Abstract

Successful telemetry monitoring relies on timely clinician response to potentially life-threatening cardiac rhythm abnormalities. Breakdowns in the processes and procedures associated with telemetry monitoring, as well as improperly functioning telemetry monitoring equipment, may lead to events that compromise patient safety. An analysis of reports submitted to the Pennsylvania Patient Safety Reporting System (PA-PSRS) from January 2014 through December 2018 identified 558 events specifically involving interruptions or failures associated with telemetry monitoring equipment or with the healthcare providers responsible for setting up and maintaining proper functioning of that equipment. The analysis highlighted a steady increase in the quantity of event reports associated with telemetry monitoring submitted to PA-PSRS. User errors accounted for nearly half (47.1%, 263 of 558) of events in the analysis. The most common event subtypes included: errors involving batteries in telemetry monitoring equipment (14.0%); errors in which patients were not connected to telemetry monitoring equipment as ordered (12.9%); errors involving broken, damaged, or malfunctioning telemetry monitoring equipment (10.9%); and errors in which patients were connected to the wrong telemetry monitoring equipment (9.0%).

Keywords: telemetry, cardiac monitoring, patient safety, alarm management, cardiac arrhythmias, communication, equipment malfunction, monitor technician
Introduction

Continuous cardiac monitoring of a patient outside the setting of the intensive care unit (ICU) is usually achieved via portable telemetry monitoring equipment (hereafter referred to in some instances as “equipment”) connected to a patient that transmits vital data, such as heart rate and rhythm, to a telemetry monitoring station that may be located on the nursing unit or to a remote centralized telemetry monitoring unit located away from the nursing unit. Successful telemetry monitoring relies on timely clinician response to potentially life-threatening cardiac rhythm abnormalities identified through the use of this healthcare technology. Breakdowns in the processes and procedures associated with telemetry monitoring, as well as improperly functioning equipment, may lead to events that compromise patient safety.

Following review of several event reports submitted to the Pennsylvania Patient Safety Reporting System (PA-PSRS) involving telemetry monitoring that resulted in serious harm, we decided to investigate the full spectrum of events in PA-PSRS involving interruptions or failures related to telemetry monitoring. In addition to our analysis, we also share relevant examples of telemetry monitoring events to promote awareness of areas in which actionable changes within healthcare facilities are possible, as well as a summary of lessons learned from these events.

Methods

We queried PA-PSRS for events submitted from January 1, 2014 through December 31, 2018. We identified events for analysis if one of the free text fields contained either “telemetry” or “tele” (excluding “telephone” and “telemed”) and one of the following: “off,” “alarm,” “batter,” “disconnect,” “expire,” or “transmit.” An analyst manually reviewed all event reports to identify events that involved interruptions or failures associated with equipment or with the healthcare providers responsible for setting up and maintaining proper functioning of that equipment. Events related to telemetry monitoring were categorized according to whether they resulted from user errors, communication breakdowns between healthcare providers, device malfunctions, or alarm issues, and were then further subcategorized within each of these categories.

Results

The query returned 1,494 event reports submitted to PA-PSRS during the five-year study period. An analyst manually reviewed all events and determined that 812 events specifically involved interruptions or failures related to telemetry monitoring. The remaining 682 events were excluded from the analysis because they did not involve interruptions or failures related to telemetry monitoring; many of these events simply mentioned that the patient was on telemetry monitoring. Of the 812 events involving interruptions or failures related to telemetry monitoring, 558 events were included in the analysis because they were related to issues with the equipment or with the healthcare providers responsible for setting up and maintaining proper functioning of that equipment (e.g., a patient who became disconnected from equipment during transfer from one unit to another); 254 events were excluded from the analysis because they were considered to be outside the control of the hospital staff and unrelated to the function of equipment (e.g., a patient who became disconnected from telemetry following a fall).
Table: Telemetry Event Subcategories

<table>
<thead>
<tr>
<th>Subcategory</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient not connected to telemetry monitoring equipment as ordered</td>
<td>Patient had verbal or written orders for continuous telemetry monitoring, but monitoring was defeated or not initiated.</td>
</tr>
<tr>
<td>Patient had orders for continuous telemetry monitoring, but was not monitored due to equipment malfunction, or improper setup of a procedure or test. However, upon return to the unit, the patient was not reconnected to the telemetry equipment in a timely fashion and was therefore unmonitored for some period of time.</td>
<td></td>
</tr>
<tr>
<td>Patient had orders for continuous telemetry monitoring, but was not monitored due to equipment malfunction, or improper setup of a procedure or test. However, upon return to the unit, the patient was not reconnected to the telemetry equipment in a timely fashion and was therefore unmonitored for some period of time.</td>
<td></td>
</tr>
<tr>
<td>Patient not reconnected to telemetry monitoring equipment upon return to unit</td>
<td>Patient was connected to telemetry monitoring equipment, which was either not connected to the telemetry monitoring equipment, or they were connected but not transmitting for an unknown reason.</td>
</tr>
<tr>
<td>Leads off or leads faded</td>
<td>Patient was transferred from one unit to another without a proper handoff, or patients had telemetry monitoring equipment switched, resulting in incorrect information appearing on the telemetry technician's central monitor for the patient in question.</td>
</tr>
<tr>
<td>Poor handoff</td>
<td>Patient was transferred from one unit to another without a proper handoff, or patients had telemetry monitoring equipment switched, resulting in incorrect information appearing on the telemetry technician's central monitor for the patient in question.</td>
</tr>
<tr>
<td>Telemetry monitoring on stand-by</td>
<td>Telemetry monitoring was placed on stand-by at some point and was not activated or reactivated at the appropriate time.</td>
</tr>
<tr>
<td>Leads off or leads faded</td>
<td>Patient's leads were either not connected to telemetry monitoring equipment, or they were connected but not transmitting for an unknown reason.</td>
</tr>
<tr>
<td>Equipment Malfunctions</td>
<td>Malfunctions included: unexpected equipment failure, timing issues, equipment mismatch, equipment malfunctions, and equipment reprogramming or reconfiguration.</td>
</tr>
<tr>
<td>Battery Issues</td>
<td>The battery life of the telemetry monitoring equipment was unexpected, and the equipment was not able to function properly.</td>
</tr>
<tr>
<td>Case Vignettes</td>
<td>The following are examples of each subcategory of telemetry monitoring event. These examples are based on actual reports submitted to PA-PSRS, but none of these examples represent an individual event report, and event details were modified to ensure confidentiality.</td>
</tr>
</tbody>
</table>

Figure 1 shows the number of events submitted each year from 2014 through 2018. The majority (97.1%, 542 of 558) of telemetry monitoring events were categorized as incidents; the remaining 16 events were categorized as serious events. Harm scores were identified by healthcare facilities at the time of their reporting. Figure 2 summarizes the frequency of each harm score and includes definitions of each harm score. Most serious events (harm scores E-I) resulted in death (13 of 16).

Telemetry monitoring events were categorized according to whether events resulted from user errors, communication breakdowns between healthcare providers, device malfunctions, or alarm issues. User errors accounted for nearly half (47.1%, 263 of 558) of the events. Events were further subcategorized based on common details among reports, and these categories are defined in the Table. The distribution of each event category and subcategory is summarized in Figure 3. The most common event subtypes included: errors involving batteries in equipment (14.0%); errors in which patients were not connected to equipment as ordered (12.9%); errors involving broken, damaged, or malfunctioning equipment (9.9%); and errors involving malfunctioning equipment (9.0%).

Incidents and serious events were distributed similarly across the various event subcategories. For this reason, it is our position that the level of harm associated with telemetry monitoring events may depend largely on chance (i.e., the level of harm is not linked to certain subcategories of contributing factors, but rather to the patient’s underlying condition). Therefore, an analysis of all events—regardless of harm level—will contribute a considerable amount of information to the current knowledge base.

User Errors

Patient Not Connected to Telemetry Monitoring Equipment as Ordered

CM, a 62-year-old male with a history of diabetes and congestive heart failure, came to the emergency department with complaints of chest pain for the past three days and a feeling of general weakness. The physician assistant who examined him determined that he was dehydrated. CM was admitted and was ordered continuous telemetry monitoring. The nurse in the emergency department signed off on the telemetry order but did not connect the equipment to CM. Two additional nurses did not notice the order for telemetry monitoring and did not connect the equipment to CM. On the day following admission, CM was found in his room on the medical/surgical unit without a pulse. A code was called, and CM was successfully resuscitated and transferred to the ICU. The order for telemetry monitoring was later found in CM’s chart; he had been unmonitored for about 18 hours, so his rhythm prior to the event was unknown.

Patient Off Unit Without Telemetry Monitoring

CV, a 75-year-old female with a history of atrial fibrillation, hypertension, and angina, was receiving a continuous infusion of diludiazem and heparin and had orders for continuous telemetry monitoring. Her physician ordered an MRI, and when the technician arrived to transport CV for testing, he disconnected her telemetry monitoring equipment and did not notify the nurse. Soon after, the nurse discovered that CV was off the nursing unit without telemetry monitoring. The nurse immediately went...
Communication Breakdowns

Poor Handoff
RS, a 22-year-old female suspected of having Wolff-Parkinson-White syndrome, was admitted through the emergency department for a full cardiac workup with orders for continuous telemetry monitoring, which was initiated in the emergency department. RS was transported from the emergency department to the medical/surgical unit by a technician. After being notified that RS would be arriving, the nurse on the medical/surgical unit registered telemetry monitoring equipment for RS and placed it on the counter in the room. Not seeing anyone immediately available for a handoff upon arrival to the unit, the technician brought RS directly to her room and removed the emergency department’s equipment. The technician did not connect the new equipment and did not notify the nurse that RS had arrived on the unit. When walking by, the nurse noticed RS in the room. RS informed the nurse that she had been waiting there for about 25 minutes. The nurse then placed RS on telemetry monitoring and found her heart rate to be elevated at 135 beats per minute.

Telemetry Monitoring Technician Unable to Notify Nursing Unit of Alarm Conditions and/or Delayed Response on Nursing Unit
A telemetry monitoring technician observed that HR, a 65-year-old male with a history of right-sided heart failure, was disconnected from his telemetry monitoring equipment. The technician attempted to page HR’s nurse four times, but a nurse was not signed in to receive pages for HR. The technician then contacted the charge nurse to inform them that HR had been unmonitored for an hour and a half. The charge nurse assured the technician that someone would check on HR to ensure that his leads were attached. After another hour, the patient was still unmonitored, so the technician reached out again and was finally able to speak with HR’s nurse, who checked on HR and reconnected his telemetry leads. In all, HR had been unmonitored for over three hours.

Miscommunication Between Telemetry Monitoring Unit and Nursing Unit
KM, a 55-year-old patient with a history of hypertension and high cholesterol, was admitted to the hospital following an acute heart attack. She was ordered continuous telemetry monitoring, which was initiated in the emergency department. After her arrival on the telemetry unit, KM was initially placed in room 1254, but after a fall from her bed, KM was moved to room 1220 so she could be closer to the nurses’ station to prevent another fall. The move was not reported to the telemetry monitoring unit when it took place. The telemetry monitoring technician observed that KM’s cardiac rhythm was not visible on the monitor, so they called to notify KM’s nurse. The nurse informed the technician that KM had been transferred to a different room and was bathing. The technician then updated the patient’s location in the telemetry monitoring system.

Alarm Issues
JR, a 76-year-old patient with a history of hypertension, high cholesterol, and atrial fibrillation, presented to the emergency department with a chief complaint of palpitations and dizziness for the past two days. JR was admitted to the hospital and was ordered continuous telemetry monitoring. The outgoing nurse reviewed JR’s alarm log and discovered that he had experienced a 21-beat run of ventricular tachycardia and a run of atrial flutter during the previous shift, despite being told that the patient had no episodes of irregular rhythms. Upon further investigation, it was found that the alarm volume on the telemetry monitoring equipment was turned down, therefore no one had heard the alert.

Discussion
Several important lessons can be learned from our analysis, which are summarized in Figure 4. Although telemetry monitoring events do not frequently result in patient harm, the events that do cause harm may be catastrophic, typically leading to patient death. The most commonly reported causes of telemetry monitoring errors were problems with dead or improperly inserted batteries in the telemetry transmitter. In addition, many reports described alarm settings being modified, leading to situations in which clinicians were unaware of heart rhythm changes. Communication breakdowns among clinicians were also widespread among reports, from incorrect or nonexistent handoffs to failures in communicating changes in patient location or status between units.

Overall, facilities may benefit from clear processes and training on the proper use of equipment for all healthcare providers who may encounter telemetry monitoring as a regular part of their job, to ensure that all patients are monitored safely and that no medical device takes the place of clinical care, observation, and judgment. A closed-loop communication protocol that outlines specific escalation strategies should be written and reviewed with all staff, especially when clinicians and monitoring staff are in different locations. In addition, facilities should follow the most up-to-date practice standards on continuous cardiac monitoring in the hospital setting to ensure this technology is not overused, as this has been tied to alarm fatigue among healthcare providers.

Limitations
Despite mandatory event-reporting laws in Pennsylvania, our data are subject to the limitations of self-reporting. The annual number of telemetry monitoring event reports submitted to PA-PSRS increased from 2014 through 2018, but this upward trend may simply highlight a growing use of telemetry monitoring or an increased awareness and reporting of telemetry monitoring events in Pennsylvania healthcare facilities.

Because a standard taxonomy for reporting telemetry monitoring events does not exist, it is possible that relevant event reports were missed with our query. In addition, equipment and practices vary greatly from one facility to another, and event details often referred broadly to telemetry without specifying a particular device, component, or practice. For this reason, we used the label “telemetry monitoring equipment” (or “equipment” for brevity) to include devices, monitors, electrodes, leads, wires, and monitors.

Conclusion
This analysis revealed that, although patient safety events associated with telemetry monitoring do not often result in harm, those events contributing to harm most often result in death. Both incidents and serious events were distributed across the various event subcategories. In addition, the reporting of
patient safety events associated with telemetry monitoring increased from 2014 to 2018.

The most common telemetry monitoring events were related to user errors, including patients not being connected to monitoring as ordered and patients being connected to the wrong monitor, and to equipment malfunctions, including damaged or broken monitors or monitors with dead batteries. It may be prudent for healthcare facilities to focus their attention on policies and processes surrounding initiation of continuous telemetry monitoring and daily care of equipment, including timely replacement of leads, patches, and batteries.

In addition, biomedical and clinical engineering staff play a critical role in ensuring proper maintenance of monitoring equipment. Any staff member who encounters or works with patients on telemetry could benefit from training on the steps necessary to initiate or maintain appropriate monitoring. In addition, lines of communication between clinicians on the frontline and technicians responsible for remote telemetry monitoring should always be kept open to ensure patients receive safe care throughout their hospital stay.

Notes

This analysis was exempted from review by the Advarra Institutional Review Board.

References


About the Authors

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