

Frequency of Serious Arrhythmias Detected With Ambulatory Cardiac Telemetry

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Ambulatory cardiac telemetry has been shown to be effective in establishing diagnoses in patients with suspected arrhythmias. A critical component of ambulatory telemetry is the immediate transfer of rhythm information to a central monitoring station without requiring patient action. The frequency with which potentially life-threatening events are detected using ambulatory telemetry has not previously been evaluated in a large patient population. All patients (n = 26,438) who underwent monitoring from April to December 2008 at a single service provider formed the patient population of this study. Arrhythmic events noted in these patients were defined as those requiring physician notification and those that represented potentially life-threatening arrhythmias. Of the 26,438 patients included in the study, 5,459 (21%) had arrhythmic events meeting physician notification criteria during a mean monitoring period of 21 days. Of these, 262 patients (1%) had arrhythmic events that could potentially be classified as emergent. These included 120 patients with wide complex tachycardia ≥ 15 beats at ≥ 120 beats/min, 100 patients with pauses ≥ 6 seconds, and 42 patients with sustained heart rates < 30 beats/min. An additional 704 patients (3%) had narrow complex tachycardia ≥ 180 beats/min at rest. In conclusion, approximately 1% of patients who underwent ambulatory telemetry for routine clinical indications experienced life-threatening arrhythmic events over a 3-week monitoring period. Ambulatory cardiac telemetry could be potentially lifesaving in this group of patients. © 2010 Elsevier Inc. All rights reserved. (Am J Cardiol 2010;105:1313–1316)

Patients who complain of intermittent symptoms such as palpitations or syncope represent a difficult diagnostic dilemma. A number of techniques have been developed to detect potential arrhythmic causes with intermittent symptoms. These include Holter monitoring, patient-activated intermittent event recorders with or without looping memory, auto-triggered memory loop recorders, and ambulatory cardiac telemetry. Several studies^{1–11} have compared these techniques and shown that the diagnostic yield of ambulatory cardiac telemetry is at least as high as that of other techniques. One unique feature of ambulatory cardiac telemetry is the ability to immediately detect life-threatening arrhythmias and transmit data to a central monitoring station without patient action. Thus, ambulatory cardiac telemetry has the potential to detect dangerous arrhythmias in real time and allow immediate transmission and rapid intervention. However, the actual incidence of these arrhythmias in clinical use has not been previously evaluated in a large population. The purpose of the present study was to use the database of a large independent diagnostic testing facility

(IDTF) to evaluate the incidence of potentially life-threatening arrhythmias using ambulatory cardiac telemetry.

Methods

The study was designed as a retrospective analysis of patient characteristics, diagnostic yield, and diagnoses of patients in a large commercial database (LifeWatch Services, Inc., Rosemont, Illinois). The LifeWatch ambulatory cardiac telemetry device consists of a small, lightweight sensor and electrodes worn on the chest that records the heart's rhythm. Each heartbeat is transmitted wirelessly to a cellular phone monitor, in which it is analyzed by a proprietary algorithm that is resident within the monitor. If an arrhythmia is detected, the cellular phone monitor automatically transmits it to a central station for review and intervention, if appropriate.

Consecutive patients presenting for ambulatory cardiac telemetry from April to December 2008 were included. The groups consisted of a consecutive series of 26,438 patients, representing a variety of diagnoses. The database contained baseline demographic information and a brief clinical history for each patient. LifeWatch's device contains programmable features that allow physicians to select criteria for transmission. Because this was a retrospective analysis, changes in programming may have been present in some patients; default programming criteria are listed in Table 1. Arrhythmic events were identified using a proprietary algorithm and reviewed by ≥ 2 trained certified cardiac technicians. In this large

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Table 1
Default settings for ambulatory cardiac telemetry

Trigger Type	Default Setting	Rate (beats/min)	Onset Duration (seconds)
Atrial fibrillation	On		30
Tachycardia	On	150	10
Bradycardia	On	40	25
Pause	On		3

Table 2
Physician notification criteria

Sustained wide complex tachycardia ≥ 120 beats/min
Sustained bradycardia (all rhythms with bradycardic rate, including averaged atrial fibrillation/atrial flutter) ≤ 35 beats/min
Sustained supraventricular tachycardia or atrial fibrillation ≥ 150 beats/min (adults)
Pause ≥ 3 seconds
Wide complex tachycardia ≥ 120 beats/min with duration ≥ 4 beats
Second- or third-degree atrioventricular block
Atrioventricular dissociation
Pacemaker failure
Sinus tachycardia greater than age-predicted maximum ($220 - \text{age}$) with duration ≥ 30 seconds (no pediatric rates; applicable for all patients)
New-onset atrial flutter and/or atrial fibrillation with duration ≥ 30 seconds

IDTF's database, review of individual tracings by the investigators was not feasible.

Arrhythmic events were characterized in 3 ways. Events meeting clinical criteria for physician notification are listed in Table 2. Those events that were determined to require emergent physician notification and were "immediately actionable" included wide complex tachycardia ≥ 15 beats at ≥ 120 beats/min and pauses of ≥ 6 seconds or sustained bradycardia with rates < 30 beats/min while awake. Last, those events that could require urgent intervention included immediately actionable events plus those patients with sustained narrow complex tachycardia > 180 beats/min. The IDTF possesses protected health information under the appropriate Health Insurance Portability and Accountability Act criteria. For the purposes of this retrospective analysis, only deidentified data were available to the data analysts and investigators.

Patient characteristics are presented as mean \pm SD for continuous variables and as counts with percentages for categorical variables. Comparisons among the device groups were done using analysis of variance for continuous variables and chi square tests for categorical variables.

Results

From April to December 2008, 26,438 patients underwent cardiac monitoring evaluations wearing ambulatory cardiac telemetry devices. Of these patients, the most common referral diagnoses were atrial fibrillation, conduction system disturbances, and syncope. However, a variety of different diagnostic codes were used (Table 3). Diagnoses that met physician notification criteria were found in 21% of patients ($n = 5,459$; Table 3). Of these, 233 patients pre-

sented with wide complex tachycardia > 5 beats, 1,302 patients with sustained heart rates > 150 beats/min, 239 patients with pauses > 3 seconds, 664 patients with sustained heart rates < 40 beats/min, and 3,021 patients with new-onset atrial fibrillation. Two hundred eighty-eight patients had > 1 type of physician notification event. In these patients, the first event was used for classification and is listed in Table 3. Examples of arrhythmias documented using the ambulatory cardiac telemetry devices are shown in Figure 1.

Overall, more women than men were referred for ambulatory cardiac telemetry. Of the 26,438 patients, 15,617 (59%) were women. The percentage of patients who met criteria for physician notification was higher in men (26%) than women (17%) ($p < 0.001$).

On the basis of predefined criteria, immediately actionable diagnoses were present in 260 patients (1%). This included 120 patients with wide complex tachycardia ≥ 15 beats, 100 patients with pauses ≥ 6 seconds, and 40 patients with sustained heart rates < 40 beats/min. One patient had 2 emergent events: wide complex tachycardia and atrial fibrillation with a rapid response. Because this study was obtained from an IDTF database, detailed follow-up of the clinical outcomes is not available. In addition, 704 patients had sustained heart rates > 180 beats/min at rest.

Discussion

Several different types of arrhythmia monitors are available for outpatient cardiac monitoring. These include Holter monitors, patient-activated event recorders, auto-triggered event monitors, and ambulatory cardiac telemetry. Previous studies have compared diagnostic yield among these monitors and have demonstrated that ambulatory cardiac telemetry monitors have the highest yield.¹¹ There are several major differences between auto-triggered event monitors and ambulatory cardiac telemetry: (1) ambulatory telemetry devices have the ability for complete data disclosure, allowing technicians or physicians to reevaluate diagnoses that were not made using an auto-trigger algorithm and to evaluate the onset and duration of arrhythmias; (2) compliance with monitoring can be assessed; and (3) ambulatory cardiac telemetry provides immediate data transfer regardless of whether patients are symptomatic.

The purpose of the present study was to evaluate the potential advantage of the immediate response feature. In the present study, we did not compare different diagnostic techniques but rather prespecified a set of criteria that would suggest that urgent or emergent intervention was necessary and determine the incidence of those findings in an unselected group of patients. The results demonstrated that over an average monitoring period of 21 days, 1% of patients developed arrhythmias that could have represented immediate life-threatening events. These definitions were developed before data examination and were meant to classify a group of events that most physicians would consider emergent. These included pauses > 6 seconds, wide complex tachycardia ≥ 15 beats, and sustained severe bradycardia due to heart block or sinus node dysfunction. An additional 3% of patients had narrow complex tachycardia that was sustained at > 180 beats/min. If such an arrhythmia persists

Table 3
Presenting diagnoses for ambulatory cardiac telemetry

Variable	Total (n = 26,438)	Physician Notification	
		Yes (n = 5,459)	No (n = 20,979)
Age (years)	55.44 ± 19.71	57.32 ± 20.46	54.95 ± 19.48
Men	40.9%	50.4%	38.55%
Referring diagnosis description			
Atrial fibrillation	6,470 (24.47%)	2,023 (37.06%)	4,643 (22.13%)
Syncope and collapse	5,671 (21.45%)	896 (16.41%)	4,843 (23.08%)
Conduction system abnormalities	4,997 (18.90%)	808 (14.80%)	4,642 (22.13%)
Palpitation	3,485 (13.18%)	548 (10.04%)	2,978 (14.20%)
Paroxysmal supraventricular tachycardia	1,944 (7.35%)	410 (7.51%)	1,537 (7.33%)
Atrial flutter	764 (2.89%)	250 (4.58%)	517 (2.46%)
Miscellaneous	1,236 (4.68%)	219 (4.01%)	251 (1.20%)
Supraventricular premature beats	677 (2.56%)	91 (1.67%)	589 (2.81%)
Dizziness and giddiness	385 (1.46%)	60 (1.10%)	325 (1.55%)
Sinoatrial node dysfunction	284 (1.07%)	56 (1.03%)	227 (1.08%)
Paroxysmal tachycardia, unspecified	154 (0.58%)	35 (0.64%)	119 (0.57%)
Paroxysmal ventricular tachycardia	146 (0.55%)	30 (0.55%)	117 (0.56%)
Lown-Ganong-Levine syndrome	103 (0.39%)	14 (0.26%)	89 (0.42%)
Anomalous atrioventricular excitation	53 (0.20%)	14 (0.26%)	39 (0.19%)
Other: ventricular premature beats	50 (0.19%)	5 (0.09%)	44 (0.21%)
Long-QT syndrome	19 (0.07%)	0 (0.00%)	19 (0.09%)

Data are expressed as mean ± SD or as number (percentage).

Patients were subdivided on the basis of whether an event requiring physician notification occurred during follow-up monitoring.

Figure 1. Examples of arrhythmias detected by ambulatory cardiac telemetry: (*top*) sinus arrest, (*middle*) 2:1 atrioventricular block, and (*bottom*) wide complex tachycardia. Sinus arrest and 2:1 atrioventricular block would meet physician notification criteria but would not be classified as urgent emergent events. Wide complex tachycardia was classified as an event requiring emergent intervention.

at rest, it could also indicate the need for urgent intervention. We are not aware of studies using Holter or event monitoring that have specifically examined the yield of these techniques in diagnosing serious arrhythmias as defined in the present study.

Gender differences in referral patterns and diagnostic yield were noted in the present study. More women than men were referred for monitoring, yet the diagnostic yield was higher in men. A number of gender differences in arrhythmias have been described in the past.¹² The extent to which referral bias or clinical differences may have been responsible for some of the gender differences noted in the present study will require further investigation.

The strength of the present study was the large number of subjects that were included in this IDTF's database. This large number of subjects provided the opportunity to evaluate the frequency of relatively uncommon events. However, as with all studies using administrative databases, there were significant limitations. First, this was not a randomized prospective study, and no comparison group was included. Second, a major limitation is that detailed clinical information on patient outcomes was not available. When urgent or emergent arrhythmias were noted, patients, physicians, or emergency medical services were immediately contacted by the IDTF technician responsible for monitoring these patients 24 hours a day, 7 days a week. These calls were initiated within 5 minutes. However, clinical follow-up on patient outcomes was not obtained. Third, detailed historical information other than demographics was not available for this patient population. Finally, cost-effectiveness was not evaluated.

Despite these limitations, the results demonstrated that in a large number of unselected patients referred for ambulatory cardiac telemetry, a low percentage but a significant number of patients developed life-threatening arrhythmias that could require immediate intervention. Although some patients with pauses > 6 seconds may not have immediate adverse consequences, the risk for recurrent events in those patients is high. Using this type of monitoring, episodes of cardiac asystole may be immediately recognized and transmitted to emergency medical services. Other diagnoses such as wide complex tachycardia or sustained bradycardia may provide important new clinical information that requires immediate intervention. In some cases, patient-activated event monitors may have been able to provide similar information. However, in other cases, immediate data transfer may not happen in the absence of ambulatory cardiac telemetry. For example, arrhythmias may be asymptomatic, particularly during sleep, or patients may be unable to ac-

tivate a telephone call or recording. Thus, the time to obtain such a recording is clearly greater than for an event that is immediately transmitted by an automatic algorithm. Although further prospective studies in large numbers of patients will be required to validate these findings, the results of the present study suggest that ambulatory cardiac telemetry may provide lifesaving clinical information that is unavailable using other techniques.

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