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Outpatient cardiac telemetry monitoring for early patient discharge: continuous focused rhythm surveillance for patients recovering outside of the hospital setting

Abstract

Objective: Mobile cardiac telemetry (MCT) is a frequently used, cost-effective tool for arrhythmia detection. By virtue of 24/7 monitoring of patient transmissions, MCT provides an opportunity for appropriately selected patients to transition earlier from inpatient hospital care to the outpatient setting. The primary objective of this study was to build a robust monitoring protocol to discharge low-risk cardiac patients with MCT.

Methods: Adult patients determined to be low-cardiac risk who were hospitalized at Mount Sinai Medical Center between January 2015 and November 2020 and eligible for MCT were included in this analysis. All participants were discharged with a Philips BioTel Heart MCT in Continuous Telemetry mode, some patients were later switched to Event mode based on insurance eligibility. Urgent arrhythmic events were tabulated and categorized. Physicians were notified for these urgent arrhythmic events by either fax or phone call.

Results: A total of 818 patients were included, 50% male, 69% > age 65. Event mode was utilized in 200 (24%) patients based on insurance allowance; the remainder were studied in Continuous mode. Urgent arrhythmias predicating physician notification were observed on 498 occasions. A total of 169 patients (21%) experienced an urgent arrhythmic event. Urgent arrhythmias occurred an average of 4.75 days from the start of monitoring.

Conclusion: A specialized protocol for hospital discharge with a Philips BioTel Heart MCT can be used to effectively identify urgent arrhythmias in low-risk cardiac patients. Urgent arrhythmias occurred within 5 days on average for those patients warranting physician notification.

Keywords: cardiac telemetry monitoring, Holter, outpatient, atrial fibrillation, electrocardiography, early discharge, mobile cardiac telemetry

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Abbreviations: ACA, Affordable Care Act; ACT, ambulatory cardiac telemetry; AV, atrioventricular; AVB, atrioventricular block; AF, atrial fibrillation or flutter; BPM, beats per minute; ECG, electrocardiogram; IVCD, intraventricular conduction delay; MCT, mobile cardiac telemetry; MCOT, Mobile Cardiac Outpatient Telemetry; PAC, premature atrial contraction; PVC, premature ventricular contractions; SVT, supraventricular tachycardia; VT, ventricular tachycardia

Introduction

Since implementation of the Affordable Care Act (ACA), the drive towards value-based care has increased pressure on health care providers to deliver high-quality care without increasing costs.[1,2] Central to this construct are protocols that improve clinical outcomes and curtail hospital inpatient stays while avoiding hospital readmission. These challenges encourage the development of care models that promote safe and efficient care delivery beyond traditional acute care venues (e.g., hospitals and skilled care facilities, etc.) and into the ambulatory environment. In patients hospitalized for cardiovascular diseases or procedures, ambulatory monitoring ranks among the most effective diagnostic tools available.[3,4] Detection of atrial arrhythmias in cryptogenic stroke, monitoring for postoperative atrial fibrillation after cardiac surgery, and evaluation of dysrhythmia in patients with syncope and palpitations are just a few common applications of rhythm monitoring.[5-11] Mobile cardiac telemetry (MCT) has become a frequently used, cost-effective tool for clinicians. By virtue of 24/7 monitoring of patient transmissions, MCT provides an opportunity for appropriately selected patients to transition earlier from inpatient hospital care to the outpatient setting.[12,13] Outpatient cardiac monitoring is often limited by logistical barriers such as application of the monitoring device, patient education on the use of the diagnostic hardware, effective physician alerting of significant clinical events, and patient compliance. The primary objective of this study was to establish the feasibility of utilizing a robust monitoring protocol to discharge low-risk cardiac patients with MCT.

Methods

This was a single center, prospective cohort study of stable cardiac patients over 18 years of age who underwent Philips BioTel Heart MCT at the Mount Sinai Medical Center between January 2015 to November 2020. All adult, low-risk cardiac patients who were hospitalized for arrhythmia monitoring and eligible for an MCT were included. Low-risk patients were defined as individuals deemed by their treating physicians as either unlikely to have an arrhythmia or those capable of being treated safely and expeditiously if an arrhythmia were to occur. Examples of low-risk patients include those with known atrial fibrillation without recurrence for 24 hours, asymptomatic low-grade AV block, first stroke without evidence of atrial arrhythmia, and syncope with no significant findings on baseline electrocardiogram,

echocardiogram, or short-term telemetry monitoring. Patients were excluded if they were at high-risk for a serious arrhythmia or high-risk for deleterious outcome if an arrhythmia were to occur.

The Philips BioTel Heart MCT device employed is this study was the LifeWatch ACT telemetry monitor. The LifeWatch ACT was a patch-based, chest worn monitor capable of continuously analyzing up to 30 days of 3-channel ECG and transmitting significant arrhythmic events securely via cellular connection 24/7 in near real-time.[14] The ACT monitor was provided to patients in MCT mode and, if required by insurance, was converted to event mode with physician approval. LifeWatch was acquired by BioTelemetry in 2017, BioTelemetry was acquired by Philips in 2021; the MCT service used in this study is currently known as MCOT® (Mobile Cardiac Outpatient Telemetry, BioTelemetry Inc, a Philips company, Malvern, PA, USA).

A standard protocol was developed to enroll patients in the Early Discharge Program (Figure 1).

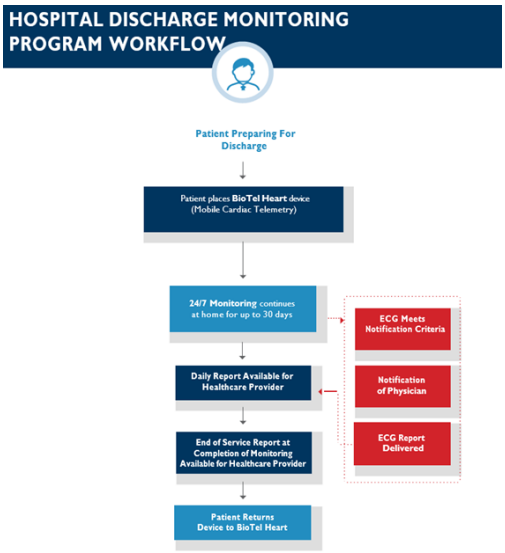

Figure 1 Hospital discharge monitoring program workflow.

Abbreviations: ECG, Electrocardiogram

i. Low-risk patients were identified by the treating electrophysiologist.

ii. The electrophysiologist instructed office staff to enroll the patient in the MCT Early Discharge Program and informed the on-site Philips BioTel Heart MCT Clinical Support Specialist.

iii. Hospital Cath Lab personnel delivered an MCT kit from their shelf-stock to the patient prior to discharge and instructed the patient to call Philips BioTel Heart upon arrival home.

iv. Philips BioTel Heart staff explained the MCT set up and confirmed the patient's ECG data was transmitted and received within 12 hours of discharge.

v. The Philips BioTel Heart MCT Clinical Support Specialist communicated with the Philips BioTel Heart MCT monitoring staff to ensure patient compliance.

vi. In the event of service disruption, the Philips BioTel Heart MCT Clinical Support Specialist contacted the physician office for assistance in communicating with the patient.

vii. Upon conclusion of the service, the patient returned the MCT to Philips BioTel Heart.

Continuous telemetry recordings were collected from the patient. Arrhythmic events were identified using a proprietary algorithm and reviewed by Philips BioTel Heart trained cardiac technicians. End of Service and Daily Reports (as requested) were provided to the physician. If an urgent arrhythmia was detected, the Philips BioTel Heart staff followed the physician notification protocol.

Age, gender, and monitoring indication for each patient were collected at enrollment and retrospectively reviewed. MCT data included the number of urgent notifications observed, and days to an urgent notification. Arrythmias reported during MCT monitoring include bradycardia, intraventricular conduction delay (IVCD), tachycardia, 1st/2nd/3rd-degree atrioventricular block (AVB), atrial fibrillation or flutter (AF), atrial runs, pause, ventricular tachycardia (VT), premature atrial contractions (PACs) and premature ventricular contractions (PVCs). Physicians were notified via fax or phone for urgent arrhythmias, defined as: pause ≥3 second, supraventricular tachycardia (SVT) ≥ 180 bpm for ≥ 30 seconds, bradycardia of <= 30 bpm for ≥ 30 seconds, atrial fibrillation and flutter ≥ 180 bpm for ≥ 30 seconds, and wide complex ventricular tachycardia (VT) ≥ 150 bpm for ≥ 6 seconds. Criteria used for urgent arrhythmias in the early discharge program are shown in Table 1.

Table 1 Mount Sinai Alert Criteria for Early Discharge Protocol

Arrythmia types	Definition
Pause	Three (3) seconds or greater – fax and call
Tachycardia (including Supraventricular Tachycardia)	180 BPM or greater for thirty (30) seconds or longer – fax only, do not call
Bradycardia	30 BPM or less for thirty (30) seconds or greater – fax only, do not call
Atrial Fibrillation (first documentation)	Any rate for sixty (60) seconds or greater – fax only, do not call
Atrial Fibrillation	180 BPM or greater for thirty (30) seconds or more – fax only, do not call
Atrial Flutter	180 BPM or greater for thirty (30) seconds or more – fax only, do not call
Wide Complex Tachycardia	150 BPM or greater for six (6) seconds or greater – fax and call

Abbreviations: BPM; beats per minute

Results

Baseline patient characteristics and the indication for MCT monitoring are reported in Table 2. Descriptive statistics were provided for age, gender, frequency of and timing of urgent notifications. Microsoft Excel 365 (v2204) was used to perform the statistical analyses and create the pie charts. The study sample consisted of 818 patients, split 1:1 by gender. Most patients (69%) were older than 65 years of age. Indications for MCT monitoring included atrial fibrillation (29%), syncope and collapse (12%), unspecified atrioventricular block (11%), palpitations (8%), and other indications (40%). Event mode was utilized in 200 (24%) patients based on insurance allowance; the remainder were studied in Continuous mode.

There were 498 urgent notifications observed in 169 patients (21% patients). The first urgent notification was detected, on average, 4.75

days (min: 1 day; max: 27 days) after application of the monitor (Figure 2). Of all first urgent notifications, 48% were noted within 48 hours of monitoring initiation while a total of 82% and 95% of first urgent notifications occurred within 7 days and 14 days of monitoring, respectively. Only 5% of events were noted over 14 days after discharge in this patient cohort.

Table 2 Patient baseline characteristics

Parameter	Inputs
Number of patients	818
Female	414
Male	414
Enrollment date by age	
20-29 years	2%
30-39 years	4%
40-49 years	4%
50-64 years	21%
65+ years	69%
Enrollment data by indication	
Atrial fibrillation	29%
Syncope and collapse	12%
Unspecified atrioventricular block	11%
Palpitations	8%
Other	40%

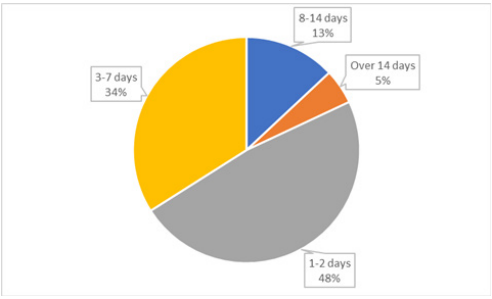

Figure 2 Days to capture of first urgent notification.

Figure 3 shows the arrhythmias identified during the technician review of triggered MCT events. Premature atrial contractions (PAC) and premature ventricular contractions (PVC) represented 17% and 16% of all events, respectively. Bradycardia, pause, and 2nd or 3rd degree AVB collectively represented 21% of the total. Supraventricular arrhythmias encompassing tachycardia, atrial fibrillation, or atrial runs contributed 25% of the events, and VT was only identified in 1% of arrhythmic events.

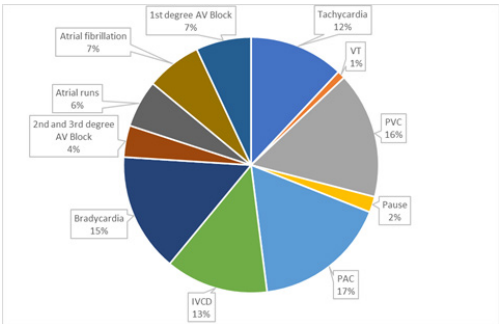

Figure 3 Types of arrhythmia detected in patients who had MCT events.

Abbreviations: AV, atrioventricular; IVCD, intraventricular conduction delays; MCT, mobile cardiac telemetry; PAC, premature atrial contraction; PVC, premature ventricular contractions; VT, ventricular tachycardia

Discussion

As burden on the U.S. health care system continuously increases, demands for high-quality and affordable health care options for diagnostic and preventive care increase.[15] Remote and outpatient cardiac telemetry monitoring solutions can significantly improve healthcare spending efficiency by reducing unnecessary hospital admissions and length of stay.[16,17] Patients and practitioners regularly use digital technology to address clinical symptoms, providing an avenue for possible health care cost reduction via patient self-management of vital health parameters, daily routines and exercise, nutrition, and medications.[18]

The Mount Sinai Medical Center Early Discharge Program was a highly collaborative effort between the Electrophysiology department and a cardiac telemetry service provider, Philips BioTel Heart. This paper demonstrates the feasibility of implementing a specialized protocol to provide early hospital discharge for low-risk cardiac patients with outpatient cardiac telemetry monitoring. The early discharge protocol utilized a Philips BioTel Heart MCT brought to the patient's bedside prior to discharge. The bedside delivery of MCT represented a key difference from traditional outpatient monitoring workflow in that it ensured outpatient telemetry from the moment the patient left the hospital. Incorporation of bedside delivery with an early discharge protocol affords patient advantages, like fewer gaps in monitoring and data collection and at home patient recovery (avoiding recognized risks of in-hospital care), with system benefits of cost reduction and increased inpatient bed availability. The ease-of-use of the MCT technology allowed the patient to be unobtrusively monitored for up to 30 days while having urgent arrhythmias communicated to care practitioners in near real-time.

The results of the present analysis are aligned with findings of previous studies. From a retrospective analysis of over 26,000 patients at a single MCT independent diagnostic testing facility, 21% had arrhythmic events meeting physician notification criteria during a mean monitoring period of 21 days.[19] An additional study demonstrated that in 174 discharged adult emergency department patients with symptoms of possible cardiac arrhythmia, a continuous recording patch detected more than one arrhythmic event in 83 patients (47.7%) with a median time to the first arrhythmia of 1.0 day.[20]

A barrier to instituting an early discharge protocol has been the ability to immediately initiate cardiac monitoring upon discharge. To overcome this, new workflows were created to facilitate communication regarding the logistics of device storage and patient enrollment between the inpatient and outpatient health care providers, and between Philips BioTel Heart and the healthcare providers. Streamlined patient education of device setup was incorporated in workflows, while modified physician notification criteria and supervision of patient adherence to patch monitoring were critical to ensuring the success seen in this program.

Limitations of the study include the single-arm, non-comparative, small patient cohort. Given this single-center observational evaluation, potential variations related to geographic patterns cannot be ruled out and may limit generalizability of our findings. For this assessment, two modalities of the MCT device (MCT and Event monitoring) were grouped together and comparative differences were not obtainable. A control group of patients was not used; consequently, no conclusions could be made regarding the robustness of MCT diagnostic yield versus conventional methods of inpatient cardiac rhythm monitoring.

The workflow assessment did not address MCT's impact upon medical expenditures and change management in the use of healthcare resources, which also plays a role in the decision-making process of

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choosing diagnostic modalities and methods for identifying low-risk cardiac patients. As is the case with all observational research, additional factors throughout this period could have also impacted outcomes.

Conclusion

Mobile health technologies provide opportunities for maintaining the continuity of care of patients discharged from the hospital. The Early Discharge collaboration described in this paper between Mount Sinai Medical Center and Philips BioTel Heart demonstrates an innovative solution using existing technology. By utilizing a Philips BioTel Heart MCT in low-risk patients applied immediately upon discharge, almost 50% of first notification of urgent arrhythmias are seen within 48 hours and urgent arrhythmias warranting physician notification occurred on average within 5 days. The use of novel communication tools and simplification of traditional workflows at the provider and device levels has the potential to enhance patient care, decrease the length of stay, and ensure safe and effective post-hospitalization monitoring.

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Disclosure

LAK, HL, JL, GM, PP, MW, and VL are employees of Philips. MNL and AA are employees of Mount Sinai Medical Center. The authors report no other conflicts of interest in relation to this work.

Authorship

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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