measurements of rate, intervals, rhythm analysis
	Include baseline monitoring data and any related to reported arrhythmia events during shift hand-off	Discuss baseline monitoring data, any arrhythmia events, changes in alarm parameters, admission and discharge

		information during shift hand off
Review telemetry rate and rhythm upon admission	Verify connectivity of telemetry transmission Verify tracings and measurements Verify alarm status is set to ordered parameters	Notify nurse of connectivity status Notify nurse of baseline rate, rhythm Verify alarm status remains at ordered parameters
Consider reevaluating alarm parameters to reduce nuisance non-actionable alarms	Assist TMP to reduce nuisance alarms by requesting team reevaluation of parameters	Report nuisance alarms to nurse
Receive reported concerns from nursing staff related to telemetry data Assess as needed Initiate orders as indicated	Assess patient and report changes in VS, rate, rhythm, or indications of physiologic changes to provider Consider activation of emergency protocols based on assessment Note and carry out orders	Notify nurse of changes in heart rate (HR), rhythm, arrhythmias, or interval alterations Consider escalation of emergency protocols (based on institution policy)

	Document notification of provider and orders obtained	Document strips during activation of emergency
Evaluate for continuing monitoring during daily rounds	Respond to calls from telemetry on an urgent basis and report arrhythmia and tele notifications to provider	Follow notification criteria for reporting arrhythmias and rates exceeding ordered parameters
	Document HR, rhythm and any arrhythmia notifications, noting interventions if needed	Document strip and who was notified
	Maintain telemetry at all times	Contact assigned nurse immediately for unexplained loss of telemetry connection, lead, or battery alarms
	Routinely change electrodes at least every 48 hours. Write date on all electrodes. Change batteries on a routine schedule per manufacturer's specifications and type of system used (Daily or Mon, Wed, Fri)	Document rhythm strips and interpret at a minimum of every eight hours or more frequently if indicated. Strips should be promptly entered patient's medical record per institution's practice
Discuss the impact of telemetry data on plan of care during	Participate in IDR discussions about plan of care including need	Inform nurse of patients who have not shown any rate, rhythm, or

interdisciplinary rounds (IDR)	for continued monitoring	arrhythmia events for 48 hours
Evaluate for discontinuation of telemetry monitoring during daily rounds	Receive and implement discontinuation orders	
Place order for discontinuation of telemetry monitoring	Notify TMP of discontinuation Remove monitor, batteries, and all electrodes from patient Document discontinuation of monitoring Clean equipment per facility reusable medical equipment SOP	Upon notification of discontinuation, document a final rhythm strip

Appendix E Sample Alarm Actionable Telemetry Alarm Communication Algorithm



Actionable Alarm – A true, potentially lethal alarm that requires a timely clinical intervention to avoid an adverse event (Patient Safety and Quality Healthcare, 2012)

Urgent (Yellow) Alarm – SVT, Non-sustained VT, onset of 3rd degree heart block, or a sudden change in heart rate or rhythm

High Priority (Red or Crisis) Alarm – Vfib, Vtach, or asystole

*Extremely high concern may include potentially lethal arrhythmias seen in 3 or more leads.

Appendix F References

References

AACN. (2018). Practice Alert Outlines Alarm Management Strategies. *American Association of Critical Care Nurses*. Retrieved October 23, 2019, from https://www.aacn.org/newsroom/practice-alert-outlines-alarm-management-strategies

AAMI. (2011). *Clinical Alarms Summit*. (Convened by AAMI, FDA, TJC, ACCE, and ECRI Institute) Retrieved October 24, 2019, from Association for the Advancement of Medical Instrumentation: http://s3.amazonaws.com/rdcms-aami/files/production/public/FileDownloads/Summits/2011_Alarms_Summit_publication.pdf

Albert N., S. E. (2014). Infection Rates in Intensive Care Units by Electrocardiographic Lead Wire Type: Disposable Vs Reusable. *American Journal of Critical Care Nurses, 23*(6), 460-467. doi:10.4037/ajcc2014362.

Albert, N. M. (2015). Differences in Alarm Events Between Disposable and Reusable Electrocardiography Lead Wires. (D. o. Technology, Ed.) *American Journal of Critical Care, 24*(1), 67-74. doi:10.4037/ajcc2015663

American Association of Critical Care Nurses. (2016). *Accurate Dysrhythmia Monitoring in Adults.* Retrieved November 5, 2019, from https://www.aacn.org/clinical-resources/practice-alerts/dysrhythmia-monitoring

Angantyr, L. H. (2009). KAMEDO Report No. 93 The Power Failure at Karolinska University Hospital, Huddinge, 07 April 2007. *Cambridge Core, 24*(5), 468-470. doi:doi.org/10.1017/S1049023X00007330

Attin, M. &. (2011). Using QRS Morphology and Qtc Interval to Prevent Complications and Cardiac Death. *Critical Care Nursing Quarterly , 34*(3), 246-253. doi:10.1097/CNQ.0b013e318221477c

Benjamin, E. K. (2013). Impact of Cardiac Telemetry on Patient Safety and Cost. *The American Journal of Managed Care, 1*(19), 225-232. Retrieved October 24, 2019, from https://www.ncbi.nlm.nih.gov/pubmed/23844751

Buchman, I. (2016). *Batteries in a portable world* (Vol. 4). Richmond, British Columbia, Canada : Cadex Electronics Inc.. . Retrieved October 24, 2019, from https://www.amazon.com/Batteries-Portable-World-Rechargeable-Non-Engineers/dp/0968211844/ref=pd_sbs_14_t_0/131-7191107-9619206?_encoding=UTF8&pd_rd_i=0968211844&pd_rd_r=a7a12655-7a07-4487-ba2b-1a75417f47bd&pd_rd_w=q2ZRR&pd_rd_wg=GxkjF&pf_rd_p=5cfcfe89-300

Burns, S. (2006). *AACN Protocols for Practice: Noninvasive Monitoring,* (Vol. 4). Jones & Bartlett Learning. Retrieved October 24, 2019

Cohen, J. H. (2009). Neural basis of the set-size effect in frontal eye field. *Journal of Neurophysiology, 101*(4), 1699-1704. doi:10.1152/jn.00035.2009

Crimlisk, J. J. (2015). Cardiac Monitoring: Hospital-Wide Education and Staff Competence. *Dimensions of Critical Care Nursing, 34*(3), 170-175. doi:10.1097/DCC.0000000000000107

Department of Veterans Affairs. (2019). *Office of Nursing Services (ONS).* Retrieved November 5, 2019, from Clinical Practice Program (CPP): https://www.va.gov/NURSING/practice/cpp.asp

Drew, B. (2006, August). Pitfalls and Artifacts in Electrocardiography. *Cardiology Clinics, 24*(3), 309-315. doi:https://doi.org/10.1016/j.ccl.2006.04.006

Drew, B. (2011, March - April). Standardization of Electrode Placement for Continuous Patient Monitoring: Introduction of an Assessment Tool to Compare Proposed Electrocardiogram Lead Configurations. *Journal of Electrocardiology, 44*(2), 115-118. doi:https://doi.org/10.1016/j.jelectrocard.2010.10.031

Drew, B. (2011). Standardization of Electrode Placement for Continuous Patient Monitoring: Introduction of an Assessment Tool to Compare Proposed Electrocardiogram Lead Configurations. *Journal of electrocardiology, 44*(2), 115-118. doi:10.1016/j.jelectrocard.2010.10.031

Drew, B. (2017). Update to Practice Standards for Electrocardiographic Monitoring in Hospital Settings: A Scientific Statement From the American Heart Association. *Circulation, 136*(19), 157-168. doi:10.1016/j.ccell.2006.01.007.

Drew, B. A. (2010). Prevention of Torsade De Pointes in Hospital Settings: A Scientific Statement From the American Heart Association and the American College of Cardiology Foundation. *Journal of American College of Cardiology*, 934-947. doi:10.1016/j.jacc.2010.01.001

Drew, B. C. (2005). AHA scientific Statement: Practice Standards for Electrocardiographic Monitoring in Hospital Settings. *Journal of Cardiovascular Nursing, 20*(2), 76-106. doi:10.1097/00005082-200503000-00003

Drew, J. &. (2006). Practice Standards for ECG Monitoring in Hospital Settings:. *Critical Care Nursing Clinics of North America, 18*(2), 157-168. doi:10.1016/j.ccell.2006.01.007

DVA. (2019). *Clinical Practice Program (CPP) Products*. Retrieved December 16, 2019, from Office of Nursing Services: http://vaww.va.gov/nursing/cppProducts.asp

Evenson, L. &. (2008). Skilled Cardiac Monitoring at the Bedside: An Algorithm for Success. *Critical Care Nurse, 30*(5), 14-22. doi:10.4037/ccn2010471

Feder, S. &. (2013). Over-Monitoring and Alarm Fatigue: For Whom do the Bells Toll? *Heart Lung, 42*(6), 395-396. doi:10.1016/j.hrtlng.2013.09.001

Flanders, S. (2007). ST-Segment Monitoring. *Advanced Critical Care, 18*(3), 275-284. doi:10.4037/15597768-2007-3006

Funk, M. F. (2017). Association of Implementation of Practice Standards for Electrocardiographic Monitoring With Nurses' Knowledge, Quality of Care, and Patient Outcomes: Findings From the Practical Use of the Latest Standards of Electrocardiography (PULSE) Trial. *Circulation: Cardiovascular Quality and Outcomes, 10*(2). doi:10.1161/CIRCOUTCOMES.116.003132

Funk, M. R. (2016). Use of Monitor Watchers in Hospitals: Characteristics, Training, and Practices. *Biomedical Instrumentation & Technology*. doi:https://doi.org/10.2345/0899-8205-50.6.428

Funk, M. W. (2010). Unnecessary Arrhythmia Monitoring and Underutilization of Ischemia and QT Interval Monitoring in Current Clinical Practice: Baseline Results of the Practical Use of the Latest Standards for Electrocardiography (PULSE) Trial. *Journal of Electrocardiology*, 542-547. doi:10.1016/j.jelectrocard.2010.07.018

George, K. W.-I. (2015). Development of Evidence-Based Remote Telemetry Policy Guidelines for a Multifacility Hospital System. *Dimensions of Critical Care Nursing, 34*(1), 10-18. doi:10.1097/DCC.0000000000000084

Ghandi, H. B. (2014). *Investigating Electrocardiography Lead Wires as a Reservior For Antibiotic-Resistent Pathogens*. Retrieved November 4, 2019, from Life Sync: https://lifesynccorp.com/603

Grossman, S. S. (2011). Is Telemetry Useful in Evaluating Chest Pain Patients in an Observation Unit? *Internal Emergency Medicine, 6*(6), 543-546. doi:10.1007/s11739-011-0648

Healthcare, G. (2019). *GE HealthCare* . Retrieved November 4, 2019, from Enterprise-wide telemetry: https://www.gehealthcare.com/products/patient-monitoring/wireless-networks/apexpro-ch-telemetry-system

Hollander, J. S. (2004). Lack of Utility of Telemetry Monitoring for Identification of Cardiac Death and Life-Threatening Ventricular Dysrhythmias in Low-Risk Patients with Chest Pain. *Annals of Emergency Medcine , 43*(1), 71-76. Retrieved November 4, 2019, from https://www.ncbi.nlm.nih.gov/pubmed/?term=Lack+of+utility+of+telemetry+monitoring+for+i

dentification+of+cardiac+death+and+life-threatening+ventricular+dysrhythmias+in+low-risk+patients+with+chest+pain.
IOM. (2001). *Crossing The Quality CHASM.* National Academy of Sciences. Retrieved October 24, 2019, from http://www.nationalacademies.org/hmd/~/media/Files/Report%20Files/2001/Crossing-the-Quality-Chasm/Quality%20Chasm%202001%20%20report%20brief.pdf
Ivonye, C. O.-F. (2010). Evaluation of Telemetry Utilization, Policy, and Outcomes in an Inner-City Academic Medical Center. *Journal of the National Medcine Association, 102*(7), 598-604. doi:10.1016/s0027-9684(15)30637-4
Ivonye, C. O.-F. (2010). Evaluation of Telemetry Utilization, Policy, and Outcomes in an Inner-City Academic Medical Center. *Journal of National Medicine Association, 102*(7), 598-604. doi:10.1016/s0027-9684(15)30637-4
Jacobsen, C. (2003). Bedside Cardiac Monitoring. *Critical Care Nurse, 23*(6), 71-73. Retrieved November 1, 2019, from http://ccn.aacnjournals.org/content/23/6/71.full
Kligfield, P. G. (2007). Recommendations for the Standardization and Interpretation of the Electrocardiogram. *Journal of the American College of Cardiology, 49*(10), 1109 - 1127. doi:10.1016/j.jacc.2007.01.024
Kohani, M. B.-C. (2014). Evaluating Operator Performance for Patient Telemetry Monitoring Stations Using Virtual Reality. *Sage Journals, 58*(1), 2388-2392 . doi:10.1177/1541931214581497
Kohden, N. (Ed.). (2019). Transmitter. *Operator's Manual ZM-920PA/921PA/930PA/931PA.* Retrieved November 5, 2019, from https://usermanual.wiki/Nihon-Kohden/ZM-921PA-1035718.pdf
Lee, J. L. (2008). Optimizing Telemetry Utilizations in Academic Medical Center. *Journal of Clinical Outcmes Management, 15*(9), 435-440. Retrieved November 4, 2019, from https://www.researchgate.net/publication/288705223_Optimizing_telemetry_utilization_in_an_academic_medical_center
Lee, J. R. (2008). Optimizing Telemetry in an Academic Medical Center. *Journal of Clinical Items, 15*(9), 435-440. Retrieved November 5, 2019, from http://seminmedpract.com/pdf/jcom_sep08_telemetry.pdf
Leighton, H. K. (2013). Effect of an Electronic Ordering System on Adherence to The American College Of Cardiology/American Heart Association Guidelines For Cardiac Monitoring. *Critical Pathways in Cardiology, 12*(1), 6-8. doi:10.1097/HPC.0b013e318270787c
Lestari T., R. S. (2013). Microbial Contamination of Manually Reprocessed, Ready to use ECG Lead Wire in Intensive Care Units. *GMS Hygiene and Infection Control, 8*(1). doi:10.3205/dgkh000207
Madhavan P. & Gonzalez, C. (2006). Effects of Sensitivity, Criterion Shifts, and Subjective Confidence on the Development of Automaticity in Airline Luggage Screening. *Proc Hum Factors Ergon Soc Annu Meet*, 334.
Majumdar A. & Ochieng, W. (2002). Factors Affecting Air Traffic Controller Workload. *Transp Res Rec, 1788*, 58-69.
National Telemetry Association. (2019). *National Telemetry Association*. Retrieved November 5, 2019, from Scope of Practice: https://nationaltelemetryassociation.org/scope-of-practice/
Olds, D. &. (2010). The Effect of Work Hours on Adverse Events and Errors in Health Care. *Journal of Safety Research, 41*(2), 153-162. doi:10.1016/j.jsr.2010.02.002
Patient Safety Authority. (2008). Alarm Interventions During Medical Telemetry Monitoring: A Failure Mode and Effects Analysis. 1-50. Retrieved November 5, 2019, from http://patientsafety.pa.gov/ADVISORIES/Pages/2008sup1_01.aspx
Perkins, J. M.-M. (2014, February). Telemetry Bed Usage for Patients with Low-Risk Chest Pain:

Review of the Literature for the Clinician. *The Journal of Emergency Medicine, 46*(2), 273-277. doi:10.1016/j.jemermed.2013.08.098

Phillips. (2011). *Phillips*. Retrieved November 5, 2019, from Instructions For use: https://www.usa.philips.com/healthcare/education-resources/ifu-search

Pickham D., S. J. (2012). Quasi-Experimental Study to Improve Nurses' QT-Interval Monitoring: Results of QTIP Study. *American Journal of Critical Care, 21*(3), 195-200. doi:10.4037/ajcc2012245

Rautaharju, P. S. (2009). AHA/ACCF/HRS Recommendations for the Standardization and Interpretation of the Electrocardiogram: Part IV:. *Journal of the American College of Cardiology, 53*(11), 982-999. Retrieved December 16, 2019, from https://www.sciencedirect.com/science/article/pii/S0735109708041363?via%3Dihub

Safdar, N. D. (2012). Telemetry Leads as Reservoir. *International Journal of Infection Control*. doi:10.3396/ijic.v8i2.012.12

Sandau, M. A. (2017). Update to Practice Standards for Electrocardiographic Monitoring in Hospital Settings: A Scientific Statement From the American Heart Association. *Circulation, 136*(19), 273-344. doi:10.1161/CIR.0000000000000527

Segall N., H. G. (2015). Patient Load Effects on Response Time to Critical Arrhythmias in Cardiac Telemetry. *Critical Care Medicine*, 1036–1042. doi:10.1097/CCM.0000000000000923

Sendelbach, S. S. (2019). Implementing Practice Standards for Inpatient Electrocardiographic Monitoring. *American Journal of Critical Care, 28*(2), 109-116. doi:10.4037/ajcc2019699.

Singh, R. P. (2015). *Reducing Overuse of cardiac Telemetry.* Boston, Mass. : Boston Medical Center, Boston University, Veterans Affairs Healthcare System. Retrieved December 16, 2019, from http://www.ihi.org/education/IHIOpenSchool/resources/Documents/27ForumPosters/27Forum%20Rajat%20Singh.pdf

Sommargren, C. &. (2007). Preventing Torsades De Pointes by Careful Cardiac Monitoring in Hospital Setting. *AACN Advanced Critical Care, 18*(3), 285-293. Retrieved November 5, 2019, from https://www.ncbi.nlm.nih.gov/pubmed/18019519

Stimpfel, A. &. (2013). Hospital Staff Nurses' Shift Length Associated with Safety and Quality of Care. *Journal of Nursing Care Quality, 28*(2), 122-129. doi:10.1097/NCQ.0b013e3182725f09. *Telemetry Leads As Reservoir*. (2012). doi:10.3396/ijic.v8i2.012.12

Turkmen A. & Pantiskas, C. (2011). Management of ECG Cables and Leadwires. *Biomedical Instrumentation & Technology*, 130-133. doi:10.2345/0899-8205-45.2.130.

USFDA. (2011). *Class II Special Controls Guidance Document: Electrocardiograph Electrodes - Guidance for Industry and Food and Drug Administration Staff*. Retrieved November 5, 2019, from U.S. Food & Drug Administration: https://www.fda.gov/regulatory-information/search-fda-guidance-documents/class-ii-special-controls-guidance-document-electrocardiograph-electrodes-guidance-industry-and-food

Wagner et. al. (2009). AHA/ACCF/HRS Recommendations for the Standardization and Interpretation of the Electrocardiogram: Part VI: Acute Ischemia/Infarction: A Scientific Statement From the American Heart Association Electrocardiography and Arrhythmias Committee, Council on Clin. *Journal of the American College of Cardiology, 53*(11), 1003-1011. doi:10.1016/j.jacc.2008.12.016

Walsh-Irwin, C. & Jurgens, C.Y. (2015). Proper skin preparation and electrode placement decreases alarms on a telemetry unit. *Dimensions of Criteria Care Nursing,* 24(3): 134

Wolfe, J. (2007). In: Integrated Models of Cognitive Systems. (G. W., Ed.)

Zaremba, J. C. (2014). Electrocardiographic Practices. *Dimensaions of Critical Care Nursing, 33*(2), 82-87. Retrieved November 5, 2019, from https://reference.medscape.com/medline/abstract/24496259

Acknowledgements

The VHA Telemetry Guidebook was produced through the collaboration of the VHA, Office of Nursing Service (10A1), VHA Office of Specialty Care Services (10P11), VHA Healthcare Technology and The National Center for Patient Safety (NCPS).

A special thank you is extended to the Telemetry Guidebook Development Team, the VHA National Telemetry Task Force and the management at their respective facilities for their support. Telemetry Guidebook Development Team members listed with an (*) also served on the National Telemetry Task Force.

Telemetry Guidebook Development Team:

John Bender, MS, MBA, MHA, Health System Specialist, VHA NCPS, Dallas, TX*
Shoshana Boar, MS, Health Science Specialist, VHA NCPS, White River Junction, VT
Davina Dietrich, DNP, RN, CCRN-K, Nurse Manager, Ralph H. Johnson VAMC, Charleston, SC*
Stephen Kulju, MS, CCE, Biomedical Engineer, VHA NCPS, Ann Arbor, MI*
Robert LaPointe, MSN, RN, CCRN, Clinical Nurse Leader, Corporal Michael Crescenz VAMC, Philadelphia, PA*
Cynthia Wilson, RN, Cardiac Cath Lab Manager, VA Palo Alto Health Care System, Palo Alto, CA*
Susan Ottenfeld, MSN, RN, Clinical Nurse Leader, Jesse Brown VAMC, Chicago, IL *

National Telemetry Task Force:

Jessie Johnson, Management Analyst, Workforce Management, Washington, D.C.
Magdalena Jusiewicz, BSN, RN, CRRN, Eastern Colorado VAMC, Aurora, CO
Scott Kopp, Biomedical Engineer, VA Central Office, West Haven, CT
Helen Muller, VISN 1 Patient Safety Officer, Bedford, MA
Natalie Parce, MSN, RN-Clinical Nurse Specialist, Durham VA Health Care System, Durham NC
Sunil Rao, MD, Chief of Cardiology Services, Durham VA Health Care System, Durham NC
Art Riba, MD, Associate Chief of Staff, Bath VAMC, Bath, NY
Alaa Shalaby, MD, VA Pittsburgh Health Care System, Pittsburgh, PA
Diana Swihart, PhD, RN-BC, P-PCA, VHA NCPS, Orlando, FL
Paul Varosy, MD, VA Eastern Colorado Health Care System, Aurora, CO

This guidebook was possible due to the dedicated VHA leadership who supported this endeavor:

Sherrie Schuldheis, PhD, RN, CENP, Special Assistant, ADUSH Clinical Operations Washington, D.C.
Colleen Walsh-Irwin, DNP, ANP-BC, AACC, FAANP, Program Manager-Evidenced Based Practice, ONS, Washington, D.C.
Wendy Morrish, MSN, RN, CNL-C, Clinical Lead National Specialty Programs, VHA NCPS, Ann Arbor, MI
Rodney Williams, JD, MSW, MPA, LLM, Health System Specialist, VHA NCPS, Ann Arbor, MI
Teresa D. Boyd, DO, ADUSH for Clinical Operations, Washington, D.C.
William Gunnar, MD, JD, Executive Director VHA NCPS, Ann Arbor, MI.
Kurt Finke, Director Healthcare Technology, VACO, Washington, D.C.