

## Telemetry Monitor Watchers Reduce Bedside Nurses' Exposure to Alarms by Intercepting a High Number of Nonactionable Alarms

Sonali Palchoudhuri, MD<sup>1,2\*</sup>, Stephanie Chen, MD<sup>1-3</sup>, Elaine Clayton, MS, RN<sup>1</sup>,  
Anthony Accurso, MD<sup>2,4</sup>, Sammy Zakaria, MD, MPH<sup>1,2</sup>

<sup>1</sup>Johns Hopkins Bayview Medical Center, Baltimore, Maryland; <sup>2</sup>Providers for Responsible Ordering, Johns Hopkins Medicine, Baltimore, Maryland; <sup>3</sup>Kaiser Permanente San Francisco, San Francisco, California; <sup>4</sup>New York University Population Health, New York, New York.

Cardiac telemetry, designed to monitor hospitalized patients with active cardiac conditions, is highly utilized outside the intensive care unit but is also resource-intensive and produces many nonactionable alarms. In a hospital setting in which dedicated monitor watchers are set up to be the first responders to system-generated alerts, we conducted a retrospective study of the alerts produced over a continuous 2-month period to evaluate how many were intercepted before nurse notification for being nonactionable, and how many resulted in code team activations. Over the 2-month period, the system gener-

ated 20,775 alerts (5.1/patient-day, on average), of which 87% were intercepted by monitor watchers. None of the alerts for asystole, ventricular fibrillation, or ventricular tachycardia resulted in a code team activation. Our results highlight the high burden of alerts, the large majority of which are nonactionable, as well as the role of monitor watchers in decreasing the alarm burden on nurses. Measures are needed to decrease telemetry-related alerts in order to reduce alarm-related harms, such as alarm fatigue. *Journal of Hospital Medicine* 2017;12:447-449. © 2017 Society of Hospital Medicine

Cardiac telemetry, designed to monitor hospitalized patients with active cardiac conditions, is highly utilized outside the intensive care unit (ICU) and generates a large number of automated alarms. Telemetry is also costly and requires substantial time and attention commitments from nursing and technician staff, who place and maintain the recording devices and address monitoring results.<sup>1,2</sup> The staff address and dismiss invalid alarms caused by telemetry artifacts,<sup>2</sup> such as the misreporting of patient movement as ventricular tachycardia/fibrillation (VT/VF) or the mimicking of asystole by a lead disconnection.

One strategy for addressing telemetry alarms is to have dedicated staff observe telemetry monitors and notify nurses with any events or findings. Studies conducted in the 1990s showed that dedicated monitor watchers, compared with automatically generated alarms alone, did not affect most outcomes<sup>3</sup> but can improve accuracy of arrhythmia detection.<sup>4</sup> Since then, given the advances in telemetry detection software, the effect of monitor watchers has not been evaluated. Mindful of the perceived burden of nonactionable telemetry alerts, we wanted to quantify the frequency of automated telemetry alerts in the wards and analyze the proportion of alerts deemed nonactionable by monitor watchers.

### METHODS

We conducted this retrospective study at a 545-bed urban academic hospital in the United States. We reviewed the

cases of all non-ICU patients with telemetry monitoring ordered. The telemetry order requires providers specify the indication for monitoring and adjust alert parameters for variables such as heart rate (preset to 60 and 100 beats per minute) and baseline rhythm (preset to normal sinus). Once a telemetry order is received, 5 leads are attached to the patient, and electrocardiographic data begin transmitting to a portable wireless telemetry monitor, or telemeter (Philips Intellispace Telemetry System), which in turn transmits to a central monitoring station in the progressive care unit (PCU; cardiac/pulmonary unit). The majority of patients on telemetry are in the PCU. Telemeters are also located in the general medicine, surgical, and neurologic non-ICU units. Data from a maximum of 96 telemeters in the hospital are simultaneously displayed in the central monitoring station.

At all times, two dedicated monitor watchers oversee the central monitoring station. Watchers are certified medical assistants with extra telemetry-specific training. Each receives a salary of \$17 per hour (no benefits), or about \$800 per 24-hour day for two watchers. Their role is to respond to audiovisual alerts triggered by the monitoring system—they either contact the bedside nurse or intercept the alert if deemed nonactionable. Consistent with the literature,<sup>5</sup> *nonactionable* alerts and alarms were defined as either “invalid” or “nuisance.” Invalid alerts and alarms misrepresent patient status (eg, patient motion is electronically interpreted as VT/VF), and nuisance alerts and alarms do not require clinical intervention (eg, persistent sinus tachycardia has already been communicated to the nurse or provider). Monitor watchers must intercept the alert within a limited amount of time: 15 seconds for suspected lethal alerts (asystole, VT/VF), 30 seconds for extreme tachycardia/bradycardia, and 60 seconds for lead displacement or low battery.

If a watcher does not intercept an alert—either intention-

\*Address for correspondence and reprint requests: Sonali Palchoudhuri, MD, 6th Floor, MFL West, Johns Hopkins Bayview Medical Center, 5200 Eastern Ave, Baltimore, MD 21224; Telephone: 410-550-5018; Fax: 410-550-2972; E-mail: sonali@post.harvard.edu

Received: June 6, 2016; Revised: November 18, 2016; Accepted: November 25, 2016

2017 Society of Hospital Medicine DOI 10.12788/jhm.2754

ally or because time ran out—the alert generates an alarm, which automatically sends a text message to the patient’s nurse’s wireless phone. The nurse acknowledges the alarm and decides on further action. If the bedside nurse does not acknowledge the alarm within the same time frames as mentioned, the alarm is escalated, first to the unit charge nurse and then to the monitoring station charge nurse (Figure). All alerts are available for provider review at the central monitoring station for the duration of the telemetry order, and select telemetry strips are printed and filed in the patient’s paper chart.

For this study, we analyzed telemetry system data for all monitored non-ICU ward patients from August 1 through September 30, 2014. We focused on the rate and relevance of alerts (system-generated) and alarms (text message to nurse). As cardiac arrhythmias leading to cardiopulmonary arrest can potentially be detected by telemetry, we also reviewed all code team activations, which are recorded in a separate database that details time of code team activation, to evaluate for correlation with telemetry alerts.

**RESULTS**

Within the 2-month study period, there were 1917 admissions to, and 1370 transfers to, non-ICU floors, for a total of 3287 unique patient-admissions and 9704 total patient-days. There were 1199 patient admissions with telemetry orders (36.5% of all admissions), 4044 total patient-days of telem-

etry, and an average of 66.3 patients monitored per day. In addition, the system generated 20,775 alerts, an average of 341 per day, 5.1 per patient-day, 1 every 4 minutes. Overall, 18,051 alerts (87%) were intercepted by monitor watchers, preventing nurse text-alerts. Of all alerts, 91% were from patients on medicine services, including pulmonary and cardiology; 6% were from patients on the neurology floor; and 3% were from patients on the surgery floor.

Forty percent of all alerts were for heart rates deviating outside the ranges set by the provider; of these, the overwhelming majority were intercepted as nuisance alerts (Table). In addition, 26% of all alerts were for maintenance reasons, including issues with batteries or leads. Finally, 34% (6954) were suspected lethal alerts (asystole, VT/VF); of these, 74% (5170) were intercepted by monitor watchers, suggesting they were deemed invalid. None of the suspected lethal alerts triggered a code team activation, indicating there were no telemetry-documented asystole or VT/VF episodes prompting resuscitative efforts. During the study period, there were 7 code team activations. Of the 7 patients, 2 were on telemetry, and their code team activation was for hypoxia detected by pulse oximetry; the other 5 patients, not on telemetry, were found unresponsive or apneic, and 4 of them had confirmed pulseless electrical activity.

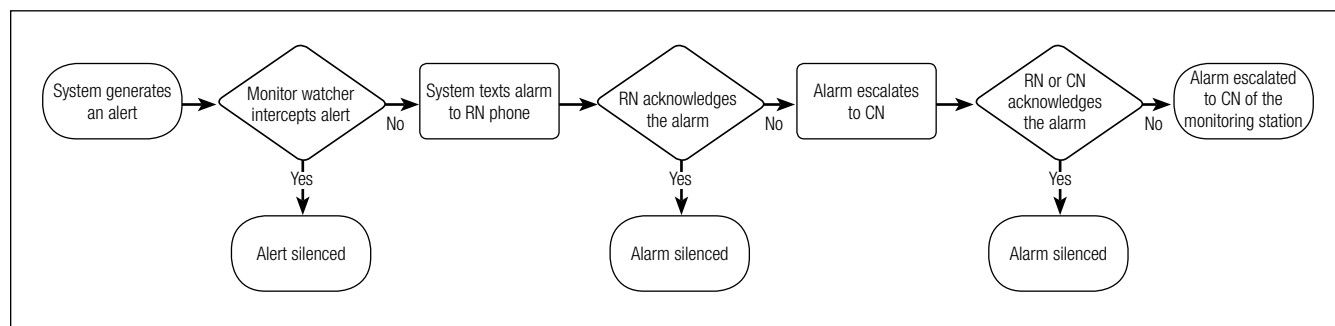
**DISCUSSION**

In small studies, other investigators have directly observed nurses for hours at a time and assessed their response to telemetry-related alarms.<sup>1,2</sup> In the present study, we found a very large number of telemetry-detected alerts over a continuous 2-month period. The large majority (87%) of alerts were manually intercepted by monitor watchers before being communicated to a nurse or provider, indicating these alerts did not affect clinical management and likely were either false positives or nonactionable. It is possible that repeat nonactionable alerts, like continued sinus tachycardia or bradycardia, affect decision making, but this may be outside the role of continuous cardiac telemetry. In addition, it is likely that all the lethal alarms (asystole, VT/VF) forwarded to the nurses were invalid, as none resulted in code team activations.

Addressing these alerts is a major issue, as frequent telemetry alarms can lead to alarm fatigue, a widely acknowledged

**TABLE.** Frequency of Alerts by Type and Proportion Being Intercepted by Monitor Watchers

Alert Type	Alerts		Intercepted Alerts	
	n	%	n	%
Asystole	2818	14	1945	76
Ventricular tachycardia	3638	18	2849	78
Ventricular fibrillation	498	2	376	77
Tachycardia	7477	36	7215	90
Bradycardia	898	4	881	92
Leads off	5032	24	4537	79
Battery	414	2	248	40
Total	20,775	100	18,051	87



**FIG.** Escalation protocol of telemetry alerts and alarms.

NOTE: Alert or alarm must be intercepted or acknowledged within described time limits to prevent escalation. Abbreviations: CN, charge registered nurse; RN, registered nurse.

safety concern.<sup>6</sup> Furthermore, nonactionable alarms are a time sink, diverting nursing attention from other patient care needs. Finally, nonactionable alarms, especially invalid alarms, can lead to adverse patient outcomes. Although we did not specifically evaluate for harm, an earlier case series found a potential for unnecessary interventions and device implantation as a result of reporting artifactual arrhythmias.<sup>7</sup>

Our results also highlight the role of monitor watchers in intercepting nonactionable alarms and reducing the alarm burden on nurses. Other investigators have reported on computerized paging systems that directly alert only nurses,<sup>8</sup> or on escalated alarm paging systems that let noncrisis alarms self-resolve.<sup>9</sup> In contrast, our study used a hybrid 2-step telemetry-monitoring system—an escalated paging system designed to be sensitive and less likely than human monitoring to overlook events, followed by dedicated monitor watchers who are first-responders for a large number of alarms and who increase the specificity of alarms by screening for nonactionable alarms, thereby reducing the number of alarms transmitted to nurses. We think that, for most hospitals, monitor watchers are cost-effective, as their hourly wage is lower than that of registered nurses. Furthermore, monitor watchers can screen alerts faster because they are always at the monitoring station. Their presence reduces the amount of time that nurses need to divert from other clinical tasks in order to walk to the monitoring station to evaluate alerts.

Nonetheless, there remains a large number of nonactionable alerts forwarded as alarms to nurses, likely because of monitor watchers' inability to address the multitude of alerts, and perhaps because of alarm fatigue. Although this study showed the utility of monitor watchers in decreasing telemetry alarms to nurses, other steps can be taken to reduce telemetry alarm fatigue. A systematic review of alarm frequency interventions<sup>5</sup> noted that detection algorithms can be improved to decrease telemetry alert false positives. Another solution, likely easier to implement, is to encourage appropriate alterations in telemetry alarm parameters, which can decrease the alarm proportion.<sup>10</sup> An essential step is to decrease inappropriate telemetry use regarding the indication for and duration of monitoring, as emphasized by the Choosing Wisely campaign championing American Heart Association (AHA) guidelines for appropriate telemetry use.<sup>11</sup> At our institution, 20.2% of telemetry orders were for indications outside AHA guidelines, and that percentage likely is an underestimate, as this was required self-reporting on ordering.<sup>12</sup> Telemetry may not frequently result in changes in management in the non-ICU setting,<sup>13</sup> and may lead to other harms such as worsening delirium,<sup>14</sup> so it needs to be evaluated for harm versus benefit per patient before order.

Cardiac telemetry in the non-ICU setting produces a large number of alerts and alarms. The vast majority are not seen or addressed by nurses or physicians, leading to a negligible impact on patient care decisions. Monitor watchers reduce the nursing burden in dealing with telemetry alerts, but we emphasize the need to take additional measures to reduce telemetry-related alerts and thereby reduce alarm-related harms and alarm fatigue.

## Acknowledgments

The authors thank Torberg Tonnessen, who was instrumental in providing the telemetry and clinical data used in this study, as well as the numerous Johns Hopkins Bayview Medical Center nurses, patient care technicians, and monitor watchers who answered questions about telemetry processes and allowed their work to be observed.

Disclosure: Nothing to report.

## References

1. Gazarian PK. Nurses' response to frequency and types of electrocardiography alarms in a non-critical care setting: a descriptive study. *Int J Nurs Stud*. 2014;51(2):190-197.
2. Varpio L, Kuziemyk C, MacDonald C, King WJ. The helpful or hindering effects of in-hospital patient monitor alarms on nurses. *Comput Inform Nurs*. 2012;30(4):210-217.
3. Funk M, Parkosewich J, Johnson C, Stukshis I. Effect of dedicated monitor watchers on patients' outcomes. *Am J Crit Care*. 1997;6(4):318-323.
4. Stukshis I, Funk M, Johnson C, Parkosewich J. Accuracy of detection of clinically important dysrhythmias with and without a dedicated monitor watcher. *Am J Crit Care*. 1997;6(4):312-317.
5. Paine CW, Goel VV, Ely E, et al. Systematic review of physiologic monitor alarm characteristics and pragmatic interventions to reduce alarm frequency. *J Hosp Med*. 2016;11(2):136-144.
6. Joint Commission on Accreditation of Healthcare Organizations. The Joint Commission announces 2014 national patient safety goal. *Jt Comm Perspect*. 2013;33(7):1, 3-4.
7. Knight BP, Pelosi F, Michaud GF, Strickerberger SA, Morady F. Clinical consequences of electrocardiographic artifact mimicking ventricular tachycardia. *N Engl J Med*. 1999;341(17):1270-1274.
8. Zwieg FH, Karfonta TL, Jeske LJ, et al. Arrhythmia detection and response in a monitoring technician and pocket paging system. *Prog Cardiovasc Nurs*. 1998;13(1):16-22, 33.
9. Cvach MM, Frank RJ, Doyle P, Stevens ZK. Use of pagers with an alarm escalation system to reduce cardiac monitor alarm signals. *J Nurs Care Qual*. 2013;29(1):9-18.
10. Gross B, Dahl D, Nielsen L. Physiologic monitoring alarm load on medical/surgical floors of a community hospital. *Biomed Instrum Technol*. 2011;Spring (suppl):29-36.
11. Drew BJ, Califf RM, Funk M, et al; American Heart Association; Councils on Cardiovascular Nursing, Clinical Cardiology, and Cardiovascular Disease in the Young. 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; endorsed by the International Society of Computerized Electrocardiology and the American Association of Critical-Care Nurses [published correction appears in *Circulation*. 2005;111(3):378]. *Circulation*. 2004;110(17):2721-2746.
12. Chen S, Palchadhuri S, Johnson A, Trost J, Ponor I, Zakaria S. Does this patient need telemetry? An analysis of telemetry ordering practices at an academic medical center. *J Eval Clin Pract*. 2017 Jan 27 [Epub ahead of print].
13. Estrada CA, Rosman HS, Prasad NK, et al. Role of telemetry monitoring in the non-intensive care unit. *Am J Cardiol*. 1995;76(12):960-965.
14. Chen S, Zakaria S. Behind the monitor—the trouble with telemetry: a teachable moment. *JAMA Intern Med*. 2015;175(6):894.