Implementing an Electronic Telemetry Downgrade Score on a General Surgical Unit

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Abstract

Problem: The problem at a Magnet® designated medical center was the continued use of telemetry monitoring when the monitoring was no longer indicated on adult non-intensive care patients. Continued telemetry past patient need, limits the availability of this monitoring for patients who require it when there is a limited supply of telemetry-monitoring packs. The hospital has a Clinical Decision Support (CDS) Telemetry Downgrade Score (TDS) tool in the electronic health record (EHR); however, it is underutilized. Evidence supports the use of both CDS and TDS by providers and nurse helps to yield fewer telemetry orders and less time on telemetry. Inappropriate ordering of telemetry monitoring may adversely affect both patient and staff satisfaction and increase the length of stay (LOS).

Purpose: The purpose of this quality improvement project was to implement the use of the TDS tool for the providers and nurses to evaluate the patients need for continued telemetry.

Methods: The providers and nursing staff were educated on the use of the TDS tool and the 2017 AHA guidelines. Mentoring and support were given to providers and nurses through emails, rounds, and meetings. During a 15-week implementation timeline, retrospective audits were completed collecting data on the duration of telemetry hours' time stamps and indication for use, including pre and post intervention audits. Using run charts, measurement trends were analyzed.

Results: Nurses and providers were educated on the intervention meeting the goal for day shift of 65 staff or 30% of the total staff. Over the 15 weeks, 415 patients were placed on telemetry. Telemetry hours for the pre-intervention period was 1034 median hours compared to 614 post-intervention period. Displaying evidenced-based guidelines and an electronic TDS, appropriate ordering improved by almost 20% and duration decreased by 422 hours. Moreover, this project provided more availability to monitoring packs for those patients' requiring placement.

Conclusions: When a TDS tool was used following education and active stewardship, more patients were appropriately placed as well as appropriately discontinued on telemetry, resulting in increased telemetry monitoring packs capacity.

Implementing an Electronic Telemetry Downgrade Score on a General Surgical Unit

In 2019, total hospital expenses were $1,192 billion with an increase of 6.2% compared to 4.2% in 2018 (Centers for Medicare and Medicaid, 2021). Telemetry monitoring contributes to the high healthcare expenditures and is often inappropriately utilized. Telemetry monitoring costs can be as high as $1400 per day, with equipment and associated costs in care (Chong-Yik et al., 2018; Yeow et al., 2018). Nurses can expend 16% to 35% of their patient care time responding to telemetry alarms, potentially spending up to twenty-minutes diverted from direct patient care, affecting direct care staff costs and efficiency. Additionally, alarms may have an adverse physiologic effect on patients and their families (Philips et al., 2019). The American Heart Association (AHA, 2017) has updated practice standards for telemetry monitoring to address appropriate use, managing alarms and electronic documenting (Sandau et al., 2017). The AHA Practice Standards, the Choosing Wisely® initiative from the American Board of Internal Medicine, and the High Value Practice Academic Alliance's (HVPAA), all advocate limiting use of small-value practices, such as telemetry monitoring, when no longer indicated (Choosing Wisely, 2021; HVPAA, 2021). Inappropriate use of telemetry monitoring is costly, may increase length of stay (LOS), and bears potential harm. Unnecessary telemetry monitoring can result in alarm fatigue, reduce the capacity of telemetry equipment, generate workflow interruptions, pose injury risks, create sleep disruptions, and lead to unnecessary workups and testing (Chakravarthy et al., 2020; Chong-Yik et al., 2018; Stoltzfus et al., 2019). As a priority safety concern, the Joint Commission's National Patient Safety Goal of 2014 calls for reducing unnecessary monitors and alarms contributing to alarm fatigue, and potential patient harm (The Joint Commission, 2014).

The problem at this Magnet® designated mid-sized medical center is the inappropriate use of telemetry monitoring when the monitoring is no longer indicated on adult non-intensive care patients. Telemetry monitoring packs are devices worn on the monitored patient's waist or around the neck. Using a hospital wireless internet connection (wi-fi), the packs are remotely monitored by a telemetry technician. The hospital has a limited supply (96) of monitoring packs, which are often all in use. If inappropriately placed telemetry was discontinued timely, some of these packs could be made more available. A practice change was implemented on the General Surgical Unit (GSU) with a daily telemetry use of 10 to 12 patients and included daily evaluating the TDS. A new clinical decision support (CDS) Telemetry Downgrade Score (TDS) Tool was hardwired into the electronic health record (EHR) to help the providers (Physicians, Nurse Practitioners (NP's), and Physician Assistants (PA's) decision about discontinuing telemetry. Unfortunately, the tool has limited operationalization and accountability in evaluating the need to renew or discontinue telemetry presented in Figure 1 and Figure 2 for processes flow. These costs place a burden on equipment overhead, such as costs of telemetry boxes, and annual losses associated with equipment (leads, Wi-Fi, and staffing) when telemetry is not indicated. The purpose of this quality improvement (QI) project was to increase capacity of telemetry monitoring packs by daily evaluating and implementing a TDS on an adult non-ICU surgical unit to support providers' decision for appropriate use of telemetry monitoring.

Evidence Review

A thorough review and synthesis of the literature, as seen in Table 1 and Table 2, was conducted to identify best practices using a CDS in the EHR and/or AHA guidelines to appropriately place patients on telemetry in non-ICUs. Seven studies were chosen for final review including two randomized controlled trails (RCTs), one quasi-experimental, one before and after design, a retrospective QI design, and one literature review evidenced-based-practice guideline. All the studies supported the practice change and included a similar target population, setting/contexts, intervention, and desired outcomes.

Najifi et al. (2019), used a cluster randomized control trial (RCT) with power analysis run over six months. The intervention had an EHR alert added to appropriately discontinue telemetry when exceeding duration. The primary outcome was telemetry monitoring hours per hospitalization, which was measured using time-stamped orders data from the EHR database. The alert prompted a significant reduction in telemetry monitoring duration (-8.7 hours per hospitalization; 95% confidence interval [CI], −14.1 to −3.5 hours; P = .001). Results showed group homogeneity of 1021 patients, with a control sample of 567 and the intervention sample 499 patients. Moreover, there was an increase in physician's writing discontinue telemetry monitoring when orders were expired.

Using a RCT over four months with the intervention group receiving a daily best practice alert (BPA) to discontinue telemetry, Chin et al. (2020) had no significant decrease in LOS. Results displayed 1042 alerts to the intervention group and trended toward fewer telemetry days (3.8 vs 5.0, p=0.017) for the control. The intervention group stopped telemetry 31.7% of the alerted patient-days compared with 23.3% for the control group (OR 1.53, 95% CI, 1.24 to 1.88).

Edholm, et al. (2018), used a two-group retrospective, observational pre-and-postintervention study of 35,871 patients' visits over a six-month period. The authors reported that an EHR telemetry order set can result in decreased days on telemetry. Further, seen in this study was a decrease in telemetry orders with an increase in telemetry appropriateness using the AHA guidelines in hospitalist care compared to the control non-hospitalist group. Among hospitalist service patients, telemetry utilization was reduced by 69%

(95% CI, −72% to −64%; $P < .001$), whereas on other services the reduction was a less marked 22% (95% CI, −27% to −16%; $P < .001$).

Wray et al. (2017) used a single interrupted time series analysis, quasi-experimental longitudinal design with a total chart review of 7,901 patients pre intervention of nine months and post of six months. Although no difference in the percentage of patients receiving telemetry orders, a significant decrease in the ordering trend for telemetry ($P <.01$) was noted after implementation. Additionally, patients receiving telemetry orders spent 18% less time on telemetry (42.5 vs 34.9 hours; $P <.01$), with an estimate of 1181 patient days without telemetry during the intervention period, a reduction of 25%.

Although Wray et al. (2017) alternatively showed no change in telemetry orders, Rizvi et al. (2017), did discern decreases in duration on telemetry, thus decreasing LOS and a trend toward improved utilization appropriateness. Rizvi et al. (2017), used a continuous QI strategy, retrospective design of 34,572 patients within three hospitals comparison of mean number of days on telemetry, pre-and post-implementation of electronic pop-ups. Three regional hospitals implemented an electronic pop-up reminder for discontinuing the use of telemetry when no longer indicated. A pop-up reminder did show the median number of days on telemetry was significantly lower after the intervention period of one year (2.25 vs 3.61 days, $p < 0.0001$), and 86.29 hours/patient/month compared to 70.86 hours/patient/month. For the physician discontinuation protocol, patients spent, on average, 81.6 hours/patient/month on telemetry compared to no significant change for the nurse driven protocol.

Duffy et al. (2020) study showed no effect on duration of telemetry, but there was a significantly lower number of telemetry orders written. A before and after design, was used with a sample of 9,881 patients over eight months. There were two protocols a nurse-driven discontinuation protocol, over 12 months, following a physician discontinuation protocol, with data from six months prior to the implementation. During the control period, the average time spent on telemetry was 86.29 hours/patient/month. For the nurse-discontinuation protocol, patients spent, on average, 70.86 hours/patient/month on telemetry, and no significant change in the likelihood that a patient was placed on telemetry throughout admission when compared with the control period. However, for the period of the physician discontinuation protocol, patients spent, on average, 81.6 hours/patient/month on telemetry with a significant decrease of 56.1% in the likelihood that a patient would be put on telemetry when compared with the control period.

Lastly, Yeow et al. (2018), used a QI project to create an evidence-based practice guideline. A comprehensive literature review of seven studies was performed using evidence from Choosing Wisely Campaign and the 2017 AHA guidelines for a set of best practices of appropriate telemetry interventions. These included, indication-based ordering, automatic discontinuation, diligent appraisal of usage and appropriateness, and education leading to significant reduction (12%-71%) in use and cost savings. Time frame ranged from 4 weeks to 52 weeks.

Overall, the evidence supports using the TDS as a provider driven CDS to appropriately place telemetry, can increase capacity of available telemetry packs. The authors reported a decrease in duration, and orders written, and an increase in appropriateness of order indications and placement of telemetry. A few studies used provider driven approaches to facilitate appropriately use telemetry (Duffy et al., 2020; Edholm, et al., 2018; Yeow et al., 2018). Moreover, most authors used an electronic CDS as a reminder to practitioners in reevaluating and/ or discontinuing telemetry use within 72 hours (Chin et al., 2020; Najifi et al., 2019, Rizvi et al., 2017; Wray et al., 2017).

Theoretical Framework

Technological Competency as an Expression of Caring by Locsin, (2005) is a middle-range theory explaining a coexistence of nursing technological proficiency and caring. Often, "caring" for patients becomes secondary due to technologies, legal consequences, and documenting. Overburden of responding to false alarms and inappropriate telemetry monitoring may cause staff's caring to become subordinate to technological care, and staff not seeing their patients as a whole person (Locsin, 2017). This theory supported the practice change in ability to reach structure, process, and outcome goals. These included, educating, and supporting the providers and nursing staff on best practices of using the AHA guidelines and the TDS. The facility and organizational characteristics for structures include a TDS in the EHR CDS. Process measures included preventing unnecessary monitoring of patients, modifying safety concerns to patients and workload for staff (nurses, patient care technicians and telemetry technicians). Outcomes for patients appropriately placed on telemetry monitoring with the use of a Downgrade Score support sustainability through monthly auditing and reporting of improved patient and staff satisfaction and quality of life.

The Framework for complex innovation by Helfrich et al. (2007) supported the implementation process and operationalizing the Downgrade Score. Hospital leadership promoted and aided in facilitating the practice change, as well as garnering Champion Innovators. Innovators identified were the nursing Director of Heart and Vascular Unit (HVU), the Chief Hospitalist of HVU, Chiefs of Surgery and Hospitalists on GSU and the Nurse Educator on the GSU. The champions gained provider-valued support and enhanced the implementation climate as a positive value fit in outcomes of decreasing LOS and increasing capacity of telemetry packs. Additionally, the practice change resonates with the hospital's mission and vision of implementing evidenced-based practice and maintaining Magnet® designation status and professional core competencies of excellence in care.

Methods

This QI project was a provider driven practice change on the use of daily evaluating the EHR TDS. Nurses and providers for a total of 65, received training on the 2017 AHA guidelines and how to add the TDS tool into worklists. A sign-in log with training dates of the trainer and trainees was created to capture data and trainees verbalized understanding on how to use the TDS. If a patient was on telemetry, the TDS icon would be displayed on the EHR worklists and order sets as a heart symbol to evaluate the score. If a zero or one populated when the user hovered over the icon, then the patient should be reevaluated for removal from telemetry. Approximately 15 providers daily reviewed the TDS. Furthermore, additional length of monitoring was considered for needed resources, assistance, and guidance to the most vulnerable patients with barriers of activity, language, auditory, reading and health literacy, non-English speaking, cultural diversity, and comorbidities. Following patient-centered care, patients were provided well-informed decision making to telemetry monitoring. The setting for the project implementation unit was a mid-sized midcentral hospital, consisting of post-surgical, predominantly bariatric, and medical patients. The average LOS was one to three days. The population was all adult patient's ≥18 years of age with a telemetry order, a LOS greater than 24 hours, and without exclusion criteria. Of these patients, approximately 10 to 12 patients were included daily in the practice change during the project implementation period of 15 weeks. Staff included approximately 65-day shift staff nurses, Charge nurses (one) on day and night shifts, Director of Nursing, seven-unit Hospitalists, Surgeons, two physician assistants (PAs) and two nurse practitioners (NPs), and daily two medical doctors (MDs).

Provider education by the QI-project lead (PL) took place via Zoom with two ten-minute presentations to the hospital surgical chiefs and one fifteen-minute presentation to the Hospitalist on the GSU. Education to staff nurses took place via zoom with a ten-minute presentation at two separate sessions. In addition, face-to-face education to individual providers and nurses with a sign-off on verbalizing understanding on the use of the TDS was also provided by the QI-project lead (PL). Moreover, handouts were provided on adding the TDS to worklists and how to use the tool along with a copy of the 2017 AHA guidelines. Additional laminated prompting flyers were placed throughout the unit. Emails were then sent to the Chief Hospitalists, Surgeons, and Innovative Champions every few weeks to remind providers and nurses to use the TDS and appropriately place telemetry. Last, weekly unit visits were done by the QI-PL to reeducate and check in with the providers and nurses.

The QI project outcome was to evaluate the effectiveness of implementing the TDS to appropriately place telemetry by increasing capacity of telemetry monitoring packs and to decrease duration on telemetry. Weekly reports were pulled by the QI-PL and organizational clinical site representative (CSR) to track these e-measures from the EHR, for time stamps on duration, telemetry order, and indication comments. All project data was recorded on a secure data management excel spreadsheet stored on a password protected device accessible only by the QI-PL. Weekly, the QI-PL accessed and logged data measures on the data management spreadsheet by code to protect data integrity and confidentiality. Data was collected and analyzed by the QI-PL on process measures in weekly data run charts using pre and post data changes to tell the data story of implementation, effectiveness, and progress for all short-term process measures. Descriptive analysis was used to assess the mean, frequency, and percentage of duration and indication of orders to explore relationships among pre- and post-implementation data. Prior to the implementation, the QI project was submitted to the Human Research Protections Office at the University of Maryland and received a non-human research determination.

Results

Over a period of fifteen weeks, an electronic audit was collected on provider telemetry monitoring ordering and indications for usage. The chart audits included data review showing both compliance with indication and duration for usage as displayed in Figures 3 and 4. The practice change involved educating clinicians on the EHR TDS and the AHA 2017 guidelines. The goal was to educate 20 staff weekly during the intervention period 9/4-10/6 for a total of 65 staff or 30% of the total staff. An unintended consequence found during the education period was a lack of adding the TDS to worklists, enabling the score to pop up when hovered over the TDS heart icon. Appropriate indication for telemetry orders (Figure 3) showed a result of 96% appropriately placed orders after the intervention compared to 76% pre-intervention. Median duration of hours on telemetry (Figure 4) showed a decrease in time on telemetry of 614 hours post-intervention period compared to pre-intervention 1035 hours.

The project measures were evaluated on structure, process, and outcomes. Structure measures of the project charter included a change to the EHR on CDS, however, linking an updated 2017 AHA guideline in clinical decision support (CDS) was not feasible for this project. Alternatively, education on using the TDS and the 2017 AHA guidelines were implemented leaving 100% of the expected Surgeons and Hospitalists, and day-shift nurses educated. Prior to implementation and in planning it was determined only day shift nurses needed to daily assess the TDS. Moreover, data audits showed that prior to the intervention period, several providers were the using wrong telemetry monitoring indication, such as “post-op”, “intravenous drug abuse (IVDA),” “history of congestive heart failure,” or an indication not found in 2017 AHA guidelines. Still, most providers continue to lack ordering, “cancel” or “discontinue” telemetry. Ultimately, after the intervention period there was a trend to appropriately place telemetry and a decrease of telemetry hours (duration), thus increasing availability of telemetry monitoring packs on the GSU.

Discussion

For this project, the Technological Competency as an Expression of Caring model helped to guide the practice change with demonstrated results. Outcome measures of the effects of telemetry monitoring when appropriately placed showed effects of preventative measures to determine best practices in care of diagnosing and treating complications and maintenance. If a patient no longer required telemetry or no longer was appropriately placed on telemetry, the improved health status from alarm burden and potential harm is avoided. More importantly, by implementing evidenced-based guidelines and an electronic TDS, appropriate ordering improved by almost 20% and duration decreased by 422 hours. These results resonate with related studies in the literature. For reduction in duration, Wray et al. (2017) reported a significant reduction of telemetry by 18% using a multifaceted approach of a CDS, education and AHA guidelines. Yeow et al. (2018) found a 12% to 71% reduction on ordering, usage, appropriateness, and education leading. Similarly, Edholm et al. (2018) had a telemetry utilization reduced by 69%. For the use of pop-up reminders, Chin et al. (2020) found a decrease in telemetry days by 1.20 days with a discontinuation of 8.4 days using an EHR alert reminder. Using a pop-up reminder, Najifi et al. (2019), found a decrease of 8.7 hours per hospitalization. Similarly, Rizvi et al. (2017) study using a pop-up reminder displayed a decrease in 1.36 days for provider driven discontinuation protocol. Duffy et. al. (2020) had a decrease in telemetry placements by 56.1%.

Additional efforts were made to acknowledge, minimize, and adjust for limitations for this QI project. These efforts included continued weekly rounding on the unit and communication with the medical team and nurse educator post intervention. Furthermore, limitations included the project being performed at a single medical center, on one unit, and over only 15 weeks. A further limitation was providers were not consistent in writing "cancel" or "discontinue" telemetry order limiting reductions in use, accurate recordings, and monitoring of removals which may have removed patients from telemetry even sooner.

There have been many strengths of this project. First, using the updated AHA guidelines and implementing the previously in place TDS proved valuable to operationalize. Secondly, using a multidisciplinary approach proved beneficial to include providers, nurses, information systems, telemetry monitoring technicians and patient care technicians. Selecting this practice change on the busiest telemetry unit, recent addition of cardiac surgeries and during a pandemic, presented a clear need for the practice change to occur within the organization and resulted in QI practice outcomes as noteworthy with limitations and further recommendations clearly visible. The observed improved outcome measures for several inappropriate indications of pre-data, showed that education to the providers displayed improvements in trends. After the intervention, a decrease in telemetry packs' duration was demonstrated thus increasing availability of monitoring packs as the observed process measures of decreasing telemetry hours on the GSU. Further, direct benefit to participants was indicated for the decrease in risk by receiving telemetry and by creating a safer institutional system.

Conclusion

This QI project improved the utilization of a TDS in the EHR as a CDS lowering the unnecessary hours for telemetry monitoring approximately on average 60 weekly hours. Moreover, there was a 20% increase in appropriate indication for ordering and discontinuing telemetry using the AHA evidenced based guidelines. Considering the spread of the gains to other units or facilities there are “lessons learned” from this project that will be helpful to others implementing a similar intervention. First, a recommendation for sustainability is having providers and nurses complete a pre-survey and post-survey to identify if the TDS was indeed added to worklists and if the tool was utilized daily in evaluating the TDS. Secondly, having more in-depth annual and onboarding provider and nurse education on the 2017 AHA Guidelines may be beneficial to adherence and buy-in in optimizing appropriate telemetry use. Third, including patients as partners in the plan of care and reasons for telemetry use may affect patient and staff satisfaction. Last, partnering with information systems to insert an education link with the 2017 AHA Guidelines and/or linking into the data ordering set could prove productive to providers as an enhanced CDS. Future QI projects can implement including patients as full members of the care team which may affect LOS, costs, and patient needs. Future projects can also use the availability of financial resources for maintaining the process improvement beyond the project end showing cost benefit of improved outcomes, in care, full time equivalent (FTE’s) days on monitoring, LOS, and increased capacity of available packs. Extending the project to other units, and the hospital systems will further practice spread and reduced unnecessary telemetry use. In conclusion, this project aligned with the hospital’s mission and vision of implementing evidenced- based practice while maintaining Magnet® designation status in providing excellence in care.

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Table 1

Evidence Based Table Using Electronic Health Record Reminders for Appropriate Telemetry Monitoring in Non-ICU's

Citation: Chin, K.-K., Svec, D., Leung, B., Sharp, C., & Shieh, L. (2020). E-HeaRT BPA: electronic health record telemetry BPA. *Postgraduate Medical Journal*, *96*(1139), 556–559. https://doi/10.1136/postgradmedj-2019-137421					**Level II**
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
To identify and apply an impactful and sustainable intervention to reduce telemetry.	Randomized controlled design	**Sampling Technique:** convenience random # generation **# Eligible:** n=600 **Excluded:** n=42 (admission to cardiac or intensive care services). **# Accepted:** n=558 All patients admitted to non-ICU services with an active telemetry order (No patients left the study) **# Control:** n=283 **# Intervention:** n=275 **Power analysis:** powered to detect a difference of 1 telemetry day at a two-sided	**Control Group:** No BPAs appeared **Intervention:** Received daily BPAs if telemetry was active **Protocol**- BPAs appeared 1x daily at 6am in ordering interface if an active telemetry order; daily BPA displayed guideline supported indications for telemetry and asked if provider would be discontinuing telemetry. Provider responses to the BPAs were reviewed along with charts assessing if telemetry was discontinued further confirmed by extraction of telemetry order times	**DV:** Primary outcome: amount of telemetry days and daily discontinuation of telemetry Secondary outcome: patient outcomes and safety, including demographic variables (age, gender, race, length of stay, code blues, rapid responses, and mortality). **Measurement tool (reliability), time, procedure:** Intervention designed and implemented by clinical experts and the Clinical Decision Support Committee. Time: intervention parallel for a total of 5 weeks -no reliability	**Statistical Procedures(s):** Descriptive statistics to compare control and intervention groups: demographics, primary outcomes; secondary outcomes. $\chi 2$ tests and two-sample t-tests assessed significance of binary and continuous outcomes; Bonferroni correction applied in performing multiple comparisons for outcomes analysis. **Results:** Intervention group triggered 1042 alerts and trended toward fewer telemetry days (3.8 vs 5.0, p=0.017); stopped telemetry 31.7% of the alerted patient-

		significance level of 0.05 (β=0.20, power=0.80). **Group Homogeneity:** The control and intervention groups have no significant demographic differences.	and durations from Epic. **Intervention fidelity:** BPA designed and implemented by clinical experts and the Clinical Decision Support Committee**.** Education to both groups across the hospital such as cost-effectiveness lectures and posters describing telemetry indications continued as previous	Data or inter-rater reliability documented -spillover effect would bias primary outcome to the null, yet the researchers were still able to find significant difference two groups. Spillover could suggest that a BPA applied toward 50% of the patients can affect more than 50%. -study conducted at a single academic institution over five months, limiting generalizability and power to detect significant differences in code blue events and rapid responses. -Heterogeneity of services experienced the same intervention.	days compared with 23.3% for the control group (OR 1.53, 95% CI 1.24 to 1.88, $p<0.001$). No significant differences in length of stay, rapid responses, code blues, or mortality between the two groups and no significant differences between two groups in age, sex, and race with no significant difference in services of patients. Overall, intervention groups; patients trended toward fewer telemetry days (3.8 vs 5.0, $p=0.017$). Limitations: A single academic institution over a short timeframe, limiting generalizability and no power to detect significant differences in rare events such as code blues and rapid responses. Additionally, no power to determine differences in sub analyses on services

					and trends toward decreased telemetry days promising but should be considered in further research. Heterogeneity of services underwent the same intervention. Future studies could be better powered to determine services benefitting the most from BPAs and help targeting the intervention. Last, quantifying provider burden and fatigue would be beneficial (time providers spend interacting with the BPA and perceptions).
Citation: Duffy, E., Niessen, T., Perrin, K., Apfel, A., Bertram, A., Keller, S. C., Feldman, L. S., & Pahwa, A. K. (2020). Empowering nurses and residents to improve telemetry stewardship in the academic care setting. *Journal of Evaluation in Clinical Practice.* https://doi/10.1111/jep.13470					**Level IV**
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
Transitioning responsibility for telemetry discontinuation from the nurse to the resident would lead to an increase in patient	Before and after study design	**Sampling Technique:** convenience **# Eligible**: n=9881 patient encounters with telemetry on general medicine units.	**Control:** time before implementation: data from 6- months prior to nurse-discontinuation protocol (pre-intervention control). hours/patient/month	**DV:** Telemetry orders per monthly admissions Primary outcome: total time spent on telemetry per patient per month. Secondary outcome: % of	**Statistical Procedures(s) and Results:** Control period: average time spent on telemetry n=86.29 hours/patient/month. Nurse-discontinuation

time spent on telemetry.		**Excluded:** intensive care, step-down, and cardiac care units **# Analyzed pre and post** n=9881 **Power analysis**: none described **Group Homogeneity:** implemented within hospital's adult general medicine units (268 beds), demographics not described	**Intervention**: 1. nurse-discontinuation protocol: nurses to trigger discontinuation of telemetry once appropriate duration had passed according to practice standards. 2. physician discontinuation protocol, instituted a best-practice advisory notifying physician via EMR when appropriate telemetry duration for each patient had elapsed and suggested termination of telemetry. **Intervention fidelity:** To assess significance of interventions and determine no pre-existing trend in time on telemetry over each study period, an interrupted time-series analysis performed to provide rates of change in	patients placed on telemetry each month. **Measurement tool (reliability): -**All data obtained from EMR - Analyses of average total time spent on telemetry every month calculated using t-test, if data did not follow a normal distribution, a Wilcoxon rank-sum test performed. Statistical computations were performed using SAS v9.4 software **Time:** n= 3 years physician-discontinuation protocol began immediately following end of nursing-discontinuation protocol**:** Data collection n= 8 months, following implementation of nurse discontinuation protocol, and n=12 months, following physician discontinuation protocol, with data	protocol, patients spent, average, n=70.86 hours/patient/month on telemetry. Physician discontinuation protocol: patients spent, on average, n=81.6 hours/patient/month on telemetry. - nurse-discontinuation protocol, no significant change in likelihood patient placed on telemetry throughout admission compared with the control period. -physician-discontinuation protocol, there was a significant decrease of 56.1% in likelihood a patient would-be put-on telemetry when compared with control time. Limitations: start of physician discontinuation protocol was start of

			time on telemetry over each period of the study Nurse used 2004 AHA Telemetry Practice Standards for indication; practice standards followed in this study were those from 2004, not 2017.	from 6- months prior to nurse-discontinuation protocol (pre-intervention control). No mention of inter-rater reliability or education.	Epic Systems, potentially effecting telemetry use. Telemetry ordering process did not change between the two EMRs. Additionally, the study followed 2004 AHA guidelines not the updated 2017 ones.
Citation: Edholm, K., Kukhareva, P., Ciarkowski, C., Carr, J., Gill, D., Rupp, A., Morshedzadeh, J., Wanner, N., & Kawamoto, K. (2018). Decrease in Inpatient Telemetry Utilization Through a System-Wide Electronic Health Record Change and a Multifaceted Hospitalist Intervention. *Journal of Hospital Medicine, 13*(8), 531–536. https://doi/10.12788/jhm.2933					**Level II**
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
To compare a system wide EHR approach to a multifaceted intervention.	A two-group retrospective, observational pre- to postintervention study. Random Control Tial	**Sampling Technique:** convenience random selection **# Eligible:** n= 46,215; Hospital encounters of patients = or older than n=18 years, at least one inpatient acute care, non-intensive care unit (ICU) room charge and admission date range January 1, 2014, to July 31, 2016	**Control:** non-hospitalist providers **Intervention:** Hospitalist group- telemetry reduction intervention including education, process change, routine feedback, and a financial incentive between January 2015 and June 2015. **Intervention Fidelity:** Hospitalist Group: multicomponent	**DV:** Primary outcome= telemetry utilization, measured as % percentage of daily room charges for telemetry. Secondary outcomes: mortality, escalation of care, code event rate, and appropriateness of telemetry utilization. **Measurement tool (reliability): Reliable and valid tools used:** p values <.05 were considered significant from SAS	**Statistical Procedures(s) and Results:** Hospitalist patients, telemetry utilization was reduced by 69% (95% confidence interval [CI], −72% to −64%; P < .001), non-hospitalist: reduction less significant 22% (95% CI, −27% to −16%; P < .001). No significant increases in

		# Excluded: n= 92 due to missing or invalid data encounters with missing encounter-level covariates, such as case mix index (CMI) or attending provider identi-fication**,** **# Accepted:** 10,344 visits occurred during the "run-in" period n=6 months, leaving n=35,871 patient visits during the pre- and postintervention periods. **# Control:** non-hospitalists; admissions pre n= 13,470, post n= 15,259; unique patients n= 10,514, n=12055 **# Intervention:** admissions pre: n= 3442, post: n = 3700; # unique patients pre: n= 2821, post: n= 3060 **Power analysis:** none **Group Homogeneity**:	program composed of elements, made before hospital-wide changes to electronic telemetry orders and maintained throughout the study period: (1) a single provider education session reviewing available evidence (i.e., AHA guidelines, and Choosing Wisely campaign), (2) removal of telemetry order from hospitalist admission order set (3) inclusion of telemetry discussion in the hospitalist group's daily "Rounding Checklist," (4) monthly feedback provided as part of hospitalist group meetings, and (5) a - financial incentive awarded to division (no individual provider payment) if performance targets met. Control Protocol: EHR telemetry order modified to	version 9.4 statistical software; Generalized Linear models, descriptive analysis mean ± standard deviation; categorical variables compared with $\chi 2$ tests; continuous variables compared with t-tests. Code rates compared using binomial probability mid-p exact test person-time data. Gamma distributional assumption/ log link for LOS, telemetry acute care days per visit, and total acute care days per visit. Negative binomial distributional, correlation matrix **Time: 12 months- Each group** n=6 months prior and n= 6 months during **Procedure:** Telemetry days= room billing charges, assigned based on presence/ absence of active telemetry order at midnight. Code events= hospital	mortality, code event rates, or care escalation, with trend toward improved utilization appropriateness. % Patients with telemetry charges decreased from 36.2% to 15.9% (P < .001) in the hospitalist group and 31.8% to 28.0% in non-hospitalist group (P < .001; Table 1). Code rate events did not change over time (P = .9) adjusted models, telemetry utilization in postintervention period reduced by 69% (95% con-fidence interval [CI], −72% to −64%; P < .001) in hospitalist group and 22% (95% CI, −27% to −16%; P <.001) in the non-hospitalist group. Compared with non-hospitalists, hospitalists

		Demographics data similar characteristics. Data obtained through enterprise warehouse.	discourage unnecessary telemetry monitoring. The new order required providers ordering telemetry to choose a clinical indication and select a duration for monitoring, after which the order would expire and require physician renewal or discontinuation July 2015, a system-wide change to the telemetry ordering process was introduced.	telephone operator log (data available July 19, 2014)- 4 authors, internal medicine physicians (performed chart reviews n= 25 randomly selected patients in each group (hospitalist and non-hospitalist) before and after intervention receiving at least 1 day of telemetry monitoring. Each reviewer provided a key based on AHA guidelines for monitoring indications and associated maximum allowable durations. n=3 Chart reviews performed to determine indication (if any) for monitoring, number of days that were indicated, number of indicated days was compared to number of telemetry days patient received to determine overall proportion of days that were indicated (Telemetry appropriateness per	had a 60% greater reduction in telemetry rates (95% CI, −65% to −54%; $P < .001$). In randomly selected sample of patients pre- and postintervention who received telemetry monitoring, there was an increase in telemetry appropriateness on the hospitalist service 46% to 72%, $P = .025$; non-hospitalist group, appropriate telemetry utilization did not change significantly. Of the 100 randomly selected patients in hospitalist group after the intervention who did not receive telemetry, no patient had an AHA Class I indication, and only four patients had a Class II indication. Limitations: a single center, limits generalizability. A multifaceted

				visit). N=3 reviewers evaluated n=100 patients on hospitalist service after intervention not receiving telemetry monitoring to evaluate whether patients with indications for telemetry monitoring were not receiving after intervention. For patients who had a possible indication, the indication was classified- Class I (Cardiac monitoring is indicated in most, if not all, patients in this group) or Class II (Cardiac monitoring may be of benefit in some patients but is not considered essential for all patients).	approach can lessen effects in discerning qualities beyond the system-wide change in the telemetry orders, and which were most responsible for the observed effect among hospitalists. There is also a lack of seeing baseline differences in telemetry utilization between hospitalists and non-hospitalist groups. Some hospitalists may have been aware of the existing guidelines prior to the intervention. Also, there was a limited sample size for chart audits, causing reduced statistical power for determining changes in appropriateness of telemetry utilization. Additionally, a spillover effect from education may have occurred with internal medicine

					residents rotating through various services to becoming non-hospitalists Finally, sustainability of the results were limited due to one year time span.
Citation: Najafi, N., Cucina, R., Pierre, B., & Khanna, R. (2019). Assessment of a Targeted Electronic Health Record Intervention to Reduce Telemetry Duration: A Cluster-Randomized Clinical Trial. *JAMA Internal Medicine*, *179*(1), 11–15. https://doi.org/10.1001/jamainternmed.2018.5859					Level (Melnyk) **II**
Purpose/ Hypothesis	**Design**	**Sample**	**Intervention**	**Outcomes**	**Results**
To determine if a single-component intervention, a targeted electronic health record (EHR) alert, could achieve similar gains to multicomponent interventions and safely reduce unnecessary monitoring. Can an EHR alert, targeted to the right physician at the right time, safely reduce unnecessary inpatient cardiac monitoring?	A cluster-randomized clinical trial	**Sampling Technique:** Convenience, patients cluster within teams, intervention is cluster randomized **# Eligible:** 12 teams general medicine; 12 teams stratified n=3522 patients**.** **Exclusion:** n=2456 patient**s** the intensive care unit (ICU), and not receiving cardiac monitoring **# Accepted:** n=1066; analyzed n= 1021 patients **# Control:** n=567 **# Intervention:** n=499	**Control Protocol:** Teams received no alerts on telemetry displayed to physicians. 4 House-staff teams of 4 physicians each 2 Hospitalist teams of 1 physician each allocated to control (1731 hospitalizations) N=567 **Intervention Protocol:** Team level intervention 4 House-staff teams of 4 physicians each	**DV**: Patient-level primary outcome telemetry hours per Hospitalization. . Secondary outcomes of rapid-response calls and medical emergency events assessed potential adverse outcomes associated with discontinuation of telemetry. These measures were recorded in the EHR via templated notes that we acquired from the EHR database. **Measurement tool (reliability), time,**	**Statistical Procedures(s):** Used a team-level intervention and a patient-level primary outcome (telemetry hours), used generalized estimating equations with the Wald test and robust standard errors to analyze difference in mean of primary outcome; assessed difference in proportion of hospitalizations with a rapid-response event using the z test and difference in proportion of hospitalizations with a medical emergency

		Power analysis: power calculation prior to the trial using data from a past telemetry-reduction campaign to estimate an anticipated 20% reduction in telemetry hours, from 50 hours to 40 hours. Assuming 75% of patients in the present study would have usable data, and assuming 204 discharges from the general medicine **s**ervice each month, calculated trial need 6 months to accrue necessary 1022 patients. **Group Homogeneity:** n=1021 unique non-ICU patients with no significant difference in age, sex, race, marital status, primary language, or insurance status	2 Hospitalist teams of 1 physician each allocated to intervention (1791 hospitalizations 1292 Hospitalizations excluded (no cardiac monitoring outside of the ICU); EHR alert was randomized to half of the teams on the general medicine service. **Intervention fidelity - **patients cluster within teams, cluster randomized -EHR alert displayed during daytime hours when physicians attempted to place an order for non-ICU patients and telemetry order duration exceeded recommended indication duration - an EHR clinical decision support alert triggered patients admitted to intervention teams (A-D and 1and 2),	**procedure: method of counting:** six months period Telemetry hours from time-stamped orders data in EHR database. Rapid responses and emergency events verified by manual EHR Six months; -education or audit feedback was not included, communicated previously. Randomized by Teams, rather than patient or individual physician, limit seeing alert for some of the patients and not for others (if randomized by patient). If alerts for some patients seen, physician may then change monitoring practices on all patients, including control., causing a “bleed over” of effect of intervention into the control arm, reducing power of intervention.	event using Fisher exact test**.** **Results:** N= 1021 patients included: intervention-mean (SD) age 64.5 (18.9) and 215 (45%) women; control-mean (SD) age 63.8 (19.1) and 249 (46%) women. The alert prompted a significant reduction in telemetry monitoring duration (−8.7 hours per hospitalization; 95% CI, −14.1 to −3.5 hours; P = .001) with no significant change in rapid-response calls or medical emergency events. -most common physician response to the alert: to discontinue telemetry monitoring (62% of 200 alerts). Limitations: a single-center study and may not be generalizable. By using a power analysis this give the

			with a pop up window on physician's computer screen when criteria met: (1) physician logged into EHR of general medicine service; (2) patient was not in ICU; (3) patient had active telemetry order; (4) duration of telemetry order had surpassed indication-based recommended duration; (5) current time between 7 AM and 5 PM; and (6) physician was engaged in order entry. - alert prompted physicians to write a telemetry: a. discontinuation order, b.a new telemetry order, c. or dismiss alert.	Indication-specific recommendations for duration of telemetry informed by local expert opinion rather than prior studies, which may have limited the effect size of this intervention.	study greater generalizability. Indication recommendations for discontinuation were not practice standards so may have been more lenient. Preintervention mean of telemetry hours was already lower than baseline in prior studies thus limiting effect size.
Citation: Rizvi, W., Munguti, C. M., Mehta, J., Kallail, K. J., Youngman, D., & Antonios, S. (2017). Reducing Over-Utilization of Cardiac Telemetry with Pop-Ups in an Electronic Medical Record System. *Cureus*, *9*(5), e1282. https://doi/10.7759/cureus.1282					**Level IV**
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results

Developed a continuous quality improvement strategy and investigated the effect of reminder pop-ups, in an electronic medical record (EMR) system, on the duration and utilization of cardiac telemetry.	Continuous quality improvement strategy Retrospective design	**Sampling Technique:** Time bound analysis, Pre, and post retrospective convenience **# Eligible:** N=34,572 charts **# Accepted:** N=34,572 **# Control:** pre-implementation n= 6 months **# Intervention:** post-implementation n=7 months **Power analysis:** none **Group Homogeneity:** patients outside ICU, no demographics listed	**Control:** **Intervention:** no pop-up reminder **Intervention fidelity (describe the protocol):** an electronic pop-up for discontinuing the use of telemetry when no longer indicated criteria for discontinuing telemetry included appearance of a pop-up after 48 hours of the patient being on telemetry. The pop-up would alert the clinician to either continue telemetry or discontinue it if no longer required.	**DV:** comparisons were drawn from pre- and postimplementation periods on the use of a telemetry pre and post alert implementation **Measurement tool (reliability):** Comparison of the mean number of days on telemetry, pre- and postimplementation of electronic pop-ups **Intervention** composite analysis of the number of days on telemetry was calculated using the Kruskal-Wallis's test **Time:** 6 months pre and 7 months post, **procedure:** retrospective analysis of data for patients on telemetry - no reliability of tool data mentioned nor inter-rater reliability documented	**Statistical Procedures(s):** Kruskal-Wallis's test **Results:** Implementation of pop-up reminder, -Median number of days on telemetry (pre-implementation) n=3.61. (Post implementation) days reduced n=2.25 Statistically significant (2.25 days vs 3.61 days, $p < 0.0001$). -Reducing overuse of telemetry by 37% between the two time periods studied. -Mean # days on telemetry pre n= 4.26 and post n=2.68. -Electronic pop-up reminders reduced duration of telemetry in non-ICU settings. -time bound analysis: unable to show if change can persist beyond project, or assess effect on individual physician practices on telemetry discontinuation.

					Limitations: a time bound analysis limits visibility if this change can persist beyond the project, or individual physician practices on discontinuation of telemetry. Additionally, financial savings from early telemetry discontinuation is implied and further research would be needed to determine.
Citation: Wray, C. M., Fahrenbach, J., Bassi, N., Bhattacharjee, P., Modes, M., Howell, M. D., & Arora, V. M. (2017). Improving Value by Reducing Unnecessary Telemetry and Urinary Catheter Utilization in Hospitalized Patients. *The American Journal of Medicine*, *130*(9), 1037–1041. https://doi/10.1016/j.amjmed.2017.04.030					**Level III**
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
To use a "silent" decision support tool embedded within the EHR along with educational reminders to optimize the use of both urinary catheters and non-ICU telemetry monitoring.	Single interrupted time series analysis, quasi-experimental longitudinal design to .	**Sampling Technique:** Convenience **# Accepted:** N=1213 patients with urinary catheter and n=7901 telemetry was assessed. **Excluded:** Patients with hospital stays >14 days, an ICU stay, or who a catheter on admission, these	**Control** Preintervention period: 9- months before intervention **Intervention:** post-intervention period: 6- months **Intervention fidelity** 1**.** Designed and put in a "silent" indicator on patient list, signaling an active telemetry or urinary catheter order for each patient in EHR.	**DV**: effects of time-delineated interventions, to estimate changes in utilization of telemetry and urinary catheters **Measurement tool (reliability):** Telemetry and catheter utilization were obtained through the EHR and analyzed with R, v3.3.2	**Statistical Procedures(s) and Results:** There was no significant decrease in ordering trend for telemetry (P <.01) after implementation. Receiving telemetry orders spent 18% less time on telemetry (42.5 vs 34.9 hours; P <.01) This can be estimated in n= 1181 patient days

		patients are more likely to require resources and thus did not fit the SHM Choosing Wisely recommendations. **# Control:** preintervention (9 months) **# Intervention:** post intervention (6 months) **Power analysis**: none **Group Homogeneity:** General medicine services, demographics of patients not listed**.** **-**The indicator was universally placed within all 5 internal medicine teaching services, as well as the 4 non-teaching hospital medicine services	A rapid visual review and re-assessment for telemetry or a urinary catheter was implemented. Clicking on indicator directed user to a “manage orders” screen, allowing provider to immediately cancel order. 2. Indicator universally placed in all internal medicine and present on commonly used printed patient list at institution. 3. American Heart Association (AHA) guidelines for telemetry use, Choosing Wisely recommendations, and a notification of the new indicator were e-mailed to house staff and attending physicians. 4. Two 1-hour presentations were given at beginning of intervention (March) and at the halfway	**Time:** pre-9 months and pos- 6 months **Procedure:** The project was selected by a committee whose members have expertise in research methods and delivery science. The Culture, Oversight, Systems Change, Training framework was used to guide creation and implementation for this value improvement intervention	without telemetry during the intervention period, reduction of 25%. There were no differences in number of rapid responses or code blues between pre-intervention and post-intervention periods. Average monthly case mix index (CMI) increased from a median of 1.38 (IQR, 1.35-1.45) to 1.46 (IQR, 1.45-1.50) (P =0 .02) for a telemetry order. No difference in CMI for overall hospital patient population pre- and post-intervention periods (1.65 [IQR, 1.57-1.73] vs 1.66 [IQR, 1.64-1.73], P =0 .34). In subgroup analysis, neither non-teaching hospitalists nor internal medicine teaching services were found to have lower rates of utilization of either resource.

			point (June) of data acquisition.		Limitations: A single hospital thus limiting generalizability; unable to determine if benefits were seen from education or the electronic indicator; a post intervention of six months was not long enough to see sustained effects.

Citation: Yeow, R. Y., Strohbehn, G. W., Kagan, C. M., Petrilli, C. M., Krishnan, J. K., Edholm, K., Sussman, L. S., Blanck, J. F., Popa, R. I., & Pahwa, A. K. (2018). Eliminating Inappropriate Telemetry Monitoring: An Evidence-Based Implementation Guide. *JAMA Internal Medicine*, *178*(7), 971–978. https://doi/10.1001/jamainternmed.2018.2409				**Level** **V**
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes
To provide a set of best practices to achieve system-wide improvements in appropriate telemetry use	Descriptive Literature review Quality Improvement guideline	A comprehensive literature search in reference databases (PubMed, Embase) **Sampling Technique:** Convenience **# Eligible:** Total # of articles and protocol not described **# Excluded:** Literature that referenced pediatric (age <18 years), surgical, or ICU patient populations; also studies devoid of an intervention or implementation strategy. **# Accepted:** N=8 studies **# Control:** none **# Intervention:** Literature review. Retrospective, cohort, pre/post intervention observational and several prospective **Power analysis:** none **Group Homogeneity:** One hospital; studies ranged from four,	A comprehensive literature search in reference databases (PubMed, Embase) was conducted to identify studies that (1) involved hospitalized patients, (2) evaluated telemetry use, and (3) reported results of intervention(s) to improve telemetry appropriateness (Table 4). Only full-text articles describing interventions aimed at improving telemetry use or appropriateness were included. Literature that referenced pediatric (age <18 years), surgical, or ICU patient populations were excluded. In addition, those studies that were	**DV:** conducted literature search to identify studies that (1) involved hospitalized patients, (2) evaluated telemetry use, and (3) reported results of Only full-text articles describing interventions aimed at improving telemetry use or appropriateness were included. **Measurement tool (reliability):** none listed, inly mentioned 2017 AHA guidelines and Choosing Wisely **Time:** Data search May-December 2017. **Procedure**: **Results**: literature review demonstrates that using multimodal interventions

		six weeks and three, six, and 12 months.	devoid of an intervention or implementation strategy were excluded. Index search was performed on May 9, 2017, with an updated inquiry performed on December 22, 2017.	such as: indication-based ordering, automatic discontinuation, routine review of use and appropriateness, and education can lead to significant reduction in inappropriate telemetry use, and subsequently significant cost savings. Step 1: Formulate a Quality Improvement Team and Recruit Relevant Stakeholders; Step 2: Incorporate Indication-Based Ordering and Leverage the EHR; Step 3: Implement Routine Review of Telemetry Appropriateness and Use; Step 4: Implement Education and Training on AHA Practice Standards and Safety. Dressler et al. (2014) 43% Reduction in mean weekly telemetry orders placed; 47% reduction in mean duration of telemetry; 70% reduction in mean daily number of monitored patients. estimated organizational cost savings $4.8M per year Ramkumar et al. (2017), 71% Reduction in nonindicated telemetry orders placed; 25% reduction in average duration of telemetry

				order, from 2.4 d to 1.8 days. no difference in LOS, events captured, or mortality Leighton et al. (2013), 25% Increase in patients with class I or II indication for telemetry; 58% reduction in compliance with recommendations at 48 hours. Boggan et al. (2014) 33% Decrease in duration of orders, although increase in number of orders, and same rate per hospitalization; overall same total amount of patient-days on telemetry. Wray et al. (2017) No difference in percentage of telemetry orders placed; 18% reduction in average duration of telemetry Svec et al. (2017) 22% Reduction in LOS and cost savings for hospitalist services; hospitalist services; no change in LOS or cost savings among non-hospitalist services. Kanwaar et al. (2008) 12% Reduction in telemetry ordering rate. 24% Increase in patients with class I or II indication for telemetry. Edholm et al. (2018), used a multifaceted intervention with a 69% reduction in telemetry use in the

				hospitalist group. EHR-intervention resulted in a 22% reduction in the non- hospitalist group. compared with non-hospitalists, hospitalists had a 60% greater reduction in telemetry use; no increase in mortality, code event rates, or care escalation Limitations: Although 2017 AHA guidelines were mentioned as part of the guide, there was no review of the guidelines. The studies reviewed were one site limiting generalizability. Also, there was no mention of how many studies were retrieved.

Note. Evidenced based table from Melnyk's Rating System for Hierarchy of Evidence.
Fineout-Overholt Ellen, Melnyk Bernadette Mazurek, Stillwell Susan B., & Williamson Kathleen M. (2010). Evidenced -Based Practice Step by Step: Critical Appraisal of the Evidence: Part I. The American Journal of Nursing, 110(7), 47–52.

Table 2

Synthesis Based Table Using Electronic Health Record Reminders for Appropriate Telemetry Monitoring in Non-ICU

Evidence Based Practice Question (PICO): Does introducing a clinical decision support (CDS) telemetry downgrade score tool (TDST) in the electronic health record (EHR) to physicians increase discontinuation of telemetry monitoring for patients in non-intensive care units after a 72-hour period compared to no CDS?			
Level of Evidence	**# of Studies**	**Summary of Findings**	**Overall Quality**
II	**3**	**Najafi et al., (2019)** found a targeted EHR alert can safely and successfully reduce cardiac monitoring by prompting discontinuation when appropriate. This alert is less resource intensive and safer than many multicomponent interventions. The EHR alert, targeted to the appropriate physician at the appropriate time, safely reducing unnecessary non-ICU cardiac monitoring. Findings in a cluster-randomized clinical trial (RCT) of 1066 hospitalizations, teams on a general medicine service received an EHR alert when a patient's telemetry order exceeded the duration recommended for the monitoring indication. In response to the alert, physicians chose to discontinue monitoring 62% of the time, resulting in a reduction of monitoring duration per hospitalization with no increase in potential adverse events. **Chin et., al (2020).** Randomized patients included N=275 (intervention) and N=283 (control). The intervention group triggered 1042 alerts and trended toward fewer telemetry days (3.8 vs 5.0, p=0.017). The intervention group stopped telemetry 31.7% of the alerted patient-days compared with 23.3% for the control group (OR 1.53, 95% CI 1.24 to 1.88, p<0.001). There were no significant differences in length of stay (LOS), rapid responses, code blues, or mortality between the two groups. Best practice alerts within the EHR are associated with decreased telemetry monitoring across different services in the non-ICU. Decreased use of telemetry is not related with increased rapid responses, code blues, or mortality.	**B**. Reasonably consistent results, sufficient sample size, some control, with fairly definitive conclusions; reasonably consistent recommendations based on fairly comprehensive literature review that includes some reference to scientific evidence Time period six months, and one hospital limiting generalizability. **B**. Reasonably consistent results, sufficient sample size, some control, with fairly definitive conclusions; reasonably consistent recommendations based on fairly comprehensive literature review that includes some reference to scientific evidence Time period five months and one hospital limiting generalizability.

		Edholm et al., (2018) found electronic telemetry ordering changes can produce decreases in hospital-wide telemetry monitoring, and a multifaceted intervention may lead to an even larger decline in utilization rates. Implementing a change in the EHR telemetry order produced reductions in telemetry days. Although unable to differentiate the exact effect of each component of the intervention, an immediate decrease in telemetry orders after removing the telemetry order from our admission order set, a trend was seen after wide-ranging EHR changes. Compared with non-hospitalists (control group), hospitalists had a 60% greater reduction in telemetry rates (95% CI, −65% to −54%; p < .001). The percent of patients with telemetry charges decreased from 36.2% to 15.9% (P < .001) in hospitalist group and from 31.8% to 28.0% in non-hospitalist group (p < .001). Rates of code events did not change over time (p = .9). For the randomly selected sample of patients pre- and post-intervention receiving telemetry: there was an increase in telemetry appropriateness in hospitalist care (46% to 72%, P = .025); non-hospitalist group, appropriateness of telemetry had no significant change. The randomly selected patients n=100 not receiving telemetry after intervention, in hospitalist group, no patient had an American Heart Association (AHA) Class I indication, and n=4 had a Class II indication. Among hospitalist service patients, telemetry utilization was reduced by 69% (95% confidence interval [CI], −72% to −64%; P < .001), whereas in non-hospitalist care, reduction was as less changed 22% (95% CI, −27% to −16%; P < .001). There were no significant increases in mortality, code event rates, or care escalation, and there was a trend toward improved utilization appropriateness.	**B.** Consistent results, with adequate control, with definitive conclusions; reasonably consistent recommendations based on fairly comprehensive literature review that includes thoughtful reference to scientific evidence. Used Choosing Wisely® campaign and AHA guidelines increasing validity. Multifaceted and one hospital limits generalizability. Limited sample size for the chart audits, which reduced the available statistical power for determining changes in the appropriateness of telemetry utilization. Use of a financial incentive could affect bias. All three studies used RCT's. Chin et al, (2020) and Najifi et al., (2019), used an EHR alert to appropriately discontinue telemetry when exceeding duration. Najif, et al., (2019) displayed an increase in discontinuation orders written by physicians once the duration expired. All studies showed no effect on code blues or rapid responses. However, Chin et al., had no significant decrease in LOS. Edholm et al., (2018) used an EHR telemetry order set which resulted in a decrease in days on telemetry. There was also a decrease in telemetry orders with an increase in telemetry appropriateness using AHA guidelines in hospitalist care compared to the control non-hospitalist group.
III	**1**	**Wray et al, (2017)** used a two different patient populations study for telemetry and urinary catheterization order sets. The intervention forced practitioners to reassess efficacy when viewing patient lists. No significant decrease in number of telemetry orders was seen; there was a significant decrease in time on telemetry, suggesting more	**B.** Reasonably consistent results, sufficient sample size, some control, with fairly definitive conclusions; reasonably consistent recommendations based on fairly comprehensive literature review that includes some reference to scientific evidence. Used Choosing Wisely guidelines and AHA no mention if used updated version 2017. Used project committee and training

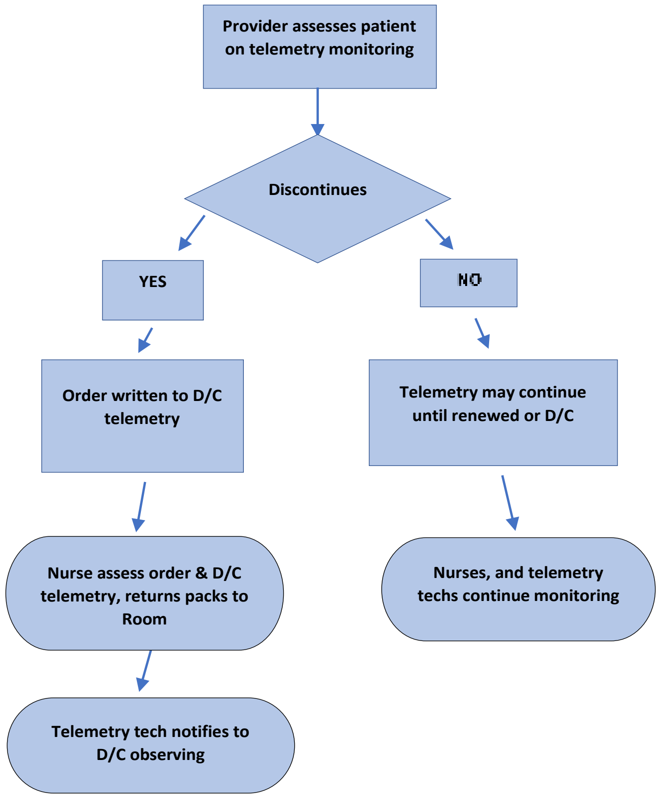
		projected after hospital admission when more viewed; also improving and advancing access to the "manage orders" screen, decreased the barrier to de-implementation; the information availability on printed patient list, enables intervention from EHR to clinical environment into daily workflow. There was no significant decrease in ordering trend for telemetry (p <0.01) after implementation. Receiving telemetry orders spent 18% less time on telemetry (42.5 vs 34.9 hours; p <0.01) This can be estimated in n= 1181 patient days without telemetry during the intervention period, reduction of 25%. There were no differences in number of rapid responses or code blues between pre-intervention and post-intervention periods.	framework. No randomization or power, one hospital limiting generalizability
IV	**2**	**Rizvi et al., (2017).** Used a continuous quality improvement strategy with retrospective design. Implementation of electronic pop-up reminders reduced the duration of telemetry in non-ICU settings**.** Median number of days on telemetry, significantly lower in 2016 than 2015 (2.25 vs 3.61days, p < 0.0001). Reduced overuse of telemetry by 37% between the two time periods studied. As a time, bound analysis, unable to show sustainability beyond the project, or ascertain effect on individual physician practices of discontinuation of telemetry. **Duffy et al., (2020).** Implementing a best practice alert (BPA) notifying residents of the recommended telemetry duration for each patient did not reduce patient time on telemetry but did lead to a significant reduction in total telemetry orders. Allowing nurses to discontinue telemetry led to a significant reduction in mean telemetry hours per patient. During the control period, the average time spent on telemetry was 86.29 hours/patient/month. During the nurse-discontinuation protocol, patients spent, average, n=70.86 hours/patient/month on telemetry. During the physician-discontinuation protocol, patients spent, average, n=81.6 hours/patient/month on telemetry. An interrupted time-series analysis found a significant level of drop-in mean hours on telemetry by 19.4	**B.** Reasonably consistent results, large sample size, some control, with fairly definitive conclusions; reasonably consistent recommendations based on fairly comprehensive literature review that includes some reference to scientific evidence; lacked randomization and power analysis to contextualize adequacy of the sample size, yet three regional hospitals same EMR n= 34,572 patient hospitalizations reviewed two time periods six months pre-implementation and seven months post-implementation adequate time to enhance generalizability, **B**. Reasonably consistent results, sufficient sample size, some control, with definitive conclusions; reasonably consistent recommendations based on comprehensive literature review that includes some reference to scientific evidence. No randomization or power to determine sample size although large with three-year time frame and two interventions. One hospital limits generalizability. Recommendations were aimed at further research. Rizvi et al., (2017) reduced the duration of telemetry in non-ICU settings with significantly lower days on telemetry over one year. However, Duffy et al., (2020) did not affect duration on telemetry but did show significantly lower number of telemetry orders written. Both studies used an electronic alert. Duffy et al., (2017) study revealed a physician driven protocol were less likely to place patients on telemetry

		hours per patient per month after nurse-discontinuation protocol (P < .001, Figure 1). This analysis found no significant change in the trend of monthly time on telemetry after the physician-discontinuation protocol when compared with the control period (P = .34, Figure 1) or the nursing-discontinuation protocol (P = .65, Figure 1). During the nurse-discontinuation protocol, there was no significant change in the likelihood that a patient was placed on telemetry throughout their admission when compared with the control period (96.1% vs 92.1%, P = .59). During physician-discontinuation protocol, there was a significant decrease of 56.1% in the likelihood that a patient would-be put-on telemetry when compared with the control time (36.5% vs 92.1%, P < .0001).	compared to nurse driven. This shows promise for the practice change driven by providers.
V	**1**	**Yeow et al., (2018)** created an overview on the safety and efficacy of incorporating the AHA Practice Standards and a review of studies highlighting successful incorporation within patient care workflow. Then outlined an Implementation blueprint for health system professionals and administrators to change institution's culture of telemetry use. As the health care landscape continues to shift, enacting high-value initiatives that improve patient safety and efficiency of care will be critical. Building on High Value Practice Academic Alliance's (HVPAA) earlier work on implementation guides targeting low-value practices, provide a set of best practices to achieve system-wide improvements in appropriate telemetry use	B. Reviews had an adequate sample size. One-unit limited generalizability for all studies. The results were consistent, and recommendations in review of Choosing Wisely campaign initiatives and 2017 AHA recommendations. However, only mentioned 2017 AHA guidelines. Informative teaching and in-service proved to hospitalist groups.

Note: Rating Scale for Quality of Evidence.
Newhouse, R. (2006). *Examining the source for evidence-based nursing practice.* JONA.Volume 36, Number 7/8, pp 337-340

Figure 1

Current Workflow Diagram for One Pilot Unit Using Telemetry Monitoring



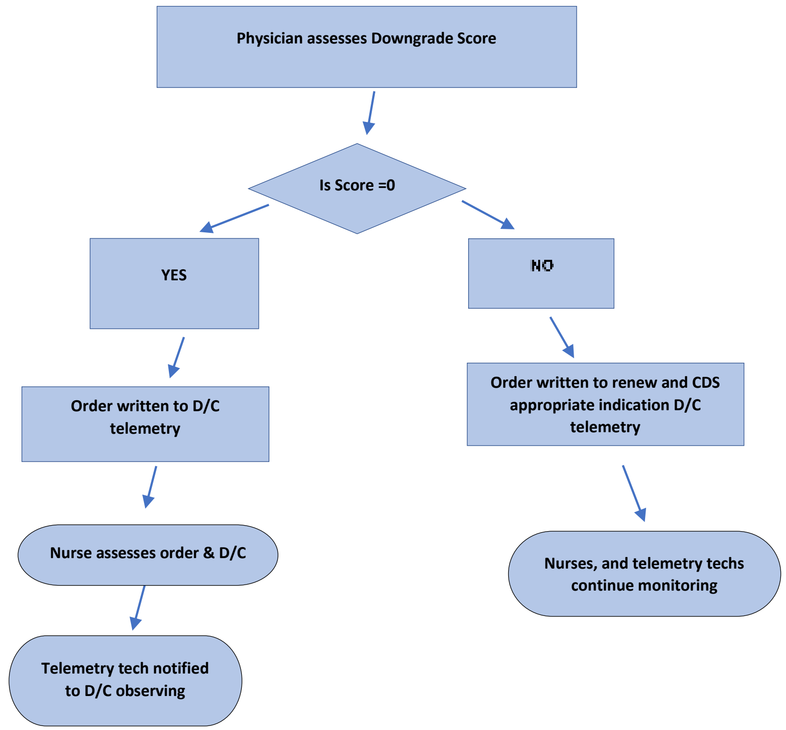
Change Opportunities

-Nurses and staff overwhelmed with inappropriate patients being monitored
-Patients at risk for injury, workups treatments, alarm fatigue
-Patients and staff dissatisfaction
-Providers may be inappropriately ordering, renewing, and discontinuing due to lack of knowledge of Best Practices
-CDS lacking prompts with AHA guidelines for use
-Operationalizing Downgrade Score
-Evaluation of staff support: workgroup, huddles, and meetings feedback from staff
-Buy-In
-Barriers, Innovators, Champions, Facilitators
-Infrastructure

Note. Evaluation ratings were made during the 2014 fall academic term.

Figure 2

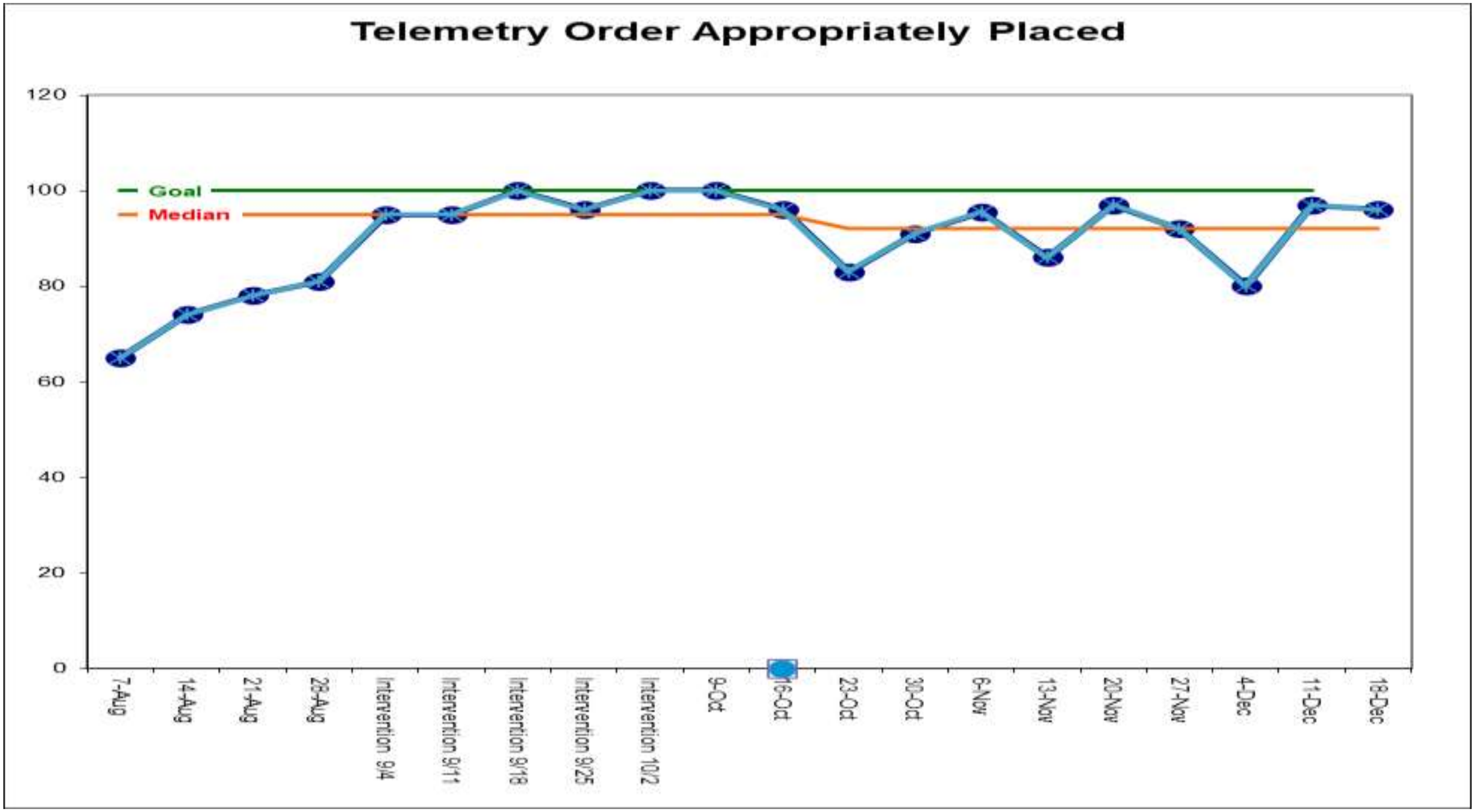
Desired Workflow Diagram for One Pilot Unit for Appropriated Telemetry Use



Note. Current workflow shows improved outcomes for appropriate use of telemetry monitoring ordering processes after the intervention.

Figure 3

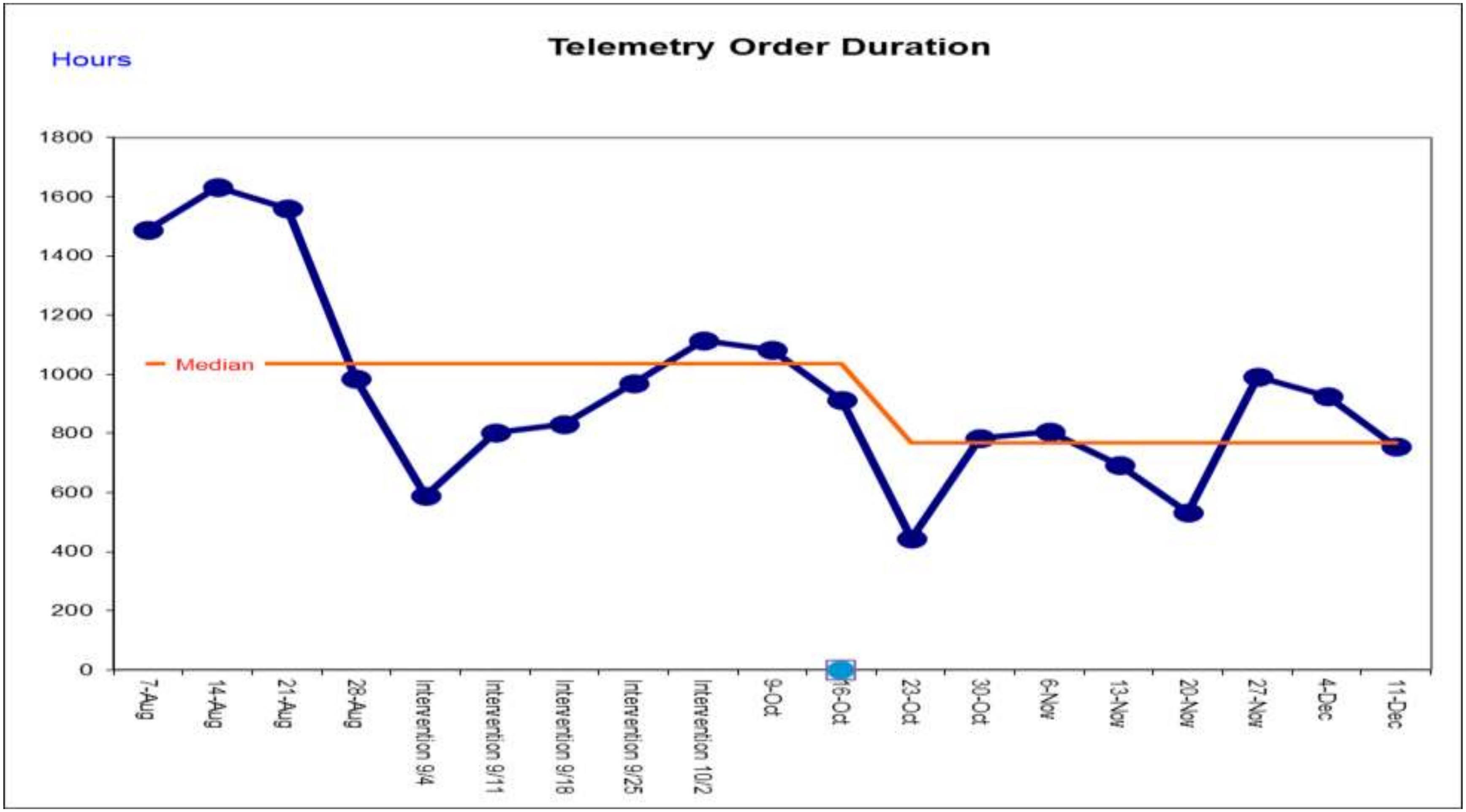
Percentage of Telemetry Orders Appropriately Placed over 12 Weeks



Note. The % of appropriately placed (indication) orders shows an increased trend towards the goal after the intervention period.

Figure 4

Duration of Weekly Hours on Telemetry Monitoring Using the TDS



Note. After the education intervention period of educating providers and nurses on using and daily evaluating the TDS, there was a trend of duration (hours) of telemetry orders below preintervention data in weekly data periods.