


'Utilization of telemetry monitoring for non-cardiac conditions in non-critical patients: what are the trends and perceptions amongst medical residents?'

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ABSTRACT

Background & Objective: Current evidence shows that telemetry monitoring is commonly overutilized for 'non-cardiac' diseases such as COPD exacerbation, pneumonia, pulmonary embolism and sepsis. This issue has not been addressed clearly in the recent American Heart Association (AHA) guidelines and no standard recommendations on the use of telemetry in non-cardiac conditions exist; therefore, clinicians continue to make such decisions based on personal preferences.

As medical residency is an important phase during which young physicians develop clinical skills and habits for their future practice, the aim of this study was to understand the prevalent trends related to inappropriate telemetry use amongst the medical residents at a community hospital and the associated factors which influence the use of telemetry monitoring in non-cardiac patients.

Methods: All the residents undergoing internal medicine training at a community hospital were surveyed with the help of a questionnaire regarding the utility of telemetry in non-critical patients admitted with non-cardiac conditions.

Results: Survey was completed by 37 residents. Analysis of the responses showed that despite the frequent use of telemetry in non-cardiac conditions, majority of the medical residents are unaware of the correct indications. Seventy-three percent choose 'continuous' telemetry when placing the order while only 16% (often or always) discontinue telemetry after 24 hours of uneventful use. Although 84% residents admitted that telemetry is overutilized, still 49% felt that it leads to better patient care while 70% considered it superior to frequent vitals monitoring for early detection of hemodynamic instability. Possible causes of inappropriate use included 'Lack of knowledge about the related literature' and 'Following trends set by the peers'.

Conclusion: Majority of the medical residents overutilize telemetry in non-cardiac conditions due to lack of knowledge, perceived sense of security and inappropriate trends set by their colleagues. In order to abolish these tendencies, we propose the provision of adequate educational resources to the clinical staff at every level along with other system-based strategies.

ARTICLE HISTORY

Received 31 January 2020
Accepted 23 March 2020

KEYWORDS

Telemetry monitoring; overutilization; medical residents; non-critical patients; non-cardiac conditions

1. Introduction

With the evolution of telemetry monitoring (TM) over the last six decades, the continuous surveillance of a patient's vitals and cardiac rhythm has been made possible. In 2004, American Heart Association (AHA) released practice guidelines for inpatient cardiac monitoring [1] in order to improve outcomes through early detection and management of any myocardial ischemic changes, arrhythmias or hemodynamic instability. These guidelines were based on experts' opinion as the clinical trials on the topic were limited at that time.

As more and more health-care facilities introduced advanced units for continuous rhythm monitoring, a huge surge in the use of telemetry was observed. However, it soon became evident that the perception of better patient care associated with TM was leading

to its mindless use in non-intensive care settings; for example, a study demonstrated that approximately 43% of the monitoring orders in non-critical care units were not indicated [2]. Furthermore, this trend of overutilizing TM was associated with harmful effects such as alarm fatigue and patient distress [3] while overburdening an already strained health-care system and wasting manpower [4].

In order to address this issue, AHA released another scientific statement as an update on standards of inpatient cardiac monitoring in 2017 [5]. Unfortunately, this step failed to resolve the main problem because:

- TM is mostly ordered for non-cardiac conditions such as chronic obstructive pulmonary disease (COPD), pulmonary embolism and

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 Supplemental data for this article can be accessed here.

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pneumonia which have not been addressed directly in the AHA statement.

- While it is advised to consider the overall cardiovascular risk, the updated guidelines do not clearly identify the actual risk factors which can be used to stratify the non-cardiac patients.
- Majority of the hospitals also use telemetry units for continuous pulse oximetry (CPO) but the AHA guidelines only discuss the indications for cardiac surveillance.

In addition, no standard recommendations have been put forward from any other major medical societies as there is a scarcity of clinical trials addressing the indications of telemetry specifically in non-cardiac conditions. Therefore, most of the physicians continue to utilize telemetry based on their own personal preferences in non-cardiac patients.

It is a well-known fact that a physician's professional practices are governed by the habits developed during his/her medical residency. Thus, we surveyed the medical residents at our hospital in order to assess their understanding regarding the utility of telemetry in the management of various non-cardiac diseases and to identify the factors that might contribute to its inappropriate use.

2. Methods and materials

We conducted an observational survey-based study at Greater Baltimore Medical Center (GBMC) which is a 255-bed community hospital. It also supports an ACGME-accredited Internal Medicine program where residents are trained to manage various medical conditions, both on the general medical floor and intensive care unit. Our study followed a deliberate purposive design where all the medical residents (18 from first year, 11 from second year and 11 from third year) undergoing training at GBMC were enrolled (excluding the three residents directly involved in formulating the survey). We chose to administer a paper survey due to it being faster and less complex in a small number of potential respondents. Also, we felt that face-to-face interaction and avoidance of so-called 'email fatigue' would lead to a higher response rate. The study was approved by the GBMC Institutional Review Board and lasted from December 2018 till May 2019.

The first phase involved designing a questionnaire. For this purpose, we defined the patient population as:

- Patients admitted to the general medical floor **WITH**
- A primary 'non-cardiac' admitting diagnosis regardless of the comorbidities **AND**
- Hemodynamically (blood pressure, pulse, respiratory rate) stable on admission.

Then, we determined the meaning of 'telemetry' on a general medical floor. As per GBMC policy, the term 'telemetry' refers to continuous pulse oximetry

(oxygen saturation and pulse rate) and/or electrocardiographic (heart rate/arrhythmia and ST-segment) monitoring in the non-critical care units.

This was followed by an extensive literature review in order to identify all the pertinent medical evidence related to our research topic. This information was then categorized into four main areas of interest:

- (1) Trends related to ordering telemetry in non-cardiac conditions.
- (2) Routine management and follow-up of the patients on telemetry.
- (3) Perceptions about the utility of telemetry in non-cardiac patients.
- (4) Level of awareness regarding the medical literature and other resources on this topic.

Questions related to the above-mentioned fields were developed with either an open- or close-ended format. For the open-ended questions, the respondents were asked to choose multiple options from a list while for the close-ended questions, the responses were either nominal (Yes, No) or ordinal (Never, Rarely, Often, Always). A question inquiring the year of training was also added. The final 24-point questionnaire (Supplementary file 1.) was accompanied by a cover page stating the study title along with a short description of the study patients.

Following an IRB approval, the medical residents were briefed on the study during the educational conferences and requested to fill out the survey. The paper questionnaire was distributed along with an 'Informed Consent' document dictating the purpose of the study, names of the investigators and the respondents' rights. Copies of the survey and secured drop-boxes were kept in the departmental conference room and residents' team rooms. The medical residents were constantly reminded and encouraged to fill the survey at regular intervals. The survey period lasted for approximately 3–4 weeks.

During the last phase of the study, all the completed questionnaires were collected for data extraction and the results were presented in either tabulated or graphical form. The data were mainly categorical, summarized as number of responses (n) and percentages (calculated as number of respondents with a particular response/total number of respondents x 100). Statistical tests included chi-square or fisher's exact test wherever appropriate. Odd's ratio with 95% confidence interval was calculated while a two-tailed p-value <0.05 was considered statistically significant. Statistical analysis was performed using OpenEpi, version 3.01.

3. Results

Out of the 40 potential participants, the survey was completed by 37 residents. These included 18 (49%) of the first-year, 10 (27%) of the second-year and 9

(24%) of the third-year residents. None of the questionnaires were incomplete. The most frequent non-cardiac condition reported was pulmonary embolism (n = 29, 78%) followed by COPD (chronic obstructive pulmonary disease) exacerbation (n = 21, 57%) and severe anemia (n = 21, 57%) while acute pancreatitis was the least reported disease (Table 1). In addition, majority of the residents identified 'elevation of cardiac enzymes' (68%), 'use of oxygen' (68%) and 'history of coronary artery disease/chronic heart failure/arrhythmias' (55%) as the risk factors that warrant the use of telemetry in any non-cardiac condition.

Overall, 73% of the residents chose the duration of monitoring as 'Continuous' when placing the initial order while 23 residents (60%) admitted to 'often' or 'always' ordering telemetry when requested by the nursing staff even with the absence of clear indications. Furthermore, a significant proportion of the respondents (95%) would either 'never' or 'rarely' discuss the matter with the patient and the code status was considered by only 32% before initiating TM (Figure 1).

Regarding management of patients already on telemetry, only three residents (8%) stated that they would 'often' or 'always' assess the need of continuing telemetry daily without being reminded and 8% (n = 3) reported 'always' discussing the issue on every patient during the daily medical teams' rounds. In addition,

telemetry was 'often' or 'always' discontinued by only 16% (n = 6) if uneventful after 24 hours.

Although 23 respondents (62%) felt confident about their knowledge on the topic, 89% (n = 33) and 86% (n = 32) admitted not being aware of the recommended duration and discontinuation criteria for TM in non-cardiac patients, respectively (Figure 2). Also, only 13 residents were familiar with the hospital's policy regarding TM on general medical floor.

When questioned about their opinion about the pros and cons of telemetry in non-cardiac patients, only 8% (n = 3) of the residents considered telemetry non-beneficial in the absence of clear indications as compared to frequent vitals monitoring while 84% felt that it was being overutilized (Table 2). 'Lack of knowledge' (n = 20, 54%) and 'Following trends set by peers' (n = 19, 51%) were the most commonly identified causes of inappropriate TM; plus, it was suggested that discussion during the daily medical rounds (n = 26, 70%) and use of electronic health record (EHR) checklists (n = 25, 68%) could help solve this issue.

4. Discussion

Telemetry allows remote surveillance of patients via continuous cardiac monitoring and is an essential health-care resource that has saved millions of lives since its invention. Due to its utmost importance in acute clinical care, telemetry use has become widespread and increasing number of physicians continue to rely on it for the management of their patients. However, this continued dependence on telemetry has also led to its uninhibited use. As a result, overutilization of this beneficial resource has emerged as a major health-care issue.

Contrary to the proven benefits of telemetry in the management of cardiac diseases, an in-depth review of the medical literature doesn't yield a compelling level of evidence on its utility in non-cardiac conditions. Despite this, it has been observed that TM is more likely to be ordered in patients who are primarily admitted for non-cardiac conditions. Chen et al. [6] identified sepsis as the most common non-cardiac condition prompting telemetry initiation by the physicians (24%) while another study [7] observed that majority of the patients being monitored were admitted with gastrointestinal bleeding (19%), renal failure (17%) or pneumonia (11%). Similarly, in our survey, a significant proportion of the medical residents admitted ordering telemetry for patients with pulmonary embolism, COPD exacerbation and severe anemia. This practice is possibly related to the increased incidence of cardiovascular events reported in various non-cardiac conditions. For example, one-third of the COPD patients can have concomitant heart failure while the severity of COPD might be independently associated with atrial fibrillation [8]. Similarly, the frequency of pulmonary edema,

Table 1. Medical residents' opinion on the risk factors and conditions that warrant telemetry monitoring in hemodynamically stable patients.

Non-cardiac conditions	Response rate, n (%)
• Sepsis	15 (41)
• COPD exacerbation	21 (57)
• Pneumonia	7 (19)
• Pulmonary embolism	29 (78)
• Acute DVT	1 (3)
• Active gastrointestinal bleeding	11 (30)
• Severe/acute anemia	21 (57)
• Alcohol withdrawal	6 (16)
• Acute drug overdose	18 (49)
• Acute kidney injury	15 (41)
• Acute pancreatitis	0 (0)
• Intestinal obstruction	5 (14)
• Patients transferred from ICU	14 (38)
• Post-op patients (any NON-CARDIAC surgery within the last 24 hours)	1 (3)
• Old age	8 (22)
• Delirium (not CVA-related)	15 (41)
• Use of oxygen (either at home/on admission)	25 (68)
• History of CAD/CHF/arrhythmias	21 (55)
• Presence of a pacemaker/defibrillator	16 (43)
• On QT-prolonging medications	16 (43)
• On anticoagulants	10 (27)
• On hemodialysis	7 (19)
• Orthostasis	10 (27)
• Electrolyte abnormalities	19 (52)
• Mild elevation of cardiac enzymes (No symptoms and EKG changes)	25 (68)
• Need for multiple blood products transfusion	11 (30)

Abbreviations: CAD, coronary artery disease; CHF, chronic heart failure; COPD, chronic obstructive pulmonary disease; CVA, cerebrovascular accidents; DVT, deep venous thrombosis; EKG, electrocardiogram; ICU, intensive care unit.

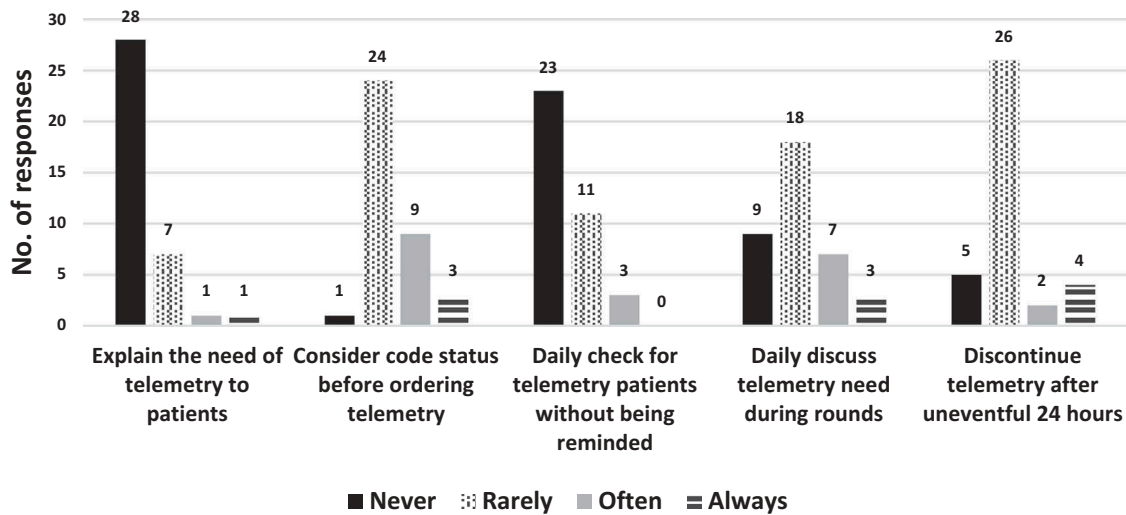


Figure 1. Routine practices related to telemetry monitoring as reported by the medical residents.

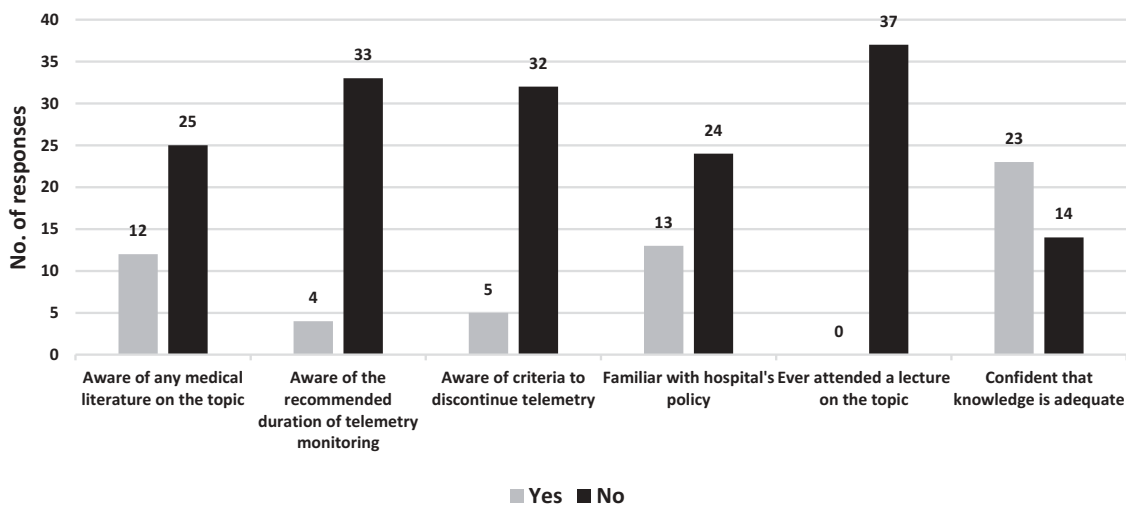


Figure 2. Respondents' knowledge and awareness of various information sources on the utilization of telemetry in non-cardiac conditions.

arrhythmia, myocardial ischemia is increased considerably among the hospitalized pneumonia patients [9]. However, the actual chances of these events being clinically significant have been documented to be very low [10] and therefore, do not justify the use of telemetry in such patients.

The only two non-cardiac conditions where AHA clearly recommends using telemetry are acute drug overdose and for surveillance after a major non-cardiac thoracic or vascular surgery [5]. This is because such patients are at higher risk of developing life-threatening arrhythmias. However, AHA has also acknowledged its inability to provide recommendations in other non-cardiac conditions since the medical research evaluating the indications of telemetry in such patient populations is clinically insufficient. In the absence of the standard guidelines regarding the use of telemetry in non-cardiac diseases, we propose that the physicians should consider the cardiovascular risk factors, the clinical features of the condi-

tion itself and the lab abnormalities present (Table 3) before initiating TM.

A few examples are given below:

- A patient with a history of severe coronary artery disease (CAD) admitted with acute gastrointestinal bleeding and anemia who is found to have asymptomatic but new electrocardiographic (EKG) changes might benefit from telemetry.
- Same approach can be considered for another elderly patient with acute renal failure and hyperkalemia who has to undergo hemodialysis.
- On the other hand, telemetry should not be ordered for a young gentleman with sepsis and non-significant elevation of troponins in the absence of symptoms and EKG abnormalities.
- Cardiac monitoring is also generally not required in an individual being managed for COPD exacerbation despite the presence of multiple risk factors (old age, chronic heart

Table 2. Perceptions of medical residents regarding their use and efficacy of telemetry monitoring in non-cardiac conditions.

Questions	Response rate, n (%)
Benefits of telemetry compared to frequent vitals monitoring	
• Early detection of hemodynamic instability	26 (70)
• Early detection of hypoxia	22 (59)
• Oxygen titration	20 (54)
• Better nursing/clinical care	18 (49)
• Early detection of rhythm changes	16 (43)
• No benefits in non-cardiac conditions	3 (8)
How often telemetry use has actually prevented complications in your patients	
• Never	13 (35)
• Rarely	19 (51)
• Often	5 (14)
• Always	0 (0)
How often need for telemetry has delayed the transfer/admission process for your patients	
• Never	0 (0)
• Rarely	6 (16)
• Often	31 (84)
• Always	0 (0)
Appropriateness of telemetry use	
• Yes	6 (16)
• No, it is underutilized	3 (8)
• No, it is overutilized	31 (84)
Possible causes of inappropriate use of telemetry	
• None as use is appropriate	5 (14)
• Lack of knowledge about medical literature	20 (54)
• Overestimation of its utility	15 (41)
• Following trends set by peers/seniors	19 (51)
• Feeling of security when patient on telemetry	13 (35)
• No idea about the costs	7 (19)
Interventions to improve use of telemetry	
• None as use is adequate	3 (8)
• Use of built-in checklists/popups on EHR	25 (68)
• Part of daily floor rounds	26 (70)
• Daily documentation in progress notes	18 (49)
• Educational sessions	16 (43)
• Regular email reminders	2 (5)

Abbreviations: EHR, electronic health record; n, number; %, percentage.

Table 3. Factors to be considered when initiating telemetry in non-cardiac conditions.

General risk factors	Clinical features	Investigations
• Old age	• Symptoms	• Electrolyte abnormalities
• History of CAD/CHF	• Oxygenation	• EKG changes
• History of arrhythmias/ICD	• Mental status	• Anemia
• On QT-prolonging drugs		• Cardiac enzymes
• Hemodialysis		

Abbreviations: CAD, coronary artery disease; CHF, chronic heart failure; EKG, electrocardiogram; ICD, implanted cardiac defibrillator.

failure, chronic atrial fibrillation) if there are no other acute clinical abnormalities.

- However, a patient with congenital long QT syndrome who requires non-cardiac arrhythmogenic medications (azithromycin, metoclopramide) for his pneumonia should be on telemetry.
- Similarly, the presence of moderate to severe electrolyte abnormalities (potassium, magnesium) in any non-cardiac condition warrants cardiac surveillance, even when there are no EKG changes.

It is important to mention here that in our study, only a small proportion of the medical residents considered the code status or even discussed the issue with their patients before ordering telemetry. As there are no

recommendations on continuous cardiac monitoring in individuals with ‘Do not resuscitate or intubate’ (DNR/DNI) and comfort care status, its use should be in-line with the overall care wishes expressed by the patients. For example, monitoring is generally not indicated in patients being transitioned to a comfort-focused end-of-life care phase; however, it may be considered if the findings trigger interventions that are required to promote comfort and alleviate symptoms such as adjustment of rate-control medications. On the other hand, the use of telemetry in individuals who are DNR/DNI (but not comfort care) should be based on the same practice standards as in a patient who opts for a full code unless there are some explicit directions in place. One such scenario where monitoring would be useless is when a DNR/DNI patient with severe sepsis wishes to be treated with intravenous fluids and antibiotics but declines any other aggressive or invasive intervention (use of vasopressors, anticoagulation, temporary pacing, cardioversion).

Next point worth discussing here is the level of awareness amongst physicians regarding inappropriate telemetry application. Interestingly, 84% of the respondents accepted the fact that telemetry is indeed overutilized while 86% of the residents admitted that monitoring patients without an indication ‘never’ or ‘rarely’ helped them prevent an actual complication. So, the question arises that despite this self-awareness, why do physicians (or residents in our study) continue to rely so much on telemetry? We have highlighted the following three points as the possible causes:

First, a significant proportion of the respondents (35%) felt that ‘Physicians/nurses are more comfortable when a patient is being monitored via telemetry’. This statement clearly sheds light on the false but strong sense of security associated with TM which continues to persist despite the medical evidence indicating otherwise [7]. In addition, the majority of the residents were of the opinion that telemetry leads to an early detection of hemodynamic instability (70%), hypoxemia (59%) and arrhythmias (43%) as compared to frequent vitals monitoring. It has been proven that signs of clinical deterioration can be recognized effectively hours before an actual event with regular physical assessments [11] while TM rarely affects the direct care or clinical outcomes when used in low-risk cases [4]; however, clinicians still tend to use it as a surrogate for direct physical monitoring due to the notion that telemetry is synonymous to better patient care.

Next, a factor that influences the use of TM in non-critically ill patients is ‘peer pressure’. Sixty percent of the residents would initiate telemetry (‘often’ or ‘always’) when asked by the nursing staff while 51% admitted to following trends set by their colleagues and seniors. These results support the theory that

a physician's working environment plays a major role in their daily use of telemetry.

Lastly, we observed that 57% residents are compelled to 'often' order telemetry for patients requiring only continuous pulse oximetry (CPO). Similarly, Chen et al. [6] reported that concerns for hypoxia resulted in the initiation of telemetry in 10% of the cases. This situation arises because, in some hospitals, CPO is integrated into the cardiac surveillance system and cannot be performed without placing patients in such specialized units. As a result, physicians are forced to initiate telemetry for the sole purpose of CPO.

A significant problem associated with overutilization of telemetry on general medical floor is its use for inappropriately long intervals. Curry et al. [12] reported that TM was continued for more than 48 hours in almost one-fifth of their study population while in another clinical trial, 39% of patients remained on telemetry till their discharge [6]. The likely reasons behind this issue are an initial lack of clinical judgement and subsequent poor follow-up; for example, when asked to specify the duration upon initiation of monitoring, 73% of the residents would choose 'continuous telemetry' while only 16% would (either 'often' or 'always') discontinue it after 24–48 hours of uneventful use. In addition, a significant number of respondents admitted that they 'never' (49%) or 'rarely' (24%) discuss the telemetry needs during the daily medical rounds.

Based on the medical data, majority of the significant events that require any kind of medical management usually arise within the first 24–48 hours of monitoring and any cardiac surveillance beyond this period has no influence on clinical outcomes or the survival rates; on the contrary, it can be harmful at times [5]. In the absence of clear guidelines, it might be very difficult for any clinician to tackle this issue and therefore, we suggest the following systematic approach:

First, review the reason why telemetry was ordered for a non-cardiac condition in the first place. If there is no clear indication, then monitoring can be discontinued immediately. However, if telemetry was indeed clinically indicated then it should be assessed whether the indication has been resolved or not. If yes then it is reasonable to stop the monitoring; otherwise, it can be continued till there is a final resolution (Figure 3). Furthermore, it is advised to order telemetry for only a short period such as 24–48 hours and then to discontinue it immediately afterwards if there is no significant event as the associated risk in non-cardiac conditions is substantially low [5]. For patients who do require a longer duration of monitoring, there should be regular assessment of such needs.

After application of this approach to the above-mentioned clinical scenarios, it can be seen that telemetry should be discontinued once there is a correction of the condition being monitored (e.g.

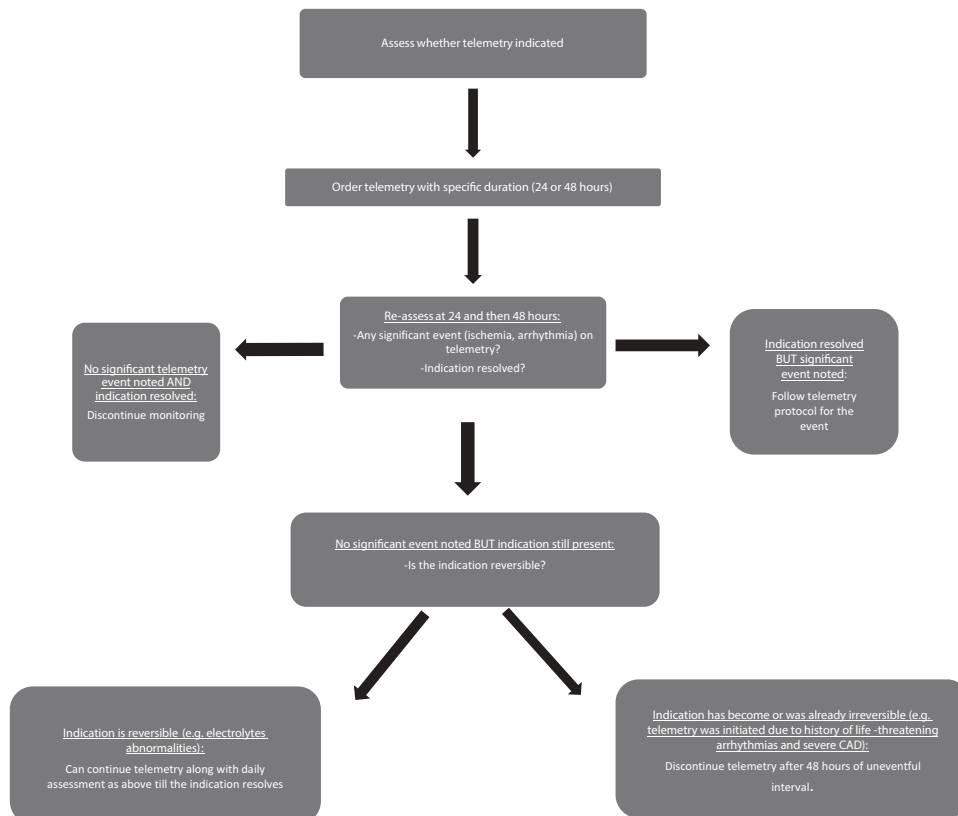


Figure 3. Proposed strategy for routine use of telemetry in non-critical settings.

EKG changes in scenario 1), reversal of the risk itself (e.g. electrolyte abnormalities in scenario 6), completion of the therapy (e.g. medication use in scenario 5) or after 24–48 hours of uneventful use if permanent or non-modifiable factors are present (renal failure requiring long-term hemodialysis in scenario 2).

5. Conclusion & practice proposals

The overuse of telemetry in non-cardiac conditions is a growing concern and in response to this need, several initiatives such as American Board of Internal Medicine Foundation's *Choosing Wisely* campaign have emerged [13]. Our study demonstrates that overutilization of telemetry is a complex issue which is driven not only by physicians' related factors but also by the culture ingrained within the health-care system that more care is better care. We, therefore, propose the following steps as potential solution to this problem:

- There exists a profound knowledge gap on the topic among the physicians which needs to be eliminated via vigorous educational exercises. However, it is imperative that this learning process starts much earlier and is an integral part of the curriculum for the medical residents. In addition, clinical staff at all levels including nurses should be educated with the help of lectures, workshops, online courses and various reading resources.
- Certain good practices should be promoted. These include careful assessment of telemetry needs during daily patient evaluation by the physicians and should be part of the clinical documentation such as progress notes. Initiation, continuation or discontinuation of monitoring should be discussed regularly for each patient during the medical and multi-disciplinary rounds.
- Protocol with a systematic evidence-based approach to ordering cardiac monitoring in non-cardiac conditions on the general medical floors should be developed by every health-care institute. In order to dissolve the perception that telemetry is superior to other methods of surveillance, an alternative protocol based on frequent vitals check and direct clinical assessment of patients should be implemented as well.
- Health-care organizations should revise and update the above-mentioned policies/protocols regularly. It should be ensured that every member of the clinical staff has easy access to these policies and are followed stringently.
- Provision of portable bedside monitors for patients that need CPO can help take some burden off the telemetry units.
- Hospitals should have checklists along with automatic expiration features built within the

electronic order sets so that telemetry is ordered for the right interval and there is no extension beyond an appropriate period. However, EHR should also have clear indicators to identify the patients being monitored along with pop-up alert notifications whenever there is a change to the telemetry status of a patient.

- Compliance with hospital policies should be part of the audit routine while involving clinical staff and physicians/residents in various quality improvement projects can help raise awareness on the topic.
- Last but not the least, due to the critical shortage of medical literature, large studies and randomized controlled trials on cardiac monitoring of non-critically ill patients admitted with non-cardiac conditions need to be carried out. The data from these trials can help in the development of standard guidelines on the use of telemetry in this specific patient population.

6. Limitations

There are several limitations and concerns pertaining to this study. It was a single medical residency program study with a small number of respondents; therefore, its results cannot be considered to represent all academic training programs. Our survey relied solely on the opinions of the medical residents and the results were not verified through review of medical records, the patients' data or any interventions. In addition, there might be a degree of bias present in the final analysis due to residents' year of training.

Acknowledgements

The authors would like to thank Dr. Tristan Flack and Dr. Maria Azhar for their tremendous help during the course of this study.

Disclosure statement

No potential conflict of interest was reported by the authors.

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