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Utility of in-hospital cardiac remote telemetry in patients with unexplained syncope

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Aims Cardiac remote telemetry (CR-TEL) is in wide use in cardiac units, but its diagnostic value in the setting of unexplained syncope is unknown.
Methods One hundred and two consecutive patients (73 $\pm$ 14 years) arriving to the emergency department due to an unexplained syncope were admitted under CR-TEL. Heart rhythm was continuously monitored from a central station by trained nurses. Events included all causes of mortality and arrhythmias unnoticed on emergency department.
Results Thirty patients (29.4%) presented events. There were no deaths during the time of monitoring (4.8 $\pm$ 2.7 days). Events requiring transfer to the coronary care units (CCU) occurred in 15 patients (14.7%), principally due to AV-block and extreme bradycardia. Cardiac remote telemetry was diagnostic in 18 patients (17.6%) in whom the arrhythmic event occurred simultaneously with the syncopal episode. Multivariate analysis showed that age $\geq$86 years ($P < 0.01$) and heart failure on admission ($P < 0.04$) were the strongest predictors of events. All transfers to the CCU were documented within the first 4 days. The best cut-off point as a threshold for CR-TEL monitoring time was 72 hours (sensitivity 73%, specificity 86%).
Conclusion Cardiac remote telemetry appears to be a useful tool in the management of patients with unexplained syncope, especially in those older and presenting heart failure on admission.

Introduction

Cardiac remote telemetry (CR-TEL) is the transmission of cardiac signals (electric or pulse or pressure derived) from a patient to a distant receiving location where they are displayed for human and software-controlled monitoring.[1,2] Several pioneer efforts stimulated a marked growth in technical design, the use of smaller transmitters and the development of devices able to transmit signals in real time.[3] The goals of continuous electrocardiographic monitoring have evolved from simple heart rate and rhythm monitoring to ST segment monitoring and sophisticated arrhythmia detection and diagnosis, usually under surveillance of trained personnel.[4] Over the past decade, CR-TEL have been introduced in many cardiac facilities, normally in tertiary care centres.[5] Cardiac remote telemetry is a class of continuous electrocardiographic monitoring that allows skilled personnel in a central station to assess heart rhythm for patients admitted in other places of the hospital out of coronary care units (CCU). Therefore, patients who would otherwise require a critical care bed can be managed on the wards, providing more effective bed utilization for critically ill patients.[6] In addition, CR-TEL provides to physicians a wide network of multiple channels and sophisticated tools for the diagnosis of those patients in whom concerns about potential rhythm disturbances are present.[6] Telemetry enables the hospital staff to recognize haemodynamically significant rhythm disturbances and to initiate therapy early, when the likelihood of successful management is greatest.[6]

There are no solid data of the accuracy of CR-TEL in the clinical setting and its utility in specific indications in order to identify the patients that really benefit from it. Controversial results could give rise to a confusing role of CR-TEL in the management of hospitalized patients and utility has not been defined.[7–11] In this study, we describe our experience in patients monitored using CR-TEL with the first diagnosis of unexplained, likely cardiogenic, syncope.

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Methods

Patient selection

From January to October 2005, a total of 1149 patients were monitored in our Institution by means of CR-TEL. We included in our study a total of 102 consecutive patients admitted for CR-TEL with the presumptive diagnosis of unexplained, likely cardiogenic, syncope. In our Institution, there is an established systematic assessment for patients referring syncope at Emergency Department. All these patients are evaluated by the cardiologist and, when a likely cardiac syncope is suspected, they are admitted under CR-TEL surveillance for further study. The cardiac origin of syncope is suspected attending to an algorithm based on medical antecedents (i.e. coronary heart disease, hypertrophic or non-ischemic dilated cardiomyopathy, LV dysfunction, previous cardiac arrhythmias, family history of sudden death, current treatment with antiarrhythmic drugs and so on), clinical presentation (clinical characteristics of the episode typical of a cardiac origin), physical exam (i.e. cardiac murmurs, bradycardia, signs of heart failure and so on), ECG (electrocardiographic abnormalities: i.e. bradycardia, AV conduction disturbances, QRS disturbances, signs of structural heart, long QT interval and others), and Rx (i.e. cardiomegaly, signs of heart failure and others). Hence, admission is considered for all patients when a cardiac cause cannot be safely ruled out. During admission, different tests are performed following an algorithmic approach to investigate a possible cardiac origin. These patients do not include those with syncope and a documented medical condition actually or potentially responsible for the syncope. The latter patients were directly admitted into the CCU. All clinical, electrocardiographic, analytical, and CR-TEL data were prospectively collected. Cardiovascular risk factors and cardiologic history (coronary heart disease, hypertrophic or non-ischemic dilated cardiomyopathy, cardiac arrhythmias, and current treatment with antiarrhythmic drugs) were recorded with the information available at Emergency Department (when the decision of CR-TEL was taken). Epilepsy, minor or disabling stroke, and chronic kidney disease history were also documented. Clinical presentation, including heart failure at admission, chest pain or previous syncopes, and 12-lead ECG at admission were recorded.

Cardiac remote telemetry

Cardiac remote telemetry allows a continuous in-hospital remote ECG monitoring. Cardiac remote telemetry is accomplished at our Institution using a wireless Siemens Draeger Infinity Network System & Multiview Workstation (Siemens Draeger Medical, Inc., PA, USA). Our system has 4 channels per patient and allows for a total of 16 simultaneous CR-TELs. The CR-TEL transmitters are equipped with five wires that allow for the recording of ECG leads I, II, III, aVR, aVL, aVF, and V. The heart rate detection range is from 15 to 300 bpm (accuracy $\pm 5\%$), the voltage detection range is from 0.5 to 5.0 mV. The ECG is filtered between 0.5 and 40 Hz at -3 dB. The transmitter has an alert button that can be activated by the patients or their attending persons. The signal emitted by the transmitters is received by a network of dedicated antennas covering 90% of the hospital wards so that our system of CR-TEL allows us to watch patients located in wards other than the cardiovascular stations. Signals are transmitted to the central Multiview workstation that is located at the monitoring station of the CCU. The surveillance of the 16 displayed signals is continuously assessed in real time by a dedicated nurse trained in arrhythmia recognition and supervised by an experienced cardiologist covering the 24 h. For unexplained syncope and suspected cardiac arrhythmias, V1 was usually the lead selected to be continuously displayed on the central Multiview workstation. All events are registered and significant ones paper printed and checked by staff. When a serious event is registered or observed by the nurse, a prompt response protocol is started and early medical assistance is provided. Moreover, together with the continuous surveillance of trained nurses and the alarms of the system, all the telemetric information is continuously stored on a hard disk that was reviewed retrospectively on daily basis. Transfer to the CCU was encouraged for all serious or potentially serious arrhythmic events detected during CR-TEL monitoring.

Endpoints

Patients were monitored under CR-TEL until discharged from hospital (after performing the pertinent procedures to rule out a cardiac origin), the documentation of a responsible arrhythmic event or non-arrhythmic cause for the syncope was encountered. Events were defined as death or any potentially serious arrhythmias detected by means of the CR-TEL system: those becoming with symptoms of syncope or presyncope, led to transfer to CCU, the change or initiation of drug therapy or the indication of definitive pacemaker or CDI. The following arrhythmias were considered: paroxysmal supraventricular tachycardia (atrial fibrillation, atrial flutter, atrial tachycardia, and atrioventricular junctional tachycardia), ventricular fibrillation, sustained ventricular tachycardia, non-sustained ventricular tachycardia, sinoatrial block, sinus arrest or extreme sinus bradycardia (<30 bpm), asystole greater than 3 s, second, or third degree atrioventricular block. We also recorded the time from the initiation of CR-TEL to the first event to define the diagnostic window of CR-TEL in the population studied.

Statistical methods

Categorical variables are expressed as total number and percentages and continuous variables as mean $\pm$ standard deviation. The receive-operator characteristic (ROC) curve was used to define the best diagnostic window and to define the diagnostic accuracy of CR-TEL as a whole in the studied population. Univariate analysis was accomplished to calculate the odds ratio of clinical and electrocardiographic variables using χ^2 test or exact Fisher's test when appropriated. The independent value of the significant variables was adjusted for confounding factors using a stepwise multivariant logistic regression analysis. The variables included in the model were those with $P < 0.1$. A P-value of <0.05 was considered statistically significant.

Results

Patient characteristics and telemetry findings

Patient characteristics are listed in *Table 1*. The study included 102 consecutive patients, 52% men, aged 73.2 $\pm$ 14.6 years. The mean duration of the telemetric monitoring

Table 1 Baseline clinical characteristics

Variable	Value (%)
n	102
Age (year) (mean ± SD)	73.2 ± 14.6
Length of stay on telemetry (days) (mean ± SD)	4.8 ± 2.7
Sex	
Men	53 (52.0)
Women	49 (48.0)
Cardiovascular risk factors	87 (85.3)
Hypertension	66 (64.7)
Diabetes mellitus	30 (29.4)
Hypercholesterolemia	32 (31.4)
Tobacco	38 (37.3)
Alcohol abuse	13 (12.7)
Medical history	
Coronary artery disease	27 (26.5)
Non-ischemic dilated cardiomyopathy	3 (2.9)
Hypertrophic Cardiomyopathy	3 (2.9)
Atrial fibrillation	23 (22.5)
Epilepsy	1 (1.0)
Stroke or transient ischemic attacks	9 (8.8)
Chronic renal failure	8 (7.8)
Clinical presentation	
Past history of syncope	55 (53.9)
Premonitory symptoms	67 (65.7)
Heart failure	12 (11.8)
Chest pain	9 (8.8)
Electrocardiogram on admission	
Sinus rhythm	84 (82.4)
Atrial fibrillation	16 (15.7)
Pacemaker	4 (3.9)
First degree AV block	23 (22.5)
Left bundle branch block	9 (8.8)
Right bundle branch block	21 (20.6)
Bifascicular block (RBBB+LAHB/LPHB)	11 (10.8)
Potentially arrhythmogenic drugs	41 (40.2)
Beta-blockers	20 (19.6)
Calcium-antagonists	11 (10.8)
Digoxin	8 (7.8)
Amiodarone	7 (6.9)
Flecainide	1 (1.0)
Sotalol	0 (0)
Propafenone	1 (1.0)

was 4.8 ± 2.7 days. Most patients (85.3%) present at least one cardiovascular risk factor. A history of a previous syncope was present in 55 (53.9%). Potentially arrhythmogenic drugs (those with effects in the conduction properties or potentially responsible of arrhythmic episodes) were taken by 41 patients (40.2%). During the monitoring period, 49 relevant arrhythmic events were detected in 30 patients (29.4%). A transfer to the CCU took place in 15 patients (14.7%), principally related with symptomatic extreme bradycardia and third-degree AV-block. None of the 102 patients died under CR-TEL surveillance. *Table 2* shows the distribution of arrhythmia episodes. Eighteen patients presented arrhythmias during CR-TEL surveillance, which coincided with syncope or presyncope (principally due to extreme bradycardia in six patients and third-degree AV-block in five patients). The mean time until the first event was 2.3 ± 1.8 days. All the events occurred in the first 7 days of monitoring and all the events resulting in a transfer to the CCU occurred within the first 4 days. The ROC curve analysis showed that the best yield in terms of CR-TEL duration was achieved at the third day (sensitivity 73.3% [95% confidence intervals, CI 54.1–87.7], specificity 86.1% [95% CI >75.9–93.1, positive predictive value 68.7%, negative predictive value 88.6%, AUC 0.85) (*Figure 1*). That was the time needed to identify a relevant event during the monitoring and get any benefit from CR-TEL.

Table 2 Outcomes detected by telemetry

Variable	Value (%)
Non-sustained ventricular tachycardia	9 (8.8)
Extreme bradycardia (<30 bpm)	8 (7.8)
Asystole greater than or equal to 3.0 s	7 (6.9)
Supraventricular tachycardias of new diagnosis	7 (6.9)
Third-degree AV-block	5 (4.9)
Sick sinus syndrome	4 (3.9)
2:1 AV-block	3 (2.9)
Second-degree type II AV-block	2 (2.0)
Second-degree type I AV-block	1 (1.0)
Sustained ventricular tachycardia	1 (1.0)
Ventricular fibrillation	0 (0.0)
Junctional rhythms	0 (0.0)
Other[a]	2 (2.0)
Patients with event	30 (29.4)
Transfer to CCU	15 (14.7)
Patients diagnosed of cardiac syncope with TL	18 (17.6)
Mortality	0 (0.0)
Time to event (days) (mean ± SD)	2.3 ± 1.8

[a]Other events include intermittent prexcitation and transient ST-segment elevation.

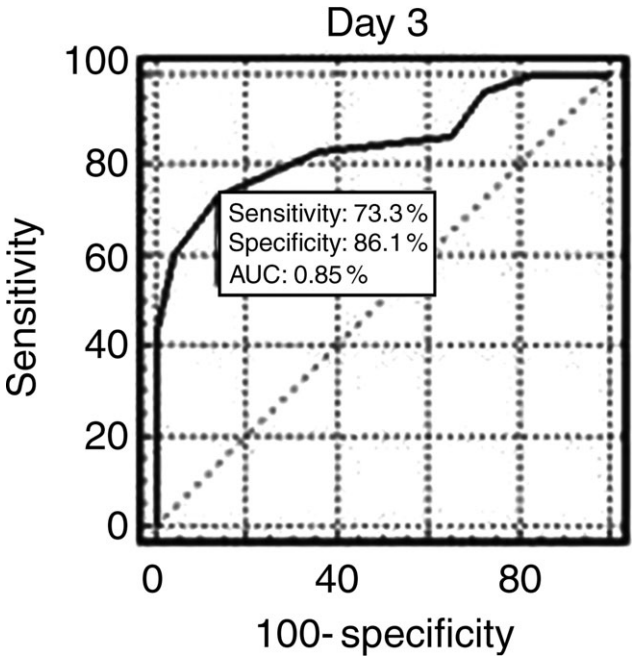

Figure 1 Receive-operator characteristic analysis. At the third day under CR-TEL surveillance, the higher accuracy was achieved: sensitivity 73.3% (95% CI 54.1–87.7), specificity 86.1% (95% CI 75.9–93.1), positive predictive value 68.7%, and negative predictive value 88.6%, AUC 0.85.

Clinical predictors of arrhythmic events

The results of the univariate analysis are exhibited in *Table 3*. A significant risk for developing events under CR-TEL was observed in elder people (77.6 ± 12.3 year-old vs. 71.4 ± 15.3 year-old, $P < 0.05$). Patients older than 86 year-old presented the highest risk for events (odds ratio [OR] 7.28, 95% confidence intervals CI 2.03–26.03; $P = 0.02$). Patients with heart failure (OR 6.18, 95% CI 1.69–22.5; $P = 0.003$), atrial fibrillation (OR 2.9, 95% CI 0.98–8.68; $P = 0.04$) or who were on digoxin (OR 8.75, 95% CI 1.65–46.3; $P = 0.008$) on admission also showed an increased risk to present significant arrhythmic events during CR-TEL monitoring. The treatment with other antiarrhythmic drugs was not associated with a higher risk for events during monitoring. On multivariate analysis, an age >86 years (OR 7.03, 95% CI 1.83–27.03; $P = 0.004$) and the presence of heart failure on admission (OR 4.77, 95% CI 1.06–21.34; $P = 0.04$) remained as predictors of an increased risk for documenting events during telemetric monitoring.

Table 3 Results of the univariate analysis

Variable	Events	No events	*P*
n	30	72	
Age			
>86 years old, *n* (%)[a]	9 (30)	4 (5.5)	0.02
Sex			
Male, *n* (%)	15 (50)	38	
(52.8)	0.79		
Female, *n* (%)	15 (50)	34	
(47.2)	0.80		
Medical history			
Coronary artery disease, *n* (%)	5 (16.7)	22	
(30.6)	0.14		
Non-ischemic dilated cardiomyopathy, *n* (%)	2 (6.7)	1 (1.4)	0.15
Hypertrophic cardiomyopathy, *n* (%)	2 (6.7)	1 (1.4)	0.15
Epilepsy, *n* (%)	0 (0)	1 (1.4)	0.51
Clinical presentation			
Previous syncope, *n* (%)	15 (50)	40	
(55.6)	0.60		
Premonitory symptoms	22		
(73.3)	45		
(62.5)	0.29		
Heart failure[a], *n* (%)	8 (26.7)	4 (5.6)	0.003
Chest pain, *n* (%)	2 (6.7)	7 (9.7)	0.62
Electrocardiogram on admission			
Atrial fibrillation[a], *n* (%)	8 (26.7)	8 (11.1)	0.04
Pacemaker, *n* (%)	0 (0)	4 (5.6)	0.18
First degree atrio-ventricular block, *n* (%)	9 (30)	14	
(19.4)	0.24		
Left bundle branch block, *n* (%)	3 (10)	6 (8.3)	0.78
Right bundle branch block, *n* (%)	6 (20)	15	
(20.8)	0.92		
Bifascicular block (RBBB+LAHB/LPHB), *n* (%)	3 (10)	8 (11)	0.85
Potentially arrhythmogenic drugs			
Beta-blockers, *n* (%)	5 (16.7)	15	
(20.8)	0.62		
Calcium-antagonists, *n* (%)	2 (6.7)	9 (12.5)	0.38
Digoxin[a], *n* (%)	6 (20)	2 (2.8)	0.008
Amiodarone, *n* (%)	0 (0)	7 (9.7)	0.07
Flecainide, *n* (%)	0 (0)	1 (1.4)	0.52
Sotalol, *n* (%)	0 (0)	0 (0)	–
Propafenone, *n* (%)	1 (3.3)	0 (0)	0.11

[a]Denotes variables with statistical significance.

Discussion

Major findings

Cardiac remote telemetry accomplished with dedicated technology and highly motivated and trained personnel was found useful for arrhythmia detection in patients admitted for unexplained syncope. Cardiac remote telemetry detected significant events in 30% of patients, some of them life threatening, and 18% of patients were diagnosed of cardiac syncope. None of the patients died during the period evaluated. Events were more prevalent in older patients and with heart failure on admission. At least 3 days of supervised CR-TEL watch has been shown beneficial in the management of these patients.

Cardiac remote telemetry in current clinical practice

The use of radiotelemetry for continuous electrocardiographic monitoring has not been well studied. Most published material has primary focused on major events and arrhythmia detection rates in non-selected patients admitted as whole, with a broad of complains and doubtful indications.[10–12] Potentially, serious arrhythmias occurred only in patients with known or suspected coronary artery disease or in those with previously documented arrhythmia.[6] Other investigators proposed the use of telemetry to detect transient shifts in the ST-segment in patients with suspected or known coronary artery disease with different results and not fully validated.[7–9] Although the overall cost of the system appears justifiable because of better utilization of special care unit beds and seriousness of the arrhythmia detected, there is no evidence showing an increase in either in-hospital or post-discharge survival in monitored patients.[6] In a prospective cohort study, telemetry did not add significant information to clinical variables for the outcome.[10] Moreover, of 2240 patients, only the 0.8% of the patients were transferred to a CCU because of an arrhythmia identified by telemetry.[11] These studies apparently showed a disappointing role of CR-TEL in the management of hospitalized patients. Indeed, the studies discussed included patients hospitalized with telemetry with a wide an inhomogeneous range of medical conditions and unspecific complains as non-documented palpitations.[6,11] These data revealed the presence of a bias in cardiologists about the need for telemetry, suggesting that the primary purpose or remote telemetry is to reassure physicians about a small number of patients. As result, only the 61% of patients under CR-TEL were classified as class I indication according to the American College of Cardiology guidelines for the use of telemetry.[12] Guidelines assign cardiac conditions and diagnoses to three classes with different priorities for monitoring.[13] Patients with chest pain and 'low risk' admitted to telemetry, rarely benefited from cardiac monitoring: they have infrequent arrhythmias and telemetry infrequently led to changes of management[14,15] When patients with chest pain and 'low risk' are moved from classes I to II indication for CR-TEL and patients with arrhythmias the opposite, more clinically significant arrhythmias

occurred.[12] In summary, the established efficacy of CR-TEL could be downplayed and the authors agree about the need of a more selective use and identify subsets of patients from whom cardiac monitoring could be of maximal benefit.[16]

Cardiac remote telemetry in cardiac and unexplained syncope

Syncope is a very common medical problem caused by a wide variety of diseases.[17,18] Diagnosing arrhythmias as a cause of syncope are often difficult.[18] The recommendations for hospital admission are based on the potential for adverse outcomes if the evaluation is delayed, although no studies have focused on this issue.[17] In this context, telemetry may benefit in the detection and diagnosis of arrhythmias. According to the practice standards of American Heart Association for electrocardiographic monitoring in-hospital setting, patients with the syncope of truly unknown origin should have $\geq$24 h of in-patient monitoring.[19] It is considered as a class II indication (ECG monitoring may be beneficial in some patients, but is not considered essential in all), it is helpful in clinical management but it is not expected to save lives.[19] Randomized clinical trial in electrocardiographic monitoring is almost non-existent; therefore, expert opinions are based upon clinical experience and related research in the field of electrocardiography.[19]

The diagnostic yield of ECG monitoring in patients with syncope may be low in the absence of a high amount of suspicion about an arrhythmic cause. In patients with syncope, heart disease is the major predictor of risk for death or significant arrhythmia.[17] When suspicion arises about an arrhythmic cause for the syncope or in patients who have primary electrophysiologic disorders inpatient monitoring is indicated for 24–48 h, or until an arrhythmic cause has been ruled out by invasive cardiac electrophysiological testing.[19]

The main limitations of continuous electrocardiographic monitoring would be time-related, demanding extended periods of monitoring, more prolonged admissions, and highest costs. Nonetheless, prolonged continuous electrocardiographic monitoring (up to 7 days) was the single most important investigation in establishing a cardiac cause for syncope. In one study, 28% of patients had documented arrhythmia that was judged a probable cause of syncope.[20] In other studies, telemetry was perceived as helpful (guided therapy or guided use of diagnostic tests) in 16% of patients with syncope and led to intensive care unit transfer in 2.6%.[11] In our study, nearly 30% of the patients presented events that guided therapy or the guide use of diagnostic test, nearly 18% were diagnosed of cardiac syncope (arrhythmias which coincided with symptoms of syncope or presyncope), and 15% were transferred to CCU. The mean time to event was 2.3 ± 1.8 days. All the events occurred in the first 7 days of monitoring and all the events that conditioned an intensive care unit transfer occurred in the first 4 days. The ROC curve analysis revealed that at least 3 days of CR-TEL disclosed the highest diagnostic accuracy. In addition, older patients ($>$ 86 years-old), those with heart failure on admission, and marginally those with atrial fibrillation, were at increased risk for events under CR-TEL watch. Although we cannot infer causality regarding the usefulness of telemetry in preventing death, in our study no death was documented during the follow-up.

Limitations

The design of our CR-TEL unit is unique and it could differ from others because of the joint of sophisticated tools for remote monitoring and the continuous watching of highly trained nurses in the identification of rhythm disturbances.

Although the last ESC Guidelines update for management of syncope were published in November 2004 and our study started months before, a systematic approach to these patients that shares great similarities with actual recommendations is established in our Institution.[21] This algorithm is consistent with the guidelines that point out the importance of study a possible cardiac cause of syncope and other variants published after.[22]

In a clinical setting, we collected data prospectively. These results could help to practicing cardiologist in daily clinical work. Although our study has the limitations derived of observational studies, these findings highlight the need for predictive instruments designed to risk-stratify patients who are considered candidates for in-patient cardiac monitoring. The present study differs in several respects from previous studies, we investigated only patients diagnosed of syncope and we tried to answer the principal question left by previous investigators about who are those that really benefit from continuous electrocardiographic monitoring. Recent studies support our results and have shown the utility of mobile cardiac outpatient telemetry for the diagnosis of presyncope and syncope. Moreover, these studies have reported better results for mobile cardiac outpatient telemetry compared with standard loop event monitoring.[23,24] Prospective and controlled studies would be warranted to validate our findings and they should include cost-effective analysis and evaluate the role of telemetry in other scenes.

Conclusions

Cardiac remote telemetry is useful and maybe lifesaving for patients with unexplained syncope, especially those older and with heart failure on admission. Moreover, our findings also show that events that conditioned a CCU transfer occurred in the first 4 days and that maybe at least 3 days of continuous electrocardiographic monitoring are needed to retire it safely. Finally, we should emphasize the important role of trained nurses in the detection and manage of clinically important arrhythmias. Irrespective of the level of sophistication of the technology used, the efficacy of any CR-TEL system is dependent on two factors: the staff involved and the ability to detect an arrhythmia and to respond to it in a timely manner.

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References

1. Parman CC. Cardiac telemetry coding. *J Cardiovasc Manag* 2004;**15**:11–2.
2. Caceres CA. Telemetry in medicine and biology. *Adv Biomed Eng Med Phys* 1968;**1**:279–316.

3. Drew BJ. Bedside electrocardiographic monitoring: state of the art for the 1990s. *Heart Lung* 1991;**20**:610–23.
4. Jenkins LS, George V. Heart watch: national survey of continuous electrocardiographic monitoring in U.S. hospitals. *J Nurs Adm* 1995;**25**:38–44.
5. Billinghurst F, Morgan B, Arthur HM. Patient and nurse-related implications of remote cardiac telemetry. *Clin Nurs Res* 2003;**12**:356–70.
6. Lipskis DJ, Dannehl KN, Silverman ME. Value of radiotelemetry in a community hospital. *Am J Cardiol* 1984;**53**:1284–7.
7. Mulcahy D. Continuous electrocardiographic monitoring. *Br J Hosp Med* 1997;**57**:36–8.
8. Dellborg M, Andersen K. Key factors in the identification of the high-risk patient with unstable coronary artery disease: clinical findings, resting 12-lead electrocardiogram, and continuous electrocardiographic monitoring. *Am J Cardiol* 1997;**80**:35–9.
9. Johnson SM, Mauritson DR, Winniford MD, Willerson JT, Firth BG, Cary JR *et al*. Continuous electrocardiographic monitoring in patients with unstable angina pectoris: identification of high-risk subgroup with severe coronary disease, variant angina, and/or impaired early prognosis. *Am Heart J* 1982;**103**:4–12.
10. Estrada CA, Prasad NK, Rosman HS, Young MJ. Outcomes of patients hospitalized to a telemetry unit. *Am J Cardiol* 1994;**74**:357–62.
11. Estrada CA, Rosman HS, Prasad NK, Battilana G, Alexander M, Held AC *et al*. Role of telemetry monitoring in the non-intensive care unit. *Am J Cardiol* 1995;**76**:960–5.
12. Estrada CA, Rosman HS, Prasad NK, Battilana G, Alexander M, Held AC *et al*. Evaluation of guidelines for the use of telemetry in the non-intensive-care setting. *J Gen Intern Med* 2000;**15**:51–5.
13. Emergency cardiac care committee members. Recommended guidelines for in-hospital cardiac monitoring of adults for detection of arrhythmia. *J Am Coll Cardiol* 1991;**18**:1431–3.
14. Goldman L, Cook EF, Johnson PA, Brand DA, Rouan GW, Lee TH. Prediction of the need for intensive care in patients who come to the emergency departments with acute chest pain. *N Engl J Med* 1996;**334**:1498–504.
15. Hollander JE, Valentine SM, McCuskey CF, Brogan GX Jr. Are monitored telemetry beds necessary for patients with nontraumatic chest pain and normal or nonspecific electrocardiograms? *Am J Cardiol* 1997;**79**:1110–1.
16. Durairaj L, Reilly B, Das K, Smith C, Acob C, Husain S *et al*. Emergency department admissions to inpatient cardiac telemetry beds: a prospective cohort study of risk stratification and outcomes. *Am J Med* 2001;**110**:7–11.
17. Kapoor WN. Syncope. *N Engl J Med* 2000;**343**:1856–62.
18. Kapoor WN. Diagnostic evaluation of syncope. *Am J Med* 1991;**90**:91–106.
19. Drew BJ, Califf RM, Funk M, Kaufman ES, Krucoff MW, Laks MM *et al*. Practice standards for electrocardiographic monitoring in hospital settings: an American Heart Association Scientific Statement from the Councils on Cardiovascular Nursing, Clinical Cardiology, and Cardiovascular Disease in the Young. *Circulation* 2004;**110**:2721–46.
20. Kuchar DL, Thorburn CW, Sammel NL. The role of signal averaged electrocardiography in the investigation of unselected patients with syncope. *Aust N Z J Med* 1985;**15**:697–703.
21. Brignole M, Alboni P, Benditt DG, Bergfeldt L, Blanc JJ, Thomsen PE *et al*. Task force on syncope, European Society of Cardiology. Guidelines on management (diagnosis and treatment) of syncope-update 2004. Executive Summary. *Eur Heart J* 2004;**25**:2054–72.
22. Brignole M, Menozzi C, Bartoletti A, Giada F, Lagi A, Ungar A *et al*. A new management of syncope: prospective systematic guideline-based evaluation of patients referred urgently to general hospitals. *Eur Heart J* 2006;**27**:76–82.
23. Rothman SA, Laughlin JC, Seltzer J, Walia JS, Baman RI, Siouffi SY *et al*. The diagnosis of cardiac arrhythmias: a prospective multi-center randomized study comparing mobile cardiac outpatient telemetry versus standard loop event monitoring. *J Cardiovasc Electrophysiol* 2007;**18**:241–7.
24. Olson JA, Fouts AM, Padanilam BJ, Prystowsky EN. Utility of mobile cardiac outpatient telemetry for the diagnosis of palpitations, presyncope, syncope, and the assessment of therapy efficacy. *J Cardiovasc Electrophysiol* 2007;**18**:473–7.