Improving Pediatric Emergency Vital Sign Monitoring with an Early Warning Score-Based Protocol

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Abstract

Problem: At a 13-bed, community Pediatric Emergency Department (PED), only 45% of high acuity patients were receiving the standard of care for vital sign (VS) monitoring. A national 25.4% increase in PED acuity highlights that lack of frequent and accurate VS monitoring is a significant clinical problem (Masler et al., 2021). Poor VS monitoring has resulted in delay in treatment, missed clinical deterioration, and necessary patient transfer at this PED. Early warning scores improve patient outcomes by guiding decisions such as frequency of monitoring, initiation of treatment, and transfer to appropriate level of care (Huff et al., 2018). **Purpose:** The purpose of this Quality Improvement (QI) project was to implement a Pediatric Early Warning Score (PEWS)-based VS protocol to improve VS documentation adherence, staff satisfaction, number of transfers to higher level of care, and number of provider reassessments. **Methods:** A pre- and post- implementation design was utilized to monitor these outcomes over a 14-week period. Pre- implementation data was collected retrospectively between the months of October 2021 and January 2022. The PEWS- based VS protocol included a new policy and procedure, changes to the electronic health record (EHR), the addition of PEWS-based VS order sets, and a PEWS Response Algorithm to guide interventions. **Results:** VS documentation adherence ranged from 43.9% to 66.7% post-implementation. The average VS adherence rate was 55.1%, demonstrating a 10.1% increase from pre-implementation (45%). PEWS-based VS order set adherence increased by 5.9% from pre-implementation (0%). Adherence to VS monitoring and documentation guidelines was 87% for patients with a PEWS-based VS order set. The number of provider reassessments increased by 39% and transfers to higher level of care decreased by 1.44%. Staff satisfaction scores for VS workflow were unchanged for nurses but increased by 84% for providers after implementation. **Conclusion:** Overall, VS documentation adherence increased after implementation of the PEWS-based VS protocol with positive patient outcomes. The findings suggest that the utilization of PEWS VS order sets increase adherence with VS monitoring and documentation.

Improving Pediatric Emergency Care and Vital Sign Documentation Using a PEWS-based Protocol

Since the beginning of the COVID-19 pandemic, pediatric emergency departments (PED) have seen a drastic increase in volume and acuity in their patient population. Since March 2020, the annual rate of pediatric intensive care (PICU) admissions has increased by 25.4% in the United States (U.S.) (Masler et al., 2021). Given this increase in acuity, frequent and accurate vital sign (VS) monitoring is more crucial than ever. Vital sign acuity rating scales guide health care decision making to include frequency of monitoring, provider notification, efficient start of treatment and transfer to appropriate level of care (Huff et al., 2018). The Pediatric Early Warning System (PEWS) utilizes VS and assessment to calculate an acuity score for the patient. This score cannot be computed without accurate and complete VS documentation. Without a standardized acuity scoring system, subtle changes to patient clinical presentation can be missed leading to poor patient outcomes.

In a small, 13-bed community PED, it was difficult for nurses to capture patient acuity due to incomplete collection of VS. Following the national trend, this PED encountered a 25% increase in volume within the past year alone, with approximately 60% of those patients considered high acuity. However, with this increase there was a decline in safe VS monitoring. Prior to implementation, only 45% of high acuity patients had a complete set of VS documented in the electronic health record (EHR) per the standard of care (every two hours). High acuity was defined as any patient assigned an emergency severity index (ESI) score of 1, 2 or 3 at triage. The ESI is a five-level emergency department triage algorithm that groups patients from 1 (most urgent) to 5 (least urgent) utilizing principles of acuity and necessary resources (Agency for Health Care Research and Quality, 2020). Poor VS monitoring and documentation was a serious clinical problem as changes in VS are often the first step in recognizing patient decline (Huff et al., 2018). Poor VS monitoring led to delay in care, missed clinical deterioration, and necessary transfer to outside facilities for higher level of care at this PED. The purpose of this quality

improvement (QI) project was to implement a PEWS-based VS protocol for high acuity patients (ESI 1-3) in a 13-bed community PED to improve VS adherence and patient outcomes.

Available Knowledge

To evaluate this clinical problem, a robust literature review was completed and ultimately, nine studies were evaluated (Appendix A). Overall, the body of literature provided reliable and consistent evidence for a practice change. The literature suggested that a standardized early warning score (EWS) would help with VS adherence as well as aide in the identification of clinical deterioration, thus improving patient outcomes (Gold et al., 2014; Huff et al., 2018; McElroy et al., 2019). Other interventions proven in the literature to enhance VS documentation adherence included the implementation of clear policies and procedures (P&P) and a vital sign alert (VSA) within the EHR (Remick et al., 2018; Huff et al., 2013).

The review consisted of multiple levels of evidence as rated by the Johns Hopkins Nursing Evidence-Based Practice (JHNEBP) guidelines (Newhouse, 2006). Most of the studies were rated a level III (4). Each evidence level was represented apart from level II studies. Most studies were given a good (B) quality rating (Newhouse, 2006). The body of evidence provided a multitude of study designs including experimental, non-experimental, clinical practice guidelines, systematic review, qualitative study, and quality improvement projects. There was an assortment of clinical settings from adult inpatient, pediatric inpatient, and the PED. The study results provided statistical analysis supporting the validity and reliability of the PEWS tool in identifying clinical deterioration and need for higher level of care (Frascogna et al., 2021; Gold et al., 2014; Lambert et al., 2017). The evidence unanimously concluded that safe VS monitoring among high acuity patients requires a multi-step approach, that includes, clear P&P, PEWS utilization, and EHR reminder functions such as a VSA. The conclusions among each study demonstrated positive outcomes for patients, nurses, and multidisciplinary teams.

Rationale and Framework

The Promoting Action on Research Implementation in Health Services (PARiHS) framework was chosen to guide this project. This framework by Kitson and colleagues (1998), suggests that successful implementation (SI) is a direct function of evidence (E), context (C), and facilitation (F) (Figure 1). This framework was chosen because it is clear, intuitive, and easy to apply across diverse implementation projects (Ullrich et al., 2014). Each element of the PARiHS framework has contributed to the planning for this QI project.

Evidence as defined by the PARiHS framework pertains not only to rigorous research studies, but also realizes the importance of clinician expertise and patient preference (Kitson et al., 1998). This project is backed by multiple levels of evidence in addition to formal input from nurses and providers. While not directly evaluated, patient preference was also considered. It is strongly suggested in the literature that better patient outcomes outweigh the inconvenience of frequent VS monitoring for parents (Lacey et al., 2021). The PARiHS framework defines context as the environment in which implementation is taking place. The three main components of an organizational context are the culture, leadership, and the organization's approach to monitoring, measuring, and evaluating (Kitson et al., 1998). An official assessment of context was completed using the Alberta Context Tool (ACT) (Estabrooks et al., 2009). Finally, facilitation in this framework focuses on the role of the facilitator as the person who guides the project with clear purpose and leadership (Kitson et al., 1998). Creating relationships with staff was imperative as an external facilitator. Frequent shifts shadowing both providers and nursing staff allowed for relationship building and provided insight to workflow, patient population, equipment, and EHR processes.

Methods

Context: Setting and Population

The setting for this project was a small, 13- bed community PED within a Mid-Atlantic Magnet Hospital. This PED does not have an on-site Pediatric Intermediate Care Unit (PIMC) or Pediatric

Intensive Care Unit (PICU). There were 10 in-patient beds for observation. Patients that had a declining clinical presentation were transferred to a higher level of care at an outside facility. The closest Children's Hospital was 30 minutes away. This PED treats patients with all diagnoses from one day old to 18 years of age. Inclusion criteria for this project were pediatric patients between 0-18 years of age with an emergency severity index (ESI) score of 1-3 and a medical chief complaint assigned at triage. The exclusion criteria included any patient over the age of 18 years old, an ESI score of 4 or 5, a chief complaint related to mental health, and a PED stay less than two hours. This PED is staffed with trained and experienced pediatricians and pediatric nurses. Additionally, there are patient care technicians (PCT), child life specialists, and a secretary that make up the staffing.

Context: Leadership Input

The culture or context of a health care organization profoundly influences the successful implementation of QI projects (Estabrooks et al., 2009). An evaluation of organizational culture was performed using the Alberta Context Tool (ACT); a valid, reliable, and comprehensive tool used to assess ten core domains of a healthcare organization (Estabrooks et al., 2009). The nurse manager, nurse educator and the clinical site representative (nurse practitioner in the PED) completed the ACT assessment. The top barriers of implementation were time, structural, and electronic resources. This information demonstrated that implementation should be incorporated into the present workflow (Powell et al., 2015). Within the domain of structural resources, the lowest scoring item was policy and procedures (P&P). Prior to this project, there was no P&P specific to VS monitoring or acuity assessment at this PED. P&P are crucial to standardizing patient care and ensuring safety (Huff, et al., 2019; Showalter, 2017).

The two domains that scored the highest on the ACT were connections among people and leadership. To further encourage connections among staff during this project, the PL identified, recruited, and prepared nurses on the unit to be champions (Powell et al., 2015). Leadership was the

second highest score and is cited in the literature as the most significant facilitator to QI projects (Alexander et al., 2022). Strategies utilized to leverage strong leadership were active involvement in meetings and planning, engagement in positive communication, recognizing staff efforts, giving feedback, and reinforcing QI initiatives within the organization (Alexander et al., 2022, Mulkey, 2021).

Context: Staff Input

Prior to project planning, PED nursing and provider staff completed an anonymous survey with the purpose of identifying root causes of poor VS monitoring. Both nursing and provider responses identified procedures and technology to be the most influential barriers. These findings were consistent with the leadership ACT results. Vital sign monitoring was not supported by technology in this PED. Vital sign alerts (VSA) were embedded into the chart and were not visible from the PED tracker board. Additionally, providers did not consistently place orders for VS monitoring in the EHR. This created poor communication and unmet expectations among nursing and provider staff.

Intervention

The proposed intervention to address the clinical problem was the implementation of a PEWS-based VS monitoring protocol. The implementation of this protocol took place over 14 weeks between October 2022 and January 2023. This multi-step intervention included (1) a new policy and procedure (P&P), (2) instrumental changes to VS documentation within the EHR, (3) addition of PEWS-based VS order sets, and (4) utilization of a PEWS Response Algorithm to guide interventions.

The implementation team first worked collaboratively to create the new VS monitoring P&P (Appendix B). The team consisted of the project lead (DNP Student), the Clinical Site Representative (CSR; NP in PED), the project Sponsor (Medical Director of PED), the nurse manager, the nurse educator, and three EPIC pediatric data analysts. Once all elements of the P&P were complete, the document was sent to unit and hospital committees for approval. Creating a P&P encouraged collaboration among

disciplines and increased accountability for both nursing and provider staff (Showalter, 2017; Remick et al., 2018).

After approval of the VS monitoring P&P, the next step for implementation was to set up the structures necessary for the new process. PEWS documentation was added to the EHR by the senior data analysts (Figures 2,3,4). When VS, oxygen requirements and capillary refill time (CRT) are documented in the EHR, the PEWS automatically populates on the patient tracker board (Figure 2). This adds to the validity and reliability of the scoring and benefits nurses by not adding more steps to documentation (Gold et al., 2014; Huff et al., 2019; McElroy et al., 2019 & Siegler et al., 2013).

When the clinician hovers over the PEWS score, a breakdown of the scoring is provided and identifies the problem (i.e., respiratory vs. circulatory) (Figure 3). The PEWS score is color coded based on the response algorithm. The clinician can review and write additional comments such as interventions needed from the patient tracker (Figure 4). Once the score is reviewed, the PEWS timer re-starts. The PEWS timer depicts which patients are due for VS and PEWS assessment (Figure 2). The last column within the PEWS documentation is the delta column which highlights if the patient's score remained the same, increased, or decreased from the last assessment (Figure 2). All members of the PED (RN, PCT and provider) have access to see these three columns from the patient tracker board.

The final EHR change was the addition of quick list order sets (QLOS) for VS monitoring based on the PEWS response algorithm (Figure 5). The QLOS include the frequency of VS monitoring, specific parameters for provider notification, and criteria for continuous cardio-respiratory monitoring. The QLOS were created to ensure consistency among providers, improve nurse-provider communication, and match the criteria determined by the P&P. This PED had the necessary human and VS equipment resources to conduct this QI project. No additional expenses were added. During implementation the following PEWS workflow was utilized (Figure 6).

Goals and Measurement

Measurements for this project were linked to process, and outcome goals. The process goals for this project were directly correlated with compliance of the PEWS-based VS Protocol. This included education and training compliance, VS documentation compliance and QLOS compliance.
The outcome goals for this project focused on patient outcomes as well as nurse and provider satisfaction. Simple quantitative measures were collected pre- and post-implementation including number of provider reassessments and number of medically necessary transfers to outside facilities for higher level of care. Nurse and provider satisfaction were also measured pre- and post-implementation. This data was collected using an anonymous 5-point Likert Scale survey.

For all project goals, data collection and analysis occurred before, during and after implementation. Before implementation, retrospective data was collected for a total of 100 patients (ESI 1-3) with a medical diagnosis. The time frame for this data collection was October 2021-January 2022. This timeframe was chosen because it is comparable to the implementation time frame of October 2022- January 2023.

Throughout the 14-week implementation, the PL compiled data weekly using an audit tool on the REDCap software system. Due to the high number of charts each week, the PL randomly selected 15-20 charts from each day to audit. The audit tool collected the following information: VS documentation adherence, QLOS utilization, ESI, length of stay, and number of provider reassessments. Outcome data such as number of transfers, and staff satisfaction were collected before and at the end of implementation. The nurse navigator on the unit provided a monthly transfer data report to the PL. The staff satisfaction data was collected through an anonymous post-implementation survey with the same 5-point Likert Scale used during pre-implementation. In addition to data collected to measure process and outcome goals, the PL collected data to determine if external factors had an impact on the intervention. The PL examined patient volume, acuity, staffing, and other major health care events that occurred during the 14-week implementation period.

Analysis

All data collected from weekly audits and reports was analyzed to draw inferences and conclusions on the success of the PEWS-based VS Protocol intervention. Audit information pertaining to documentation adherence was tracked using separate run charts. The data was plotted weekly during implementation to elicit trends or patterns within the process. Using run charts determined if additional education or changes to the process needed to be made (Kellar & Kelvin, 2013). At the end of the project, percentages for VS and QLOS compliance were compared between the pre- and post-implementation groups using descriptive statistics (percentages). In addition, pre- and post-implementation data for patient outcome goals and staff satisfaction were compared using descriptive statistics (percentages) (Kellar & Kelvin, 2013).

Ethics

To prepare for this implementation project, the PL completed Health Insurance Portability and Accountability Act (HIPPA) training provided by the University of Maryland School of Nursing (UMSON) in addition to online training provided by the Collaborative Institutional Training Initiative (CITI) program. The activities within this project occurred within the standard of care, and the implementation of a new VS monitoring protocol provided no risk to the patient. The UMSON Institutional Review Board (IRB) in addition to the medical institution's IRB Board reviewed the project to determine that it qualified as "non-human subject's research" prior to the start of implementation. The PL has no conflict of interest. In accordance with HIPPA, all data collected for this project followed guidelines to protect patient identity (Centers for Disease and Control [CDC], 2018). Data collection from the medical record and review of the code key and data set file were conducted in a private area to comply with HIPPA standards. The RN and provider satisfaction data did not contain identifiers and were recorded onto Qualtrics, a password protected server that only the PL had access to. The project data (staff training and chart audits) were recorded onto REDCap, a HIPPA compliant, password protected server. The aim

of the QI project was to improve VS compliance, staff satisfaction and patient safety at this specific PED. The design of this project was specific to the resources, practice gap, preferences, and workflow at this community PED and therefore the outcomes are not generalizable to external settings or populations. External dissemination of project findings will be conducted with site permission only.

Results

Process Goals

During 14 weeks of implementation, VS documentation adherence ranged from 43.9% to 66.7%. The average VS adherence rate was 55.1%, demonstrating a 10.1% increase from pre-implementation (45%). PEWS-based QLOS adherence increased by 5.9% from pre-implementation (0%) (Figure 8). Adherence to VS monitoring and documentation guidelines was 87% for patients with a QLOS (Figure 9). This is a key finding that suggests QLOS increase VS monitoring and documentation adherence.

Outcome Goals

Provider reassessment rates increased after implementation of the PEWS-based VS monitoring protocol (Figure 10). Pre-implementation data demonstrated an average number of provider re-assessments at 2.6 with an average length of stay (LOS) of 7.57 hours (Ratio: 34.6%) (Table 1). Post-implementation data demonstrated an average number of provider reassessments at 3.3 with an average LOS of 4.49 hours (Ratio: 73.5%) (Table 2). Overall, the number of provider reassessments for high acuity patients increased by 39% post-implementation. Medical transfers between October 2021-January 2022 accounted for 4.03% of high acuity patients (ESI 1-3). Post-implementation (October 2022-January 2023) medical transfers accounted for 2.59% of high acuity patients (Table 3). This is a 1.44% decrease in high acuity medical transfers. Staff satisfaction scores were unchanged for nurses after implementation of the PEWS-based VS monitoring protocol but increased by 84% for PED providers (Figure 10).

Barriers and Facilitators

While there was success found in this project, it was also met by numerous barriers throughout implementation that directly affected process and outcome goals. The three most significant barriers included increased patient volume and acuity, staffing challenges, and a national respiratory syncytial virus (RSV) surge. Between October 2021 and January 2022, the total number of patients seen in this PED was 6,210. Between October 2022 and January 2023, the total number of patients seen in the PED was 8,035. This is an increase of 1,825 patients within the same four-month period (Table 4). In addition to this increase in volume, patient acuity remained high with 57.8% of patients given an ESI score of 1-3 at triage. The average time between arrival and disposition by a provider was 199 minutes compared to 176 minutes pre-implementation. This data validates the overall business of the unit during implementation (Figure 11). The increase in volume and acuity can be directly linked to a national RSV surge. Between October 2nd and December 3rd of 2022, there was an unprecedented increase in the number of RSV hospitalizations in the U.S. (Figure 12). The overall RSV hospitalization rate for October 2022-Januray 2023 is 49.8 per 100,000 people compared to 17.6 per 100,000 in October 2021-January 2022 (CDC, 2023). The RSV surge was a major contributing factor to the increase in volume and acuity during implementation.

Staffing challenges made managing this influx of patients more difficult. At the start of implementation there were 41 nurses and 12 providers on staff at this PED with 4 nursing FTE vacant positions and 3 provider FTE vacant positions. Of the nursing staff, only 48.8% work full time (36 hours/week) (Table 5). Among the provider staff, 16.6% work less than 36 hours per week (Table 6). These statistics showcase the difficulty of educating, communicating, and adopting a practice change. It is harder for implementation to be successful when large percentages of staff are not on site regularly. In addition, float and travel nurses were utilized to fill staffing gaps regularly during implementation. This could impact PEWS-based VS monitoring protocol compliance as these nurses were not educated or aware about this QI initiative.

Overall, these challenges directly impacted staff buy-in for this project. Nurses were working diligently and adapting to high volume and acuity while navigating staffing shortages. Therefore, a new practice change was extremely low on the priority list. This is demonstrated by the low education compliance rates (Provider: 33%, Nursing: 51.2%, PCT: 7.7%) (Figure 13, Table 7) and the slow to adopt practice of placing QLOS by the providers (1.3%-12.5% compliance). During a mid-point feedback evaluation, multiple nurses identified lack of time as the main barrier to completing education and the new PEWS documentation. Other barriers identified at this mid-point evaluation included lack of clarity regarding EHR documentation. To combat this, the PL came to the unit for change of shift huddles and provided in-person instruction as well as sent out two additional instructional videos for nurses to watch. To increase buy-in the PL sent out weekly emails in addition to updating an onsite bulletin board in the staff breakroom with reminders, data updates, and staff recognition. Incentives were offered to staff who were regularly compliant with the PEWs-based VS protocol workflow and documentation. These changes and added strategies did allow for steady compliance rates for the remaining eight weeks of implementation.

Despite multiple barriers to implementation, there were key facilitators that kept the project moving forward and ultimately resulted in positive outcomes. Strong and involved leadership was one of the most instrumental facilitators. Despite the challenges the unit was facing, the medical and nursing leadership team continued to present this project at all staff meetings, staff evaluations, and huddles. Leadership also invested time biweekly in meeting with the PL and team to discuss how to improve compliance and overall success of the project. Other facilitators included ease of use of the EHR changes, and an overall culture of providing evidence-based quality care to pediatric patients.

Discussion

Ultimately, this project was successful in increasing VS monitoring and documentation adherence for high acuity patients in a small, community PED. The most significant finding is the positive

effect QLOS had on increasing VS adherence. This finding also showcases the importance of teamwork and including both the nursing and provider team during a major practice change. Computing a PEWS score or monitoring VS will not lead to positive patient outcomes without the throughput of nurse to provider communication. Both the nurse and provider understanding the PEWS score and what that means for patient acuity and management in the PED is crucial to the success of this project moving forward. Increasing VS monitoring adherence had a positive impact on the patient population and the healthcare system. The health care system was impacted by an increase in provider satisfaction with VS workflow in the PED which is consistent with findings from a similar study completed in British Columbia, Canada (McElroy et al., 2019). In addition to staff satisfaction, the PEWS-based VS protocol may have impacted the number of medically necessary transfers in this PED. With more frequent and accurate VS monitoring, there is decreased probability of adverse events, missed clinical deterioration and number of emergency response calls or emergent transfers (Franscogna et al., 2021; Gold et al., 2014; Vredebregt et al., 2018). After implementation of the PEWS-based VS protocol there was a decrease in medically necessary transfers. This positive patient outcome is consistent with results seen in the study by Franscogna and colleagues (2021). Decreasing the number of medically necessary transfers can also result in increased revenue for the hospital. The average cost for a pediatric hospital admission in the U.S. is $7,800 (HCUP, 2019). The number of patient transfers was decreased by 26 patients from pre-implementation (October 2021- January 2022) to post-implementation (October 2022-January 2023). That equates to $202,000 in potential revenue back to this Mid-Atlantic Magnet hospital within a four-month period.

Limitations

Limitations to this project included the large pool of data and external factors affecting data collection. The PL was the only person completing data audits weekly. There were over 100 patients per day, and it was impossible for one person to audit all charts in one day per week. For this reason, the PL

would randomly select 15-20 charts per day to audit. This means that not all eligible charts were included in the overall assessment of this protocol. External factors such as the national RSV surge could have affected transfer data. While the percentage of medically necessary transfers did decrease post-implementation, this could have been due to a shortage of PICU beds in the state of Maryland at this time. Many patients were kept in the PED for care due to lack of transfer options. Additionally, while the number of provider reassessments saw a slight increase, it could be attributed to the higher acuity of the patients requiring more frequent assessments, rather than a direct result of this protocol.

Other factors that could have potentially impacted the data include differences among shifts and the small number of providers. Further data analysis would need to be done to check if compliance was higher or lower given the shift the chart was completed during. For example, day shift saw a larger volume of patients than night shift and this could have impacted compliance rates. In addition, with only 12 providers on staff during implementation, it is possible that the small number of providers who did not utilize the QLOS, could have greatly affected the overall compliance rates.

Conclusion

This QI project adds to the valuable research that exists related to usefulness of PEWS. While it is widely understood that PEWS is helpful in the early identification of clinical deterioration, this QI project also demonstrates its value in increasing VS documentation adherence as well. The results of this project also unexpectedly showcased the value of including both nursing and providers with PEWS implementation and how QLOS can increase VS monitoring adherence. Moving forward, this project will be continued by unit staff to ensure sustainability. The team will include the nurse educator, champions from both the nursing and medical team, bedside staff, leadership, and the quality improvement committee for best results. Based upon the post implementation feedback results, suggested changes to the project include modifications to the QLOS and vital sign timer, along with a shortened workflow for nursing documentation. Other suggestions include modifying the education to reflect project revisions

and transforming the educational module into a HealthStream module for ease of distribution to staff. This HealthStream module will be managed by the nurse educator and required of all newly hired staff upon orientation and then annually during competencies.

Overall, VS documentation adherence increased after implementation of the PEWS-based VS monitoring protocol. The findings suggest that the utilization of PEWS QLOS increase adherence with VS monitoring and documentation. Furthermore, while it is unsure if the implementation of this protocol alone resulted in positive changes to patient outcomes, there were positive trends post-implementation that included increased provider reassessment rates and decreased rates of medically necessary transfers. Additionally, provider satisfaction with the VS workflow increased tremendously post-implementation. As this project continues to be modified based on data, evidence, and staff feedback there is a high probability that patient, unit, and staff outcomes will continue to improve.

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Table 1

Provider Reassessment and Length of Stay Pre-Implementation (October 2021-January 2022)

Measurement	Data
Average number of Provider Reassessments in the PED	2.61
Average Length of Stay (LOS) in the PED (hours)	7.57
Ratio (average # of provider reassessment/average length of stay)	2.61/7.57 = **34.5%**

Note: N= 100

Table 2

Provider Reassessment and Length of Stay Post-Implementation (October 2022-January 2023)

Measurement	Data
Average number of Provider Reassessments in the PED	3.3
Average Length of Stay (LOS) in the PED (hours)	4.49
Ratio (average # of provider reassessment/average length of stay)	3.3/4.49= **73.5%**

Note: N= 1416

Table 3

Pre- and Post- Implementation Transfer Data in a 13-bed, community Pediatric Emergency Department

Measurement	Pre-Implementation (Oct 2021-Jan 2022) N= 146	Post-Implementation (Oct 2022- Jan 2023) N= 120
October		
Number of **Total Transfers**	33	26
Number and percentage of those transferred with disposition to discharge time **less than 2 hours**	15 (45.5%)	6 (23.1%)
Number and percentage of those transferred with disposition to discharge time **less than 1 hour**	4 (12.5%)	3 (11.5%)
Average Disposition to Discharge Time (Hours)	3.1	8.6
November		
Number of **Total Transfers**	44	28
Number and percentage of those transferred with disposition to discharge time **less than 2 hours**	21 (47.7%)	10 (35.7%)
Number and percentage of those transferred with disposition to discharge time **less than 1 hour**	4 (9.1%)	3 (10.7%)
Average Disposition to Discharge Time (Hours)	3.3	3.1
December		
Number of **Total Transfers**	43	32
Number and percentage of those transferred with disposition to discharge time **less than 2 hours**	19 (44.2%)	13 (40.6%)
Number and percentage of those transferred with disposition to discharge time **less than 1 hour**	5 (11.6%)	3 (9.4%)
Average Disposition to Discharge Time (Hours)	2.7	3.0

Measurement	Pre-Implementation (Oct 2021-Jan 2022) N= 146	Post-Implementation (Oct 2022- Jan 2023) N= 120
January		
Number of **Total Transfers**	26	34
Number and percentage of those transferred with disposition to discharge time **less than 2 hours**	13 (50%)	16 (47.0 %)
Number and percentage of those transferred with disposition to discharge time **less than 1 hour**	4 (15.4%)	4 (11.8%)
Average Disposition to Discharge Time (Hours)	2.5	3.2

Table 4

PED Volume and Acuity Pre- and Post- Implementation

Measurement	Pre-Implementation (October 2021-January 2022)	Post-Implementation (October 2022-January 2023)
October		
Volume (# of All patients seen in PED)	1807	2530
Acuity (# of ESI 1-3 patients seen in PED/% of total volume)	1077 (59.6%)	1411(55.8%)
Business (Arrival to First Disposition in Minutes; Average)	181	229
November		
Volume (# of All patients seen in PED)	1580	2146
Acuity (# of ESI 1-3 patients seen in PED/% of total volume)	954 (60.3%)	1228 (57.2%)
Business (Arrival to First Disposition in Minutes; Average)	173	210
December		
Volume (# of All patients seen in PED)	2074	1675
Acuity (# of ESI 1-3 patients seen in PED/% of total volume)	1129 (54.4%)	974 (58.1%)
Business (Arrival to First Disposition in Minutes; Average)	173	176
January		
Volume (# of All patients seen in PED)	749	1684
Acuity (# of ESI 1-3 patients seen in PED/% of total volume)	464 (62.0%)	1013 (60.2%)
Business (Arrival to First Disposition in Minutes; Average)	177	182

Table 5

Nurse Staffing for this 13-bed, community Pediatric Emergency Department

Type of Staffing	Number (Percentage)
Total Number of Nurses	**41**
Total Number of Full Time Nurses (36hr/week)	20 (48.8%)
Total Number of Part Time Nurses (less than 36hr/week)	21 (51.2%)
Total number of Part time (24 hr./week)	6 (14.6%)
Total number of Part time (16 hr./week)	4 (9.8%)
Total number of Part time (12 hr./week)	4 (9.8%)
Total number of Part time (8hr/week)	2 (4.9%)
Total number of Part time (PRN)	2 (4.9%)

Table 6

Provider Staffing for this 13-bed, community Pediatric Emergency Department

Type of Staffing	Number (percentage)
Total Number of Full Time Providers (36 hr./week) Physician, Nurse Practitioner, Physician Assistant	12
Total Number of Part Time and Moonlighting Providers (Less than 35 hr./week)	2 (16.6%)

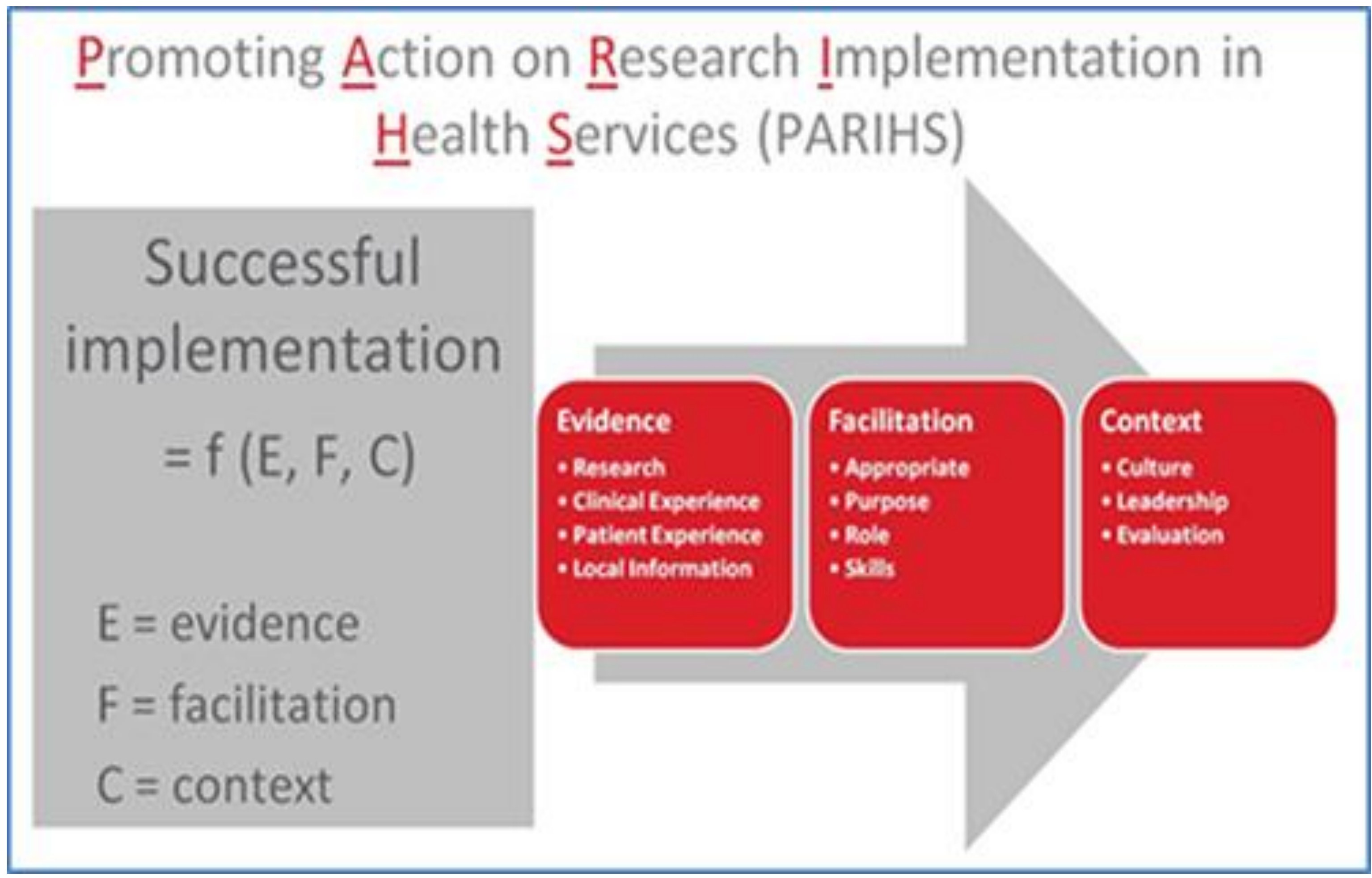
Table 7

PEWS-based VS Protocol Education Module Compliance by Staffing Group (Nursing, Providers, Patient Care Technician)

Staffing Group	Total # of Employees	Number of Compliant Employees	Percentage of Compliance
Providers (MD, NP, PA)	12	4	33%
Nursing (RN, LPN)	41	21	51.2%
Patient Care Technicians/Student Nurse	13	1	7.7%

Figure 1

Promoting Action on Research Implementation in Health Services (PARIHS) Framework



(Kitson et al., 2009)

Figure 2

Three Pediatric Early Warning Score Columns Added to the Patient Tracker Board

PEWS	PEWS Delta	PEWS Time Since Reviewed
7	↑ 6	164 hrs 44 mins
0	=	168 hrs 38 mins
0	+	Never reviewed
0	+	Never reviewed
0	+	Never reviewed
4	+ 4	Never reviewed
2	=	505 hrs 39 mins
0	=	192 hrs 23 mins
2	+ 2	Never reviewed
7	=	168 hrs 41 mins

Figure 3

Pediatric Early Warning Score Breakdown in the Electronic Health Record

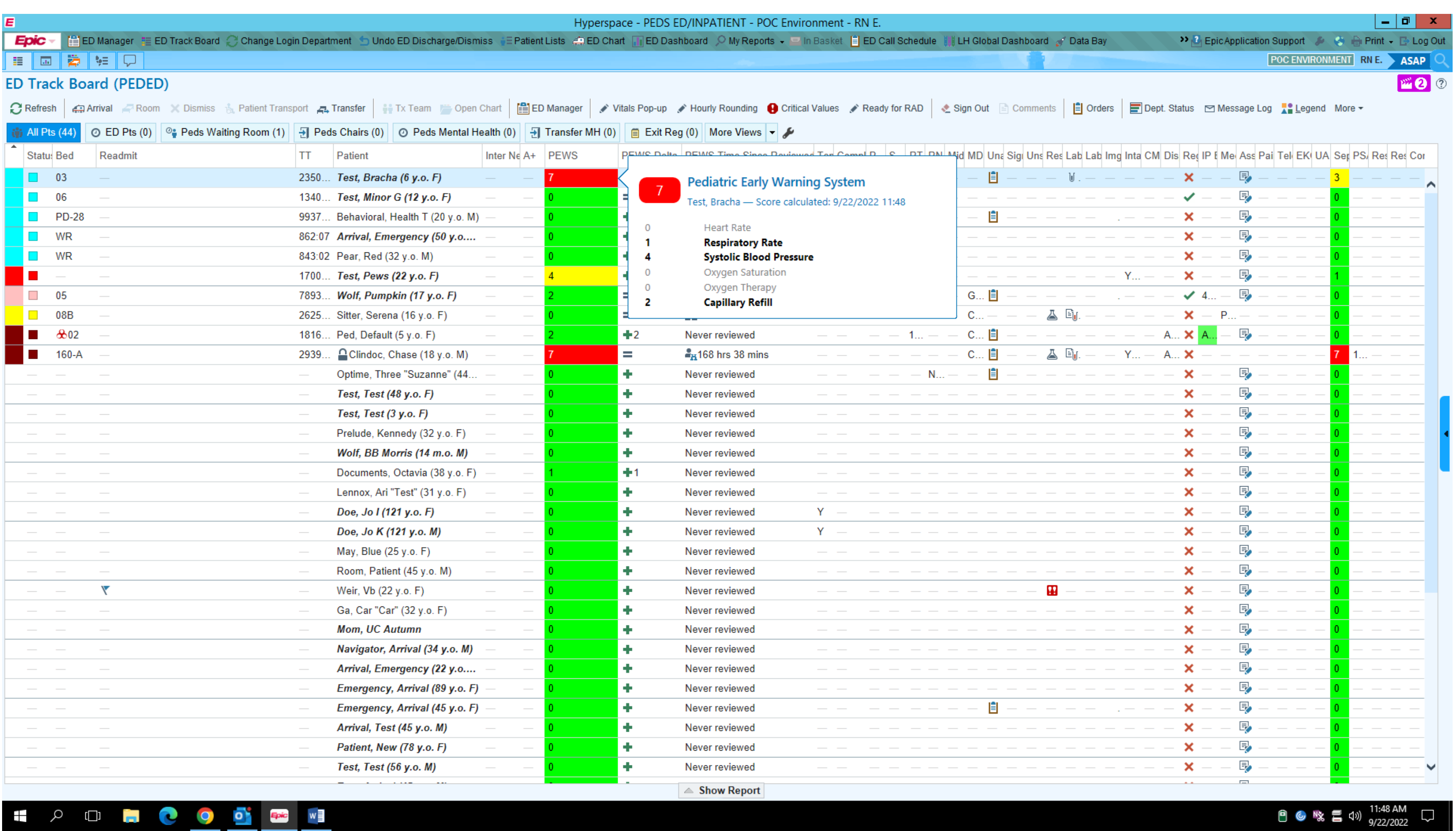


Figure 4

Nursing Documentation for Pediatric Early Warning Score from Patient Tracker Board

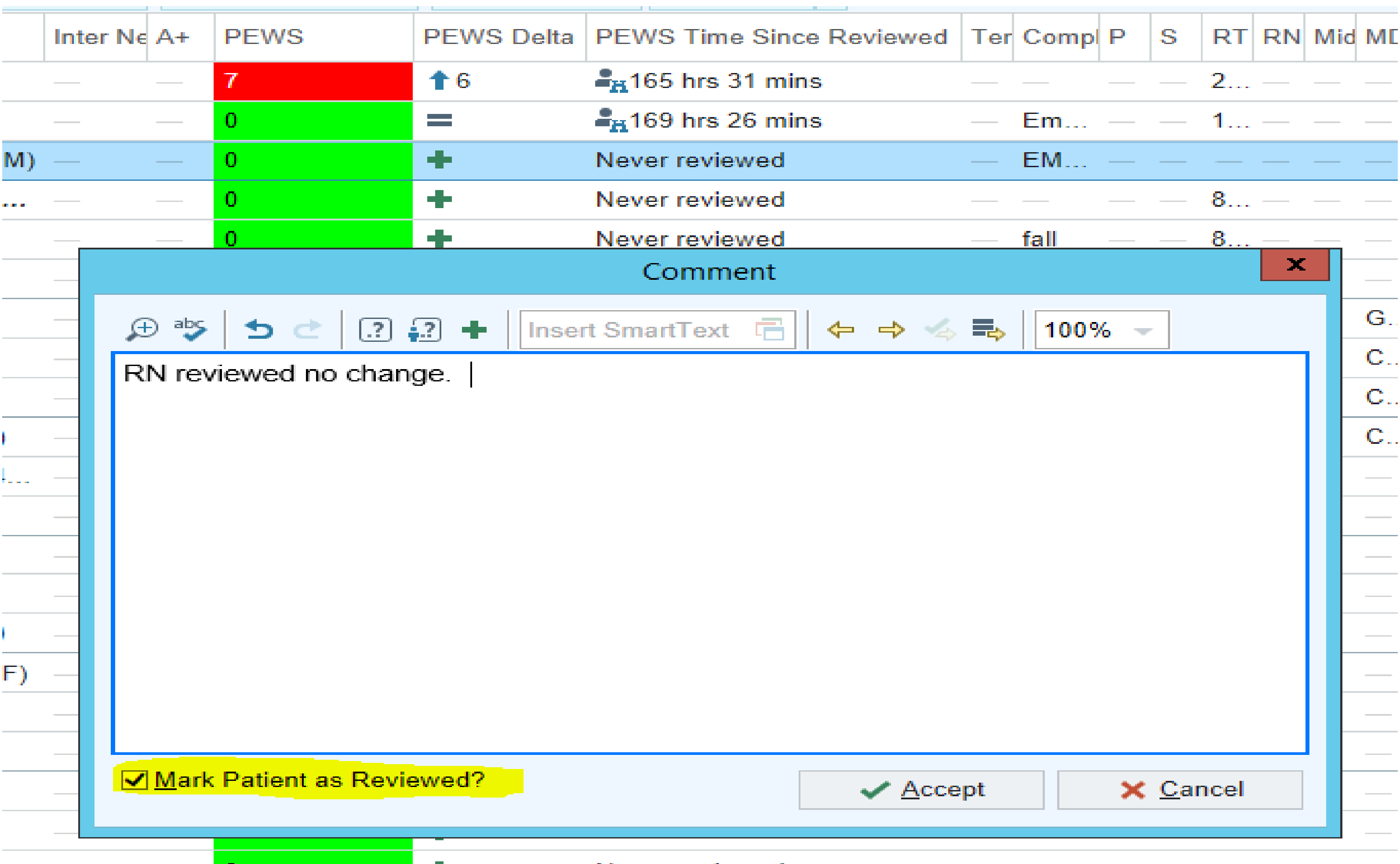


Figure 5

Example of PEWs-Based Quick List Order Sets in EHR

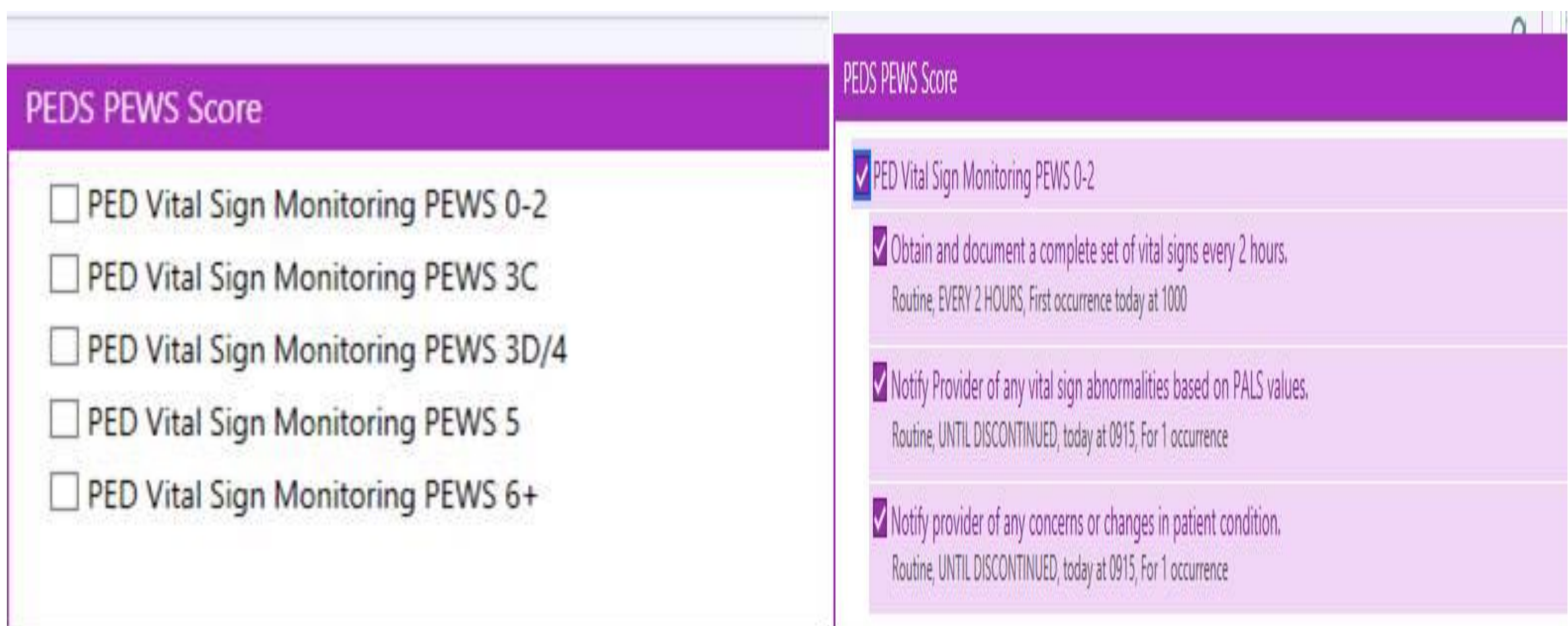
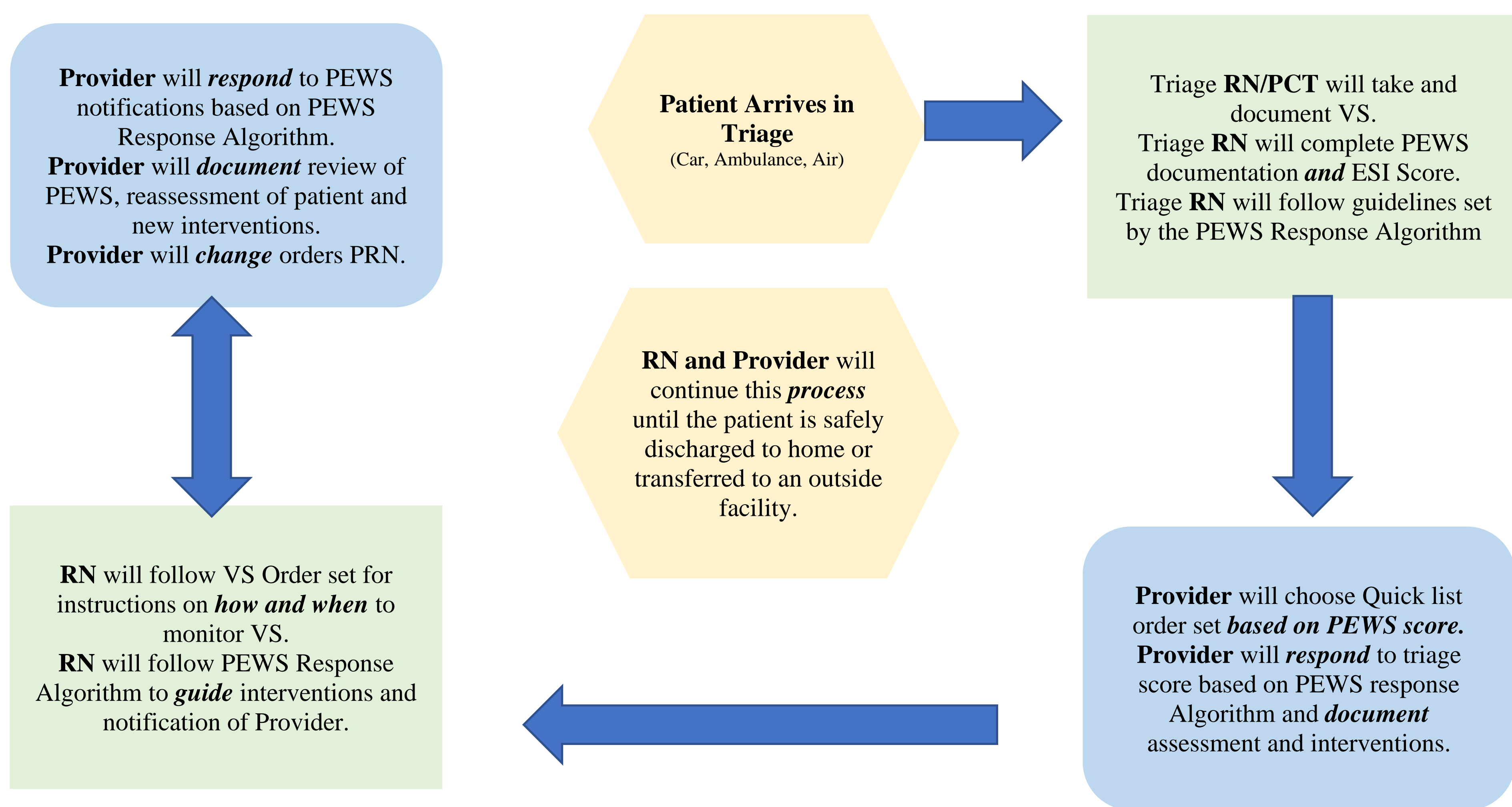


Figure 6

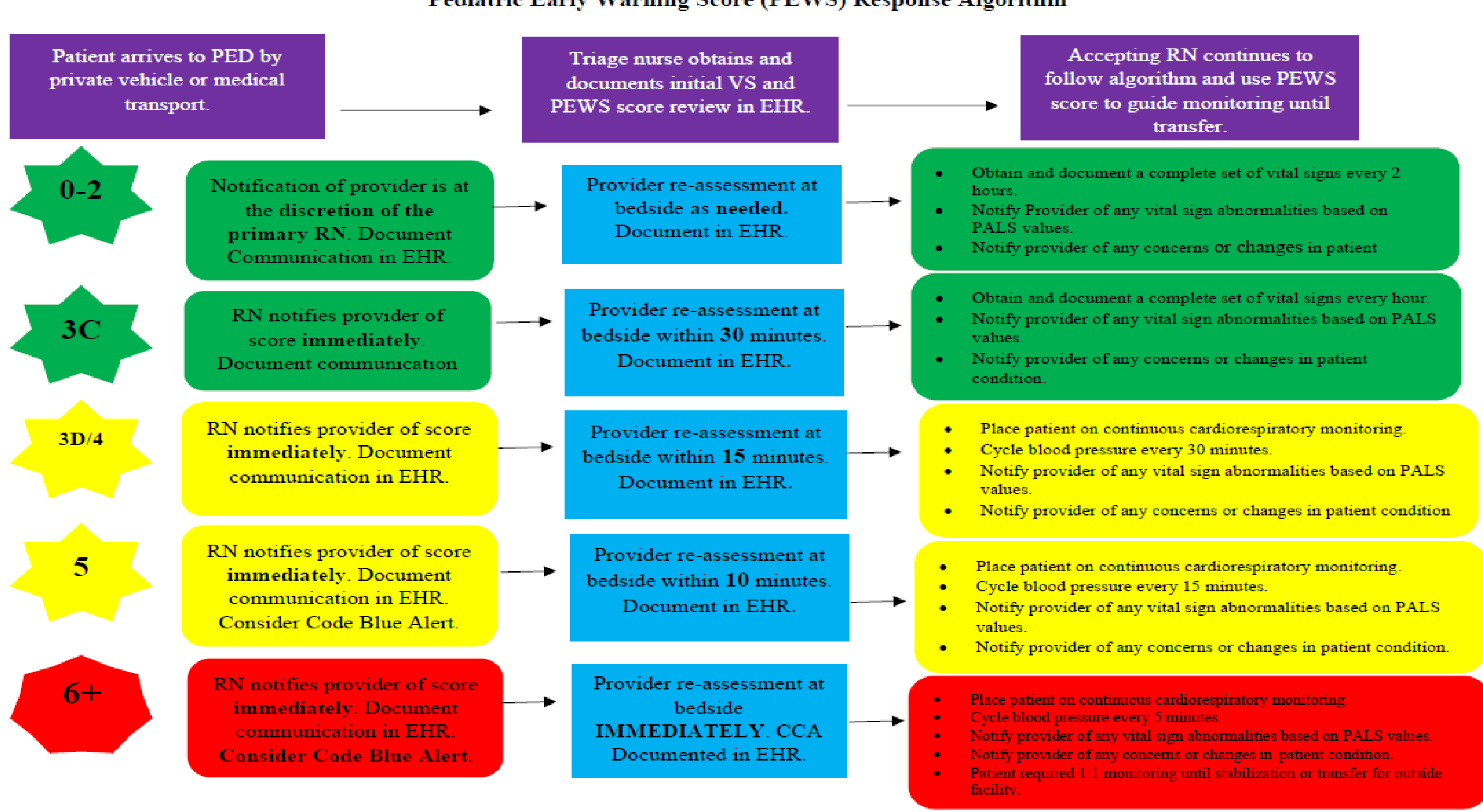
Process Map for PEWS- based Vital Sign Protocol Workflow for High Acuity Patients at a Community Pediatric Emergency Department



Key: Yellow Hexagons= Start and Stop; Green Rectangle: Nursing or Nursing Support Actions; Blue Rounded Rectangle: Provider Actions; Arrows: Guide steps

Figure 7

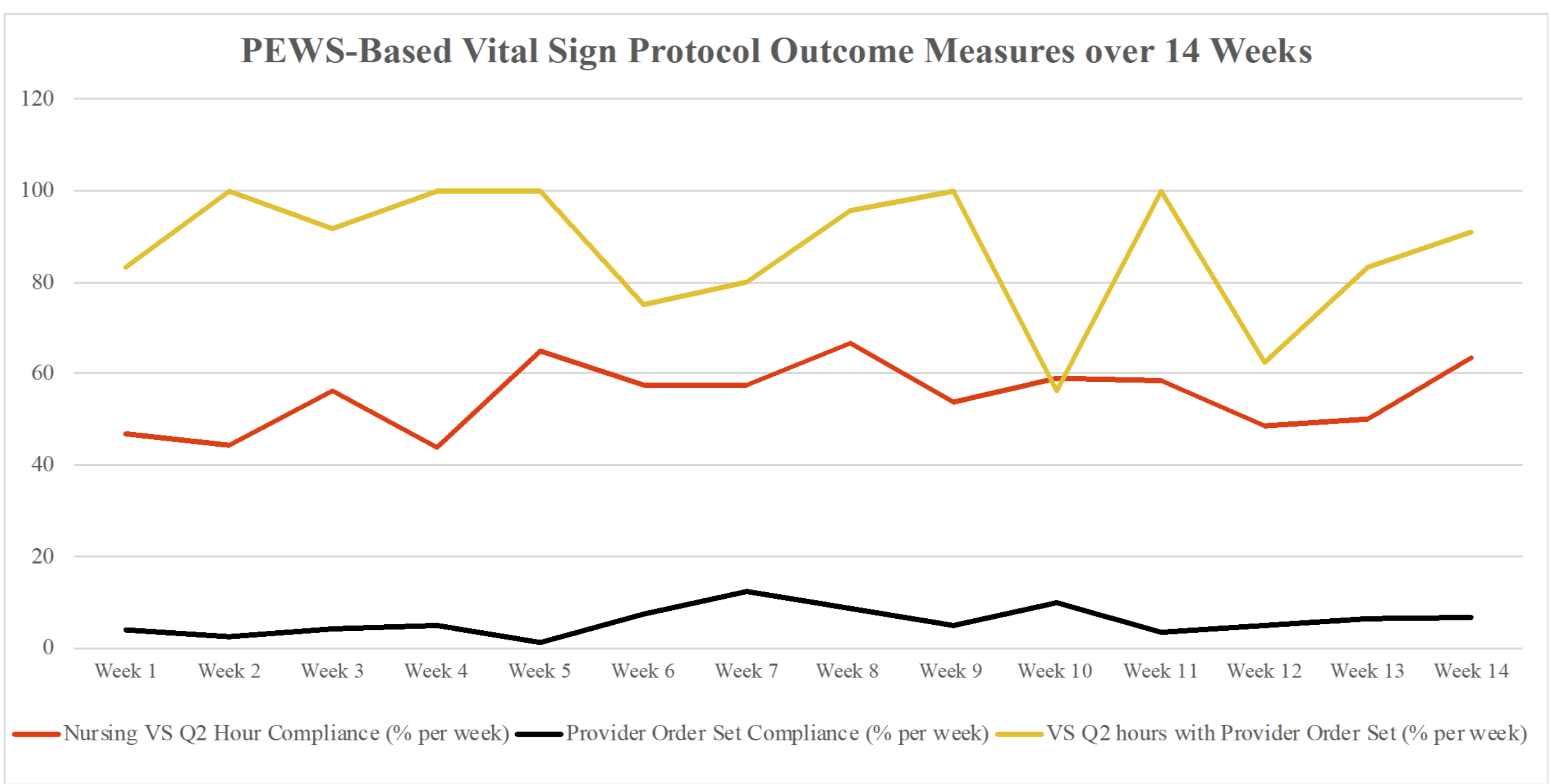
Pediatric Early Warning Score Response Algorithm



Key: Stars= PEW Score; Purple boxes= Workflow; Blue boxes= Provider Response; Color Coded boxes= Nurse Response based on PEWS.
Abbreviations: 3C: PEWS score of three from combined categories, 3D: PEWS score of 3 in ONE category, EHR= Electronic Health Record; PALS= Pediatric Advanced Life Support; PEWS= Pediatric Early Warning Score, PED= Pediatric Emergency Department, Provider= Physician (MD) OR Nurse Practitioner (NP), CCA= Critical Care Addendum

Figure 8

Process Outcomes throughout 14-weeks of Implementation



Note: N=1416

Figure 9

Vital Sign (VS) Adherence for patients with a Quick List Order Set (QLOS) in Electronic Record (EHR)

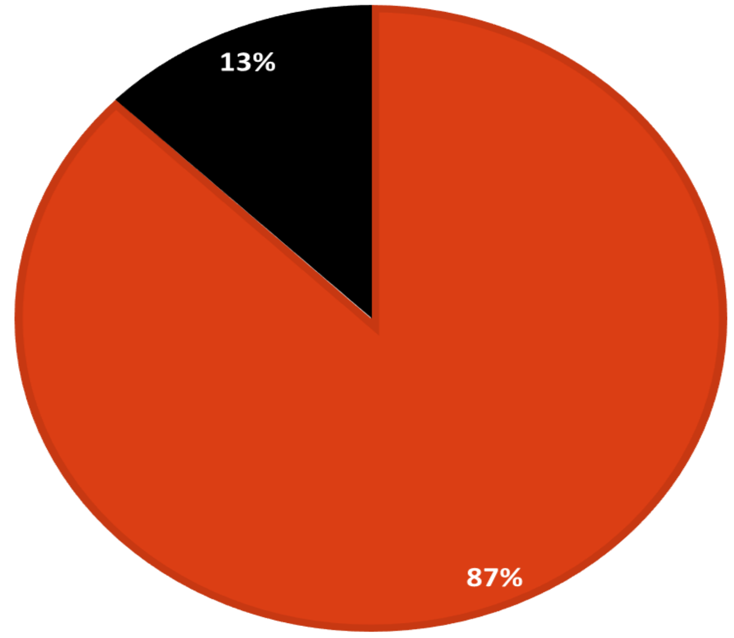


Figure 10

Pre-and Post Implementation Outcome Data

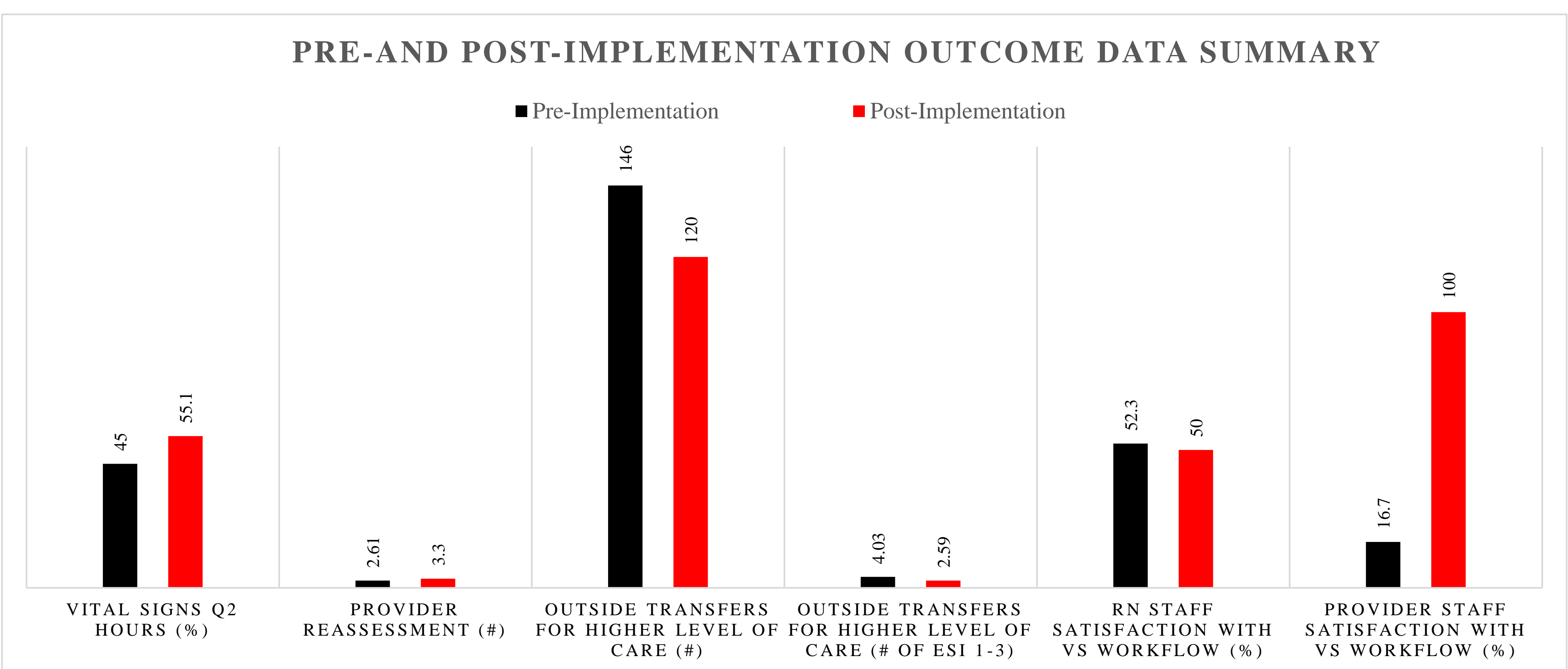


Figure 11

PED Volume and Acuity during Implementation (By Week)

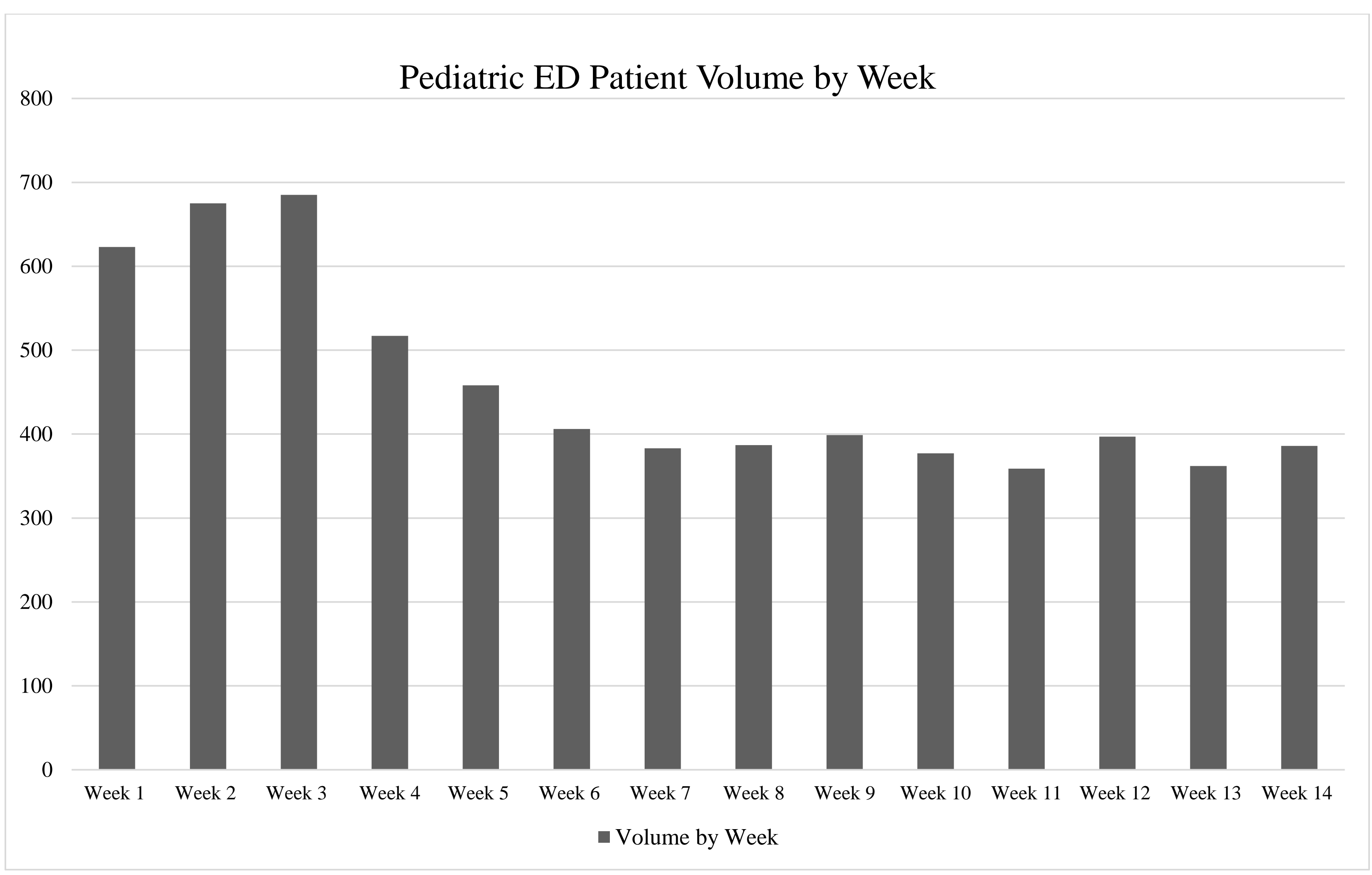


Figure 12

RSV Hospitalizations by Respiratory Season, (CDC, 2023)

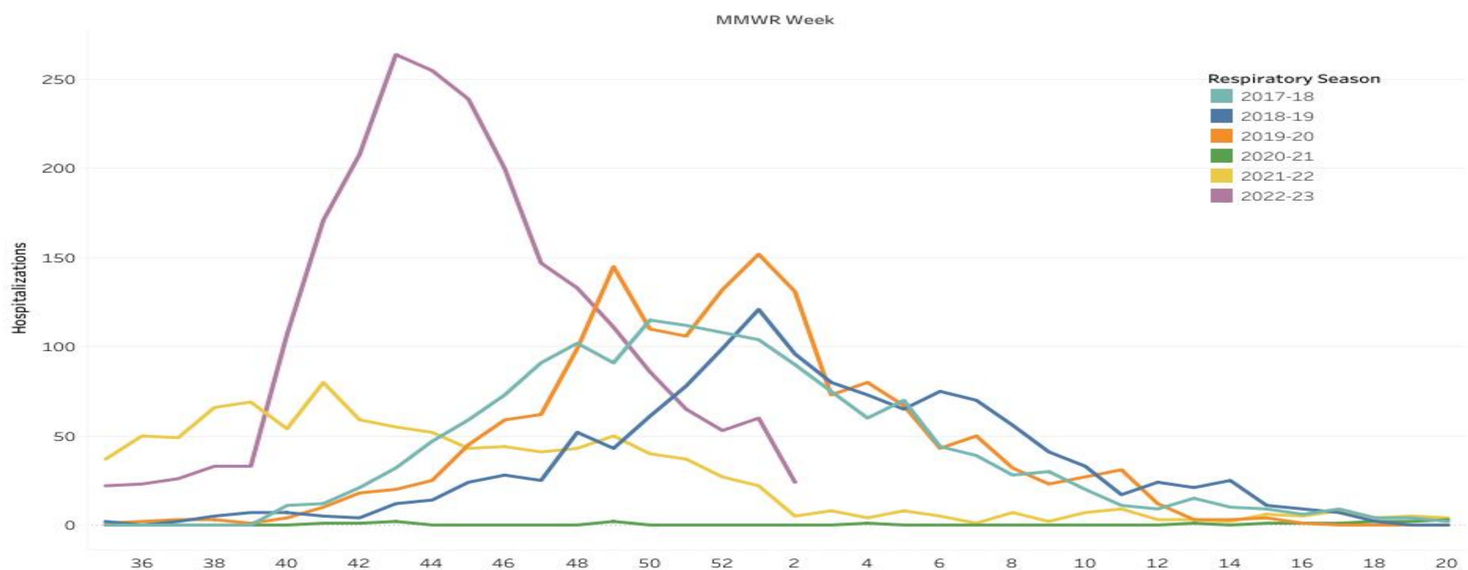
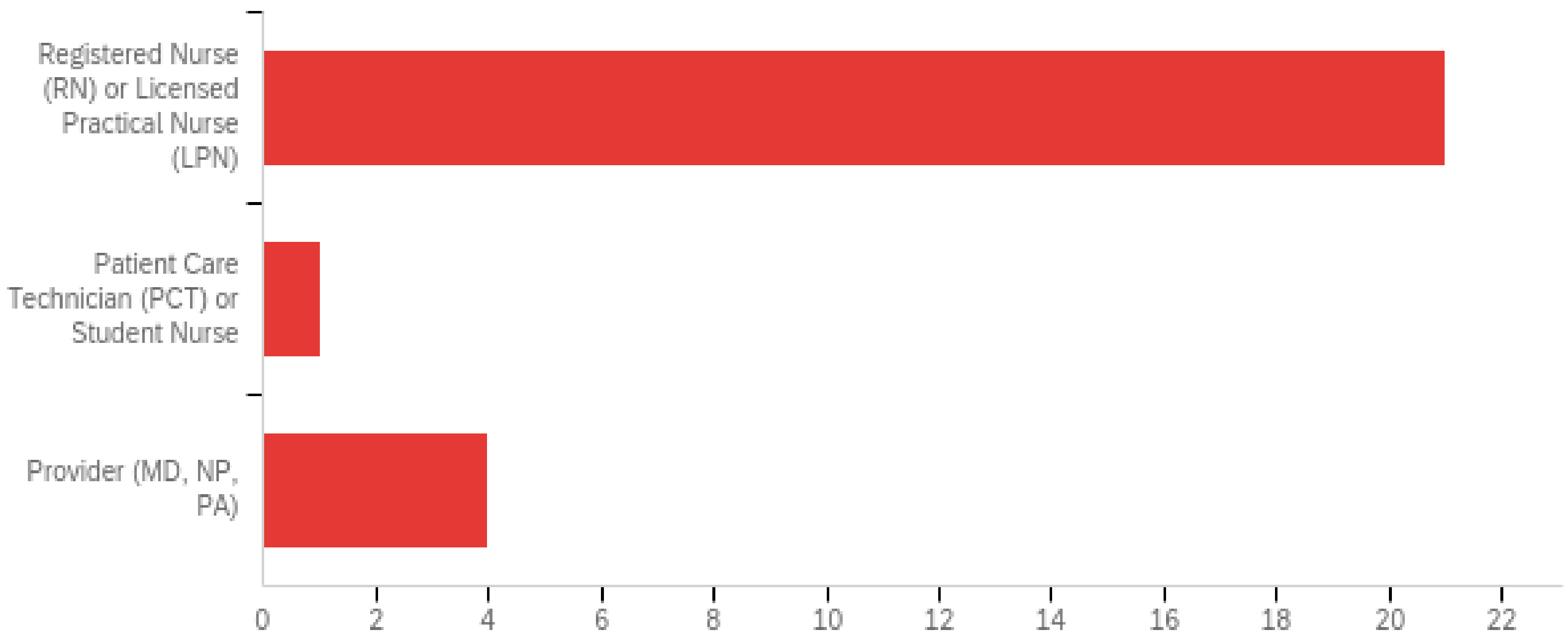


Figure 13

Number of Education Modules Completed by Staff Group (Nursing, Providers, Patient Care Technician)



Appendix A

Evidence Review and Synthesis for Improving Vital Sign Compliance in Pediatric Emergency Department

Citation 1: Bonafide, C. P., Roberts, K. E., Weirich, C. M., Paciotti, B., Tibbetts, K. M., Keren, R., Barg, F. K., & Holmes, J. H. (2013). Beyond statistical prediction: qualitative evaluation of the mechanisms by which pediatric early warning scores impact patient safety. *Journal of Hospital Medicine*, *8*(5), 248–253. https://doi-org.proxy-hs.researchport.umd.edu/10.1002/jhm.2026					**Level and Quality** **Level III** **Quality B**
Purpose/ Hypothesis	**Design**	**Sample – Population, Size, Setting**	**Intervention/Procedures**	**Primary Outcome/Measures**	**Results/Conclusions**
The purpose of this qualitative study was to examine other ways in which early warning scores (EWS) help clinicians in decision making besides statistical data.	**Research or Practice:** Research **Study design:** Qualitative Study	**Sampling Technique:** Specific recruitment and some random selection. **Setting:** Children's Hospital of Philadelphia; an urban tertiary care pediatric hospital; 504 beds. Medical and Surgical wards. **# Eligible:** Eligibility numbers not discussed. Nurses and physicians who recently cared for children less than or equal to 18 years of age on general medical or surgical wards with false- negative or false-positive EWSs were eligible for recruitment. Recruitment ended when thematic saturation was achieved. **# Accepted:** 27 nurses and 30 physicians Of this sample, 3 surgical nurses and 7 surgical physicians were randomly selected due to low representation from surgery ward. **# in control:** N/A **# in intervention:** N/A **Power analysis:** N/A, thematic saturation achieved. **Group Homogeneity:** For both physician and nursing group, there was more representation from medical than surgical units (RN:	**Control: N/A** **Intervention: N/A** **Intervention fidelity (describe the protocol):** A semi-structured interview guide was created based on literature findings and expert consult. Interviews were performed by non-clinical personnel. The interviewer team consisted of two experienced qualitative researchers and two trained study interviewers. Interviews were recorded and professionally transcribed and imported into NVivo 8.0 software.	**DV:** N/A **State the instrument, reliability, and measurement procedure:** Semi-structured interview guide was used. This was created by researchers. Reliability and validity not discussed. Interview results were coded inductively. There were no predetermined set of themes. The researchers used the grounded theory methodology.	**Statistical Results: N/A** **Thematic Results:** Surgeons did not contribute meaningfully to themes, as there were not familiar with EWS. Four themes were identified: **Theme 1:** The EWS facilitates patient safety by alerting nurses and physicians to concerning vital sign changes and prompting them to think critically about the possibility of deterioration. **Theme 2:** The EWS provides less-experienced nurses with helpful age-based reference ranges for vital signs that they use when caring for hospitalized children. **Theme 3:** The EWS provides concrete evidence of clinical changes in the form of a score. This empowers nurses to overcome escalation barriers and communicate their concerns, helping them take action to rescue their deteriorating patient. **Theme 4:** In some patients, thee EWS may not help with decision-making. These include patients who are very stable and have low likelihood of deterioration, patients with abnormal physiology at baseline who consistently have high EWS and patients experiences neurologic deterioration. **Clinical Significance** • This study is the first to analyze EWS impact on decision making among RNs and MDs who have experiences previous score failures. • This was performed in a children's hospital and builds on findings from similar studies done in adults.

		81.5% to 18.5% and MD: 70% to 30%). Both groups were primarily white, non-Hispanic (RN: 81.5%, MD: 86.7%). In terms of gender, MD group was equally distributed, the RN group was predominately female (92.6%). For both groups, experience was well represented and ranged from less than a year to over 20 years.			• Weaknesses of EWS that were identified can help to drive EWS optimization for these patient groups in the future. **Conclusions:** • Pediatric EWS have performed marginally well as statistical tools to perform clinical deterioration. • RN and MD have identified EWS valuable in identifying deterioration and overcoming hierarchal barriers. • For a better system, EWS should be combined with clinician judgement.
Citation 2: Frascogna, M. N., Merkle, E., Dowdy, K., & Seals, S. (2021). The Effect of Pediatric Early Warning Score Use on Emergency Response Calls After Admission From the Pediatric Emergency Department. *Pediatric Emergency Care*, *37*(12), e930–e933. https://doi-org.proxy-hs.researchport.umd.edu/10.1097/PEC.0000000000001798					**Level and Quality** **Level V** **Quality B**
Purpose/ Hypothesis	**Design**	**Sample – Population, Size, Setting**	**Intervention/Procedures**	**Primary Outcome/Measures**	**Results/Conclusions**
"The goal of this study was to determine if using PEWS in our pediatric emergency department (PED) at the time of admission to the hospital was associated with decrease in number of emergency	**Research or Practice:** Practice **Study design:** Retrospective chart reviewed before and after implementation of PEWS at admission.	**Sampling Technique:** Specific requirements. Inclusion: Patients who had been admitted to a pediatric inpatient unit other than PICU from the PED and then deteriorated to the point of rapid response or code blue. Exclusion: Patients that were not admitted from PED (direct admissions and transfers). Patients admitted to PICU, OR or Psych from PED. **Setting:** University of Mississippi Medical Center, Urban, tertiary care children's hospital. Five pediatric inpatient floors, 1 PICU, 1 IMC, 3 general inpatients. **# Eligible:** Pre implementation 6-month period: 1978 patients, Post implementation 6-month period: 2027 patients. **# Accepted:** All eligible patients were accepted. A total of 4005 patients for the course of the study.	**Control: N/A** **Intervention:** Implementing PEWs scoring on admission to PED. **Intervention fidelity (describe the protocol):** Pre- and post-implementation data collection performed. **Patient Outcomes measured:** • Length of Stay • Number of Rapid Response Calls • Number of Code Blue Calls • Appropriateness of placement pre- and post- PEWS implementation was examined using the X2 test.	**DV:** Number of emergency response calls within 6 hours oof admission to pediatric inpatient unit. **State the instrument, reliability, and measurement procedure:** PEWs was the tool implemented in this study. • 13-point scale to assess child's status based on behavior, color/CV status, and respiratory status. • Adds 30 sec to standard assessment.	**Statistical Results:** • The percentage of patients requiring emergency calls pre-implementation was 1.77%. • The percentage of pediatric patients requiring emergency calls post-implementation was 0.79%. • This is a 55% reduction (p=0.0070). **Clinical Significance** • Improved patient outcomes with implementation of PEWs score at PED admission. • Demonstrates helpfulness of PEWs score in specific setting of PED. • This implementation reduced number of response calls but did not change patient outcomes of the RRT calls that were made. • PEWs is the not the sole determinate of correct patient placement- clinician judgement is also taken into account. **Conclusions:** • Assessing PEWs score on admission to PED was associated with a reduction in the number of emergency response calls within 6 hours of being admitted.

response calls within 6 hours of admission" (p. e930).		**# in control:** N/A **# in intervention:** N/A **Power analysis:** Not discussed. **Group Homogeneity:** No demographic data collected. In both pre- and post- implementation groups respiratory diagnoses accounted for 80% of patients needing an emergency response call. The most common diagnosis was asthma exacerbation for both groups (60% and 57%). The outcomes for patients with emergency were also similar in both groups. For pre- and post-implementation 50% of patient required admission to higher level of care, 50% were able to be managed on the floor and not require transfer.		• PEWs score of 5 or above ono general floor = RRT • PEWs score of 7 or above no IMC= RRT • Study mentions that PEWs is "shown to be a reproducible assessment of a child's clinical status with excellent interrater reliability" (p. e930). • Validity not discussed.	
Citation 3: Gold, D. L., Mihalov, L. K., Cohen, D. M., & Walthall, J. (2014). Evaluating the Pediatric Early Warning Score (PEWS) System for Admitted Patients in the Pediatric Emergency Department Evaluación de la Escala de Puntuación Pediatric Early Warning Score (PEWS) para Pacientes Ingresados en el Servicio de Urgencias Pediátrico. *Academic Emergency Medicine*, *21*(11), 1249–1256. https://doi-org.proxy-hs.researchport.umd.edu/10.1111/acem.12514					**Level and Quality** **Level III** **Quality B**
Purpose/ Hypothesis	**Design**	**Sample – Population, Size, Setting**	**Intervention/Procedures**	**Primary Outcome/Measures**	**Results/Conclusions**
"The goal of this study was to explore the test characteristics of an ED-assigned PEWs score for	**Research or Practice:** Research **Study design:** Prospective 12-month observational study.	**Sampling Technique:** Specific Criteria **Inclusion:** Pediatric patients less than 21 years old presenting to ER between October 2012 and September 2013. **Exclusion:** Older than 21 years old, NICU admission, Transfer to another facility, ESI Category 1 (Critically Ill), expired in ER. **Setting:** Urban, free-standing, tertiary care children's hospital • Over 85,000 ED visits per year	**Control: N/A** **Intervention:** PEWS score done at first assessment and time of admission. **Intervention fidelity (describe the protocol):** • PEWS was determined at initial assessment (P0) and then again at time of admission (P1). • Trends were measured.	**DV:** Clinical deterioration of patients within 6-24 hours after admission. **Two Groups:** • Transfer to ICU within 6 hours of admission to floor. • Transfer within 6-24 hours of admission to floor.	**Statistical Results:** • Interrater Reliability excellent (ICC=0.91). • 98.9% patients had at least one PEWS in ED • 1.1% patients were missing BOTH (P0 and P1) PEWS. • Patients missing a PEWs score in PED (either Po or P1) had significantly higher odds of admission to ICU (odds ratio= 4.4; p=<0.0001). • Both P0 and P1 were significantly higher for ICU group (P0=2.8, SD 2.4; P1= 3.2, SD= 2.4; p <0.0001) when compared to the floor group (P0= 0.7, SD=1.2; P1= 0.5, SD = 0.9; p <0.0001).

intensive care unit (ICU) admission or clinical deterioration in admitted patients" (p. 1249).		• 18% admission rate. **# Eligible:** 13,184 hospital admissions from PED (15.5% admission rate) **# Excluded:** 878 (6.6%) **# Accepted:**.12,306 (93.3%); 11,066 were directly admitted to the floor (89.4%). 1,211 directly admitted to ICU (9.8%) **# in control:** N/A **# in intervention:** N/A **Power analysis:** Not discussed. **Group Homogeneity:** The group had an excellent mixture of patients. In terms of gender 45.6% were female, 54.4% were male. Ages ranged from 0-3 months to 21 years old. All age categories were represented from 11.2% (3-12 months) to 27.6%. (4-12 years). In terms of acuity, 54.9% were nan ESI Category II and 45.1% were an ESI Category III. No other demographic dates provided.	• Scores were entered into EHR but providers did not have access to them. • Disposition decisions were made without knowledge of PEWS score. **Patient Outcomes measured:** • ICU Admission • Floor Admission • Need for transfer of care 6 hours after admission. • Need for transfer of care 6-24 hours after admission.	**State the instrument, reliability, and measurement procedure:** • **Tool:** Monaghan PEWs • Tool was adapted to hospital parameters for normal vital signs based on Pediatric Advanced Life Support and Literature. • Tool is simple, flexible and is not age-specific. • Measures five domains: behavior, cardiovascular, respiratory, nebulizers, and persistent post-op emesis. • Validated in multiple studies for inpatient setting. • Few studies regarding PED. • Interrater reliability measured.	• For every one unit increase in P0, the odds of admission to the ICU were 1.9 higher that admission to the floor (95% CI= 1.8-1.9, $p<0.0001$). • For every one-unit increase in P1, the odds of admission to ICUU were 2.9 higher that admission to the floor (95% CI = 2.7-2.9, $p<0.0001$). **<u>Clinical Significance</u>** • Missing PEWs Score= higher odds for ICU, importance of VS and PEWS compliance • High scores would help PED determine need for ICU admission and transfer • PEWS is feasible in fast-paced, busy PED setting. • PEWS can be embedded into EHR with excellent interrater reliability. This utilizes all ED nurses scoring their own patients. • PEWs scores are not significantly affected by medical interventions or length of stay in ED. • Results are in agreement with recent publications. • Optimal cut off scores show that there would be inappropriate admission of patients to the floor in about 25% of patients when used alone. **Conclusions:** • An elevated PEWS is associated with the need for an ICU admission directly from the PED. • PEWS lacks the necessary test characteristics to be used independently in the PED.
Citation 4: Huff, S., Stephens, K., Whiteman, K., Swanson-Biearman, B., & Mori, C. (2019). Implementation of a Vital Sign Alert System to Improve Outcomes. *Journal of Nursing Care Quality*, *34*(4), 346–351. https://doi-org.proxy-hs.researchport.umd.edu/10.1097/NCQ.0000000000000384					**Level and Quality** **Level V** **Quality B**

Purpose/ Hypothesis	Design	Sample – Population, Size, Setting	Intervention/Procedures	Primary Outcome/Measures	Results/Conclusions

"The goals of this project were to (1) improve the frequency and documentation of VS; (2) develop an electronic vital sign alert (VSA) system based on the NEWS system that incorporated and electronic sepsis screen; (3) improve clinical outcomes; (4) improve sepsis bundle compliance and (5) evaluate nursing satisfaction with the	**Research or Practice:** Practice
	
	Study design: Implementation on Quality Improvement Study.
		Sampling Technique: Convenience
		Inclusion: All patients admitted on designated units.
		Exclusion: N/A
		Setting: 172 bed community hospital.
		• Cares for 177,000 patients per year
		• Implementation on Following units:
		  ○ 2 medical surgical units (44 beds)
		  ○ Progressive Care unit (29 beds)
		# in control: N/A
		# in intervention: N/A
		Power analysis: Not Discussed
		Group Homogeneity: Not Discussed.
			Control: N/A
			Intervention: Implementation of a vital sign alert (VSA) using National Early Warning System (NEWS) and sepsis bundle.
			Intervention fidelity (describe the protocol):
			Framework: The Iowa Model of evidence-based practice.
			Plan-do-study-act was used for implementation.
			Education (Pre-Implementation):
			• Revised VS policy
			• Mandatory education via electronic learning system.
			Implementation Strategies:
			• Leadership rounds/Staff Feedback
			• Tracking boards
			• EHR functionality assessment
			• Audits
			Patient Outcomes measured:
			• Number of Rapid Response Activations
			• Number of Code Blues
			• Number of Unplanned Transfers to ICU within 24 hours of admission
				DV: Improved VS documentation, Improved Sepsis bundle documentation, improved patient outcomes.
				State the instrument, reliability, and measurement procedure:
				• Vital Sign Alert System Components: Heart rate, systolic blood pressure, respiratory rate, oxygen saturation, temperature, level of consciousness.
				• NEWS scoring placed patient in low, medium or high-risk category.
				• Based on acuity category an escalation in care algorithm was followed by RN.
				Outcome measures were assessed by audits
				• Three trained nurses completed audits.
					Statistical Results:
					• A full set of vital signs was documented 98% of the time.
					• Full protocol was followed 34% of the time.
					• Unplanned transfers to ICU increased by 31% but was not statistically significant.
					• LOS decreased from 5.53 to 4.29 days (22.42%).
					• Patients transferred to ICU for sepsis and respiratory failure shows a 28.46% and 4.2% decrease in LOS respectively.
					• Mortality rates for patients transferred to ICU within 24 hours of admission decreased by 23%.
					• Two most common reasons for transfer with respiratory failure and sepsis.
					• 21% increase in identification of sepsis.
					• Mortality rates for both transfer reasons decreased: Resp Failure (50% to 33% p=.0146) Sepsis: 7% to 0%, P=.0047).
					• 51% of nurses stated that VS supported their intuition
					• 62% of nurses agree that VSA helped in identifying patients at risk.
					• 64% of nurse said VSA did NOT improve provider response.
					Clinical Significance
					  • Number of total critical events decreased.
					  • Improved patient outcomes
					  • Improved VS documentation
					  • Most nursing staff are satisfied with implementation.
					  • Outcomes cannot be generalized, but ideas and strategies can be transferred to other clinical settings and patient populations.
					Conclusions:
					• Implementation of an electronic VSA with sepsis screen may improve LOS and mortality rates,

VSA" (p. 347).			• Length of Stay • Mortality Rate **Nursing Outcomes:** • VS documentation compliance • Sepsis Bundle Compliance • Satisfaction	• Selected random days to complete audits • Results shared with unit monthly. **Nursing Satisfaction** was measured by a survey: • Voluntary • Anonymous • 4 months after implementation. • 10-point Likert Scale.	specifically among patients with sepsis or respiratory failure diagnosis. • Implementation of an electronic VAS with sepsis screen can reduce the overall number of critical events experienced by patients.
Citation 5: Jensen, C. S., Olesen, H. V., Aagaard, H., Svendsen, M., & Kirkegaard, H. (2019). Comparison of Two Pediatric Early Warning Systems: A Randomized Trial. *Journal of pediatric nursing*, *44*, e58–e65. https://doi-org.proxy-hs.researchport.umd.edu/10.1016/j.pedn.2018.11.001					**Level and Quality** **Level I** **Quality C**
Purpose/ Hypothesis	**Design**	**Sample – Population, Size, Setting**	**Intervention/Procedures**	**Primary Outcome/Measures**	**Results/Conclusions**

The purpose of this study was to compare two different PEWS and see if there was a difference in number of patients experiencin g clinical deterioratio	**Research or Practice:** Research
	
	Study design: Randomized Control Trial (RCT)
		Sampling Technique: Randomly Assigned
		• All patients assigned in a 1:1 ration to one of the two arms.
		Inclusion: All patients' ages 0-19 years old admitted or examined at the acute pediatric assessment units in the CDR.
		Exclusion:
		• Children admitted directly to neonatal unit.
		• Children admitted directly to PICU
		• Children dead on arrival to hospital
		• Children admitted due to social interaction problems
			Control: Original Bedside PEWS
			Intervention: CDR PEWS
			Intervention fidelity (describe the protocol):
			
			• Both PEWS measured seven parameters.
			• NO discussion of tool validity or reliability.
			• PEWS measured on admission
			• Actions and re-scoring PEWS assessment then followed the PEWs algorithm.
				DV: Sum of patients experiencing in hospital clinical deterioration requiring transfer to higher level of care. (Unplanned Transfers)
				
				Secondary Outcomes:
				• Pediatric index of mortality score 3 (PIM3)
				• Severity of illness during
					Statistical Results:
					• Out of 719 transfers during this time, only 22 were identified at unplanned transfers.
					  ○ 14 were in the Bedside PEWs group.
					  ○ 8 were in the CDR PEWS group
					  ○ p=0.20
					• Based on sensitivity, specificity and comparison of ROC curved, there is no significant different in accuracy of predicting unplanned transfer due to clinical deterioration (Bedside: AUROC 0.91; CDR: AUROC 0.88, p=0.78).
					• No significant difference observed in secondary outcomes.
					Clinical Significance
					• First study to compare two PEWs in RCT.
					• Bedside PEWS has same outcomes as other derived PEWS. "In a comparison of 18

<table>
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<td>n transferred to higher level of care.

Hypothesis: “The Central Denmark Region (CDR) PEWS is superior to the Bedside PEWS in terms of reducing the number of patients experiencing in-hospital clinical deterioration requiring transfer to higher level of care” (p. e59).</td>
<td></td>
<td>• Children receiving palliative care
• Children without parental informed consent.
Eligible: 35,300
Accepted: 16,213
in control: 4,910
in intervention: 5,799
Power analysis: Power calculation was made based on preliminary data from 2013. Calculation based on power of 80%, significance of 5% and an expected 30% reduction in the number of transfers.
Results: study needs 7112 admissions in each group. Power not achieved.
Group Homogeneity: The groups were similar. Average age of both groups was 4.68 years. In Bedside group, 44.94% of patients were female and in CDR group, 45.72% of patients were female. The most common diagnosis for both groups was disease of the respiratory system (Bedside: 21.25%; CDR: 21.81%). For the bedside group average minutes from admission to transfer was 1670, for the CDR group, the average was 412 minutes.
Setting: Multicenter study in Denmark
• Nine Units at Four different hospitals.
• All Pediatric inpatient units.</td>
<td>• At minimum patients were reassessed with PEWS every 12 hours.
• The medical doctor has the option to assign modified PEWS for individual VS in patients with chronically impaired physiology (e.g. Cystic Fibrosis).
• Pre-implementation education was the same for both groups:
  ○ Education Module reviewing registration, PEWs, and EHR
  ○ Mini-pamphlet continuing decision-making algorithm.
  ○ 2-hour teaching session</td>
<td>PICU stay measured by:
  ○ LOS
  ○ Intubation
  ○ CPAP
  ○ Inotropes
State the instrument, reliability, and measurement procedure:
NO discussion of tool validity or reliability.</td>
<td>pediatric track and trigger systems, Bedside PEWS was one of the best performing tools” (p.e62).
• Overall, unplanned transfers decreased from 92 annually to 72 after implementation of PEWS. This result could indicate that implementing PEWS increases focus on early warning signs.
• This study displays importance of multifaceted implantation approach and actively engaged staff and clinicians.
• Study highlights problem with missing Vital Signs. – make all fields in EHR mandatory for PEWS score.
Conclusions:
• No significant difference in unplanned transfer was identified using the Bedside PEWS compared with CDR PEWS.
• Shorter median time to PEWS reassessment when CDR PEWS was used.</td>
</tr>
<tr>
<td colspan="5">Citation 6: Lambert, V., Matthews, A., MacDonell, R., & Fitzsimons, J. (2017). Paediatric early warning systems for detecting and responding to clinical deterioration in children: a systematic review. BMJ open, 7(3), e014497. https://doi.org/10.1136/bmjopen-2016-014497</td>
<td>Level and Quality
III, B</td>
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Purpose/ Hypothesis	Design	Sample – Population, Size, Setting	Intervention/Procedures	Primary Outcome/Measures	Results/Conclusions

"The aim of this review was to systematically identify and synthesize available evidence on PEWS in acute pediatric healthcare settings for the detection of, and timely response to, clinical deterioration in children" (p.2)	**Research or Practice:** Research
	
	Study design: Systematic Review
		Search Strategy: The following electronic databases were systematically searched PubMed, MEDLINE, CINAHL, EMBASE and Cochrane (inclusive of Cochrane Database of Systematic Review; Database of Abstracts of Review Effects and CENTRAL—Cochrane Central Register of Controlled Trials).
		
		Other searchers: electronic guideline clearing houses, scoping searches of Google and Bing.
		
		Inclusion Criteria: Time: Database inception to August 2016.
		
		• Language: English only.
		• Papers had to refer to PEWS, inclusive of rapid response systems (RRS) and rapid response teams (RRT).
		• Had to include outcomes of identification of and/or response too clinical deterioration in. a child.
		• Setting had to be in a pediatric hospital.
		• No study design restrictions.
		Exclusion Criteria:
		• Pediatric community health settings.
		• PEWS specific to intrahospital transfer
		• Trigger tools for identification of adverse events
			Control: Varied
			All forms of studies were included in Systematic Review:
			• Cohort (13)
			• Case-Control (11)
			• Before and After (8)
			• Cross-Sectional (6)
			• Review Papers (8)
			• Interrupted Time Series Quasi-Experimental (3)
			• Chart/database reviews (23)
			• Quality Improvement (9)
			• Qualitative (4)
			• Case Reports (1)
			• Feasibility (1)
			• Cost Analysis (1)
			• Protocol (1)
			
			Intervention: Varied
			• PEWS detection systems (45)
			• PEWS response mechanisms (29)
			• PEWS implementation strategies (16)
				DV: Outcomes specific to identification of and/or response to clinical deterioration in children in a pediatric hospital system.
				Review Questions:
				1. What is the available evidence on the effectiveness of different PEW detection systems?
				
				2. What evidence exists on the effectiveness of PEW response mechanisms, and what interventions are used?
				3. What evidence exists on PEWS Implementation strategies/interventions?
				State the instrument, reliability, and measurement procedure:
				• PEWs was the instrument that was being examined.
					Conclusions:
					• PEWs is widely used internationally.
					• Lack of consensus on which PEWS tool is the most effective.
					• There are positive trends in improved patient outcomes such as:
					  ○ Reduced Cardiopulmonary arrest
					  ○ Earlier intervention and transfer to PICU
					• PEWS encourages a wider safety culture and has been shown to enhance multidisciplinary teamwork, communication, and confidence in clinical decisions.
					• No multi-center site studies, no national guidelines, no research evaluating PEWS as complex health care intervention= Need for future research.
					
					Recommendation for clinical practice:
					• "PEWS should be embraced as a part of a larger multifaceted safety framework that will develop and grow over time with strong governance and leadership, targeted training, ongoing support and continuous improvement" (p.11).

		• Severity of illness scales • Patient classification systems • Adult data **PRISMA** chart clearly shows the search and selection process: **Total Papers:** 2742 **Eligible Papers included in review:** 90 **Power Analysis:** N/A **Studies from following Countries:** • USA (46) • UK (19) • Canada (10) • Canada and UK (1) • Australia (5) • Netherlands (2) • Ireland (2) • Norway (1) • Pakistan (1) • Sweden (1) • Thailand (1) • South America (1)\		• PEWs stands for Pediatric Early Warning Score. • It is defined as a "bedside track and trigger tool to help alert staff to clinically deteriorating children by periodic observation of physiological parameters, generation of a numeric score, and predetermined criteria for escalating urgent assistance with a clear framework for communication" (p. 2).	
Citation 7: McElroy, T., Swartz, E.N., Hassani, K., Waibel, S., Tuff, Y., Marshall, C., Chan, R., Wensley, D. & O'Donnell, M. (2019). Implementation study of a 5-component pediatric early warning system (PEWS) in an emergency department in British Columbia, Canada, to inform provincial scale up. *BMC Emergency Medicine*, *19*(1), 1–14. https://doi-org.proxy-hs.researchport.umd.edu/10.1186/s12873-019-0287-5					**Level and Quality** **Level V** **Quality B**
Purpose/ Hypothesis	**Design**	**Sample – Population, Size, Setting**	**Intervention/Procedures**	**Primary Outcome/Measures**	**Results/Conclusions**
"The objective of this study was to evaluate the implementa	**Research or Practice:** Practice **If research – state study design:** Implementation Study	**Sampling Technique:** Specific Requirements **Inclusion:** • Seen in the ED in the 12 months pre and post intervention. • Under the age of 17 years old. • Had an ED stay longer than 2 hours to allow for trending.	**Control: N/A** **Intervention:** 5-component PEWS consisting of: • Pediatric Assessment Flowsheet • Brighton PEWS score • Situational Awareness • Escalation Aide	**DV:** Evaluating intervention across three dimensions: • Fidelity • Effectiveness • Utility	**Statistical Results: N/A** • At triage, 80.2% of PEWS scores were documented, of the documented 87% were calculated correctly. • At time of first bedside assessment, 81.2% of PEWS were documented and 88.5% were accurate. • Missed PEWS scoring was more common on highly acute patients and low acuity patients

tion, fidelity, effectiveness, and utility of a 5-component PEWS implemented in the ED" (p. 2).
 	
Hypothesis: This system will enhance providers ability to recognize and communication risk and accelerate mitigating actions.
	Quality Improvement	• Disposition of admission or transfer to another hospital.
		• Acuity score (CTAS) of 1-4
		Setting: ED of Richmond Hospital.
		• Urban, public, general hospital in British Columbia, Canada.
		• Average of 68,000 Pediatric visits per year (12% of total ED visits).
		# Eligible: 192
		# Accepted: 192
		Pre-Implementation: 96
		Post-Implementation: 96
		# in control: N/A
		# in intervention: N/A
		Power analysis: N/A,
		
		Group Homogeneity:
		The pre and post implementation groups were similar to one another. In terms of gender, both groups were well distributed. In pre-implementation (PRI) 54.2 % were female and in the post-implementation (POI) 40.6% were female. Ages ranged from 0-3 months to 12-17 years old. The PRI group had the majority of patients in the 0-3 months group (22.9%) and the POI group had 24% of patients in the 1–3-year group. Overall, all age groups were represented within both groups. Outside of "other diagnosis", the most common diagnosis among PED patients for both groups were Respiratory Illness. (PRI: 24% and POI: 27%). In the PRI group, 38.5% of patients were transferred to higher level of care and 61.5% were admitted
			• Communication Framework
			PEWS score was done at triage and then with every vital sign assessment (Q2 hours)
			
			Education (pre-implementation):
			• Instructions for flowsheet
			• E-learning training modules
			• On-site training workshops
			• Case studies
			• Reinforced: concept that PEWS was a tool to aid clinical judgement, not replace it.
			• Education to ALL ED nurses
			
			Framework: Campbell et al. framework for evaluation of complex health intervention.
				12-month pre- and post- implementation retrospective review
				Mixed Methods Approach:
				• **Quantitative:** Medical record review
				• Collected by experienced pediatric acute care nurses and input into data capture tool (REDCap).
				• **Qualitative:** Online survey and semi-structured interviews.
				• One-year post-implementation
				• Voluntary, staff invited to participate
				• Measured Usefulness, effectiveness, satisfaction.
				• Surveys pilot tested by experienced RN
				• Surveys used 5-point Likert Scale.
				• 40 min interview-focused on utility (barriers and facilitators).
					(p=0.0375 for triage and 0.0354 for bedside assessment).
					• 61.4% of patients had a PEWS score at every set of vital signs while in the ED.
					• Overall, both nurses and providers were satisfied or very satisfied with PEWS scoring system (RN: 71.8%, MD: 81.8%).
					• 51% increase in documentation of notification of provider.
					• Majority of staff (78.9%) agreed that PEWS in the ED was valuable in pediatric care.
					• PEWS score and CTAS scores were found to be inversely correlated (Spearman's rho= -0.574, p <0.001).
					• Majority (89.6%) felt that it was valuable or possibly valuable to complete BOTH PEWS score and CTAS score at triage.
					• Qualitative Themes that showed perceived positive impact of PEWS:
					  ○ Identification
					  ○ Assessment
					  ○ Monitoring
					  ○ Communication
					  ○ Mitigation
					
					Clinical Significance
					• Incorrect PEWS calculations due to user error = argument for calculated score embedded into EHR. No room for error.
					• PEWS= Better Vital Sign Documentation
					• PEWS= better communication from RN to Provider.
					
					Conclusions:
					• This study shows that high-fidelity implementation of PEWS in ED is feasible.
					• Multicomponent PEWS can be effective in improving patient care AND well-accepted by staff.

		internally. In the POI group, 22.9% of patients were transferred to higher level of care and 77.1% were admitted internally. Most patients for both groups were classified as an acuity score of 2 (PRI: 45.8%; POI: 44.8%).		Interviewer took notes and summarized for participants at end of interview. **State the instrument, reliability, and measurement procedure:** PEWS was used as a tool in this study. Did not discuss specific PEWS that was used. No graphic or chart to explain. Validity and reliability not discussed. Did mention that PEWS is widely used in literature.	• PEWS significantly improved comprehensiveness of assessment and documentation at triage and throughout ED stay. • PEWS increased perceived identification and awareness of increased risk to patient. • PEWS increased perceived confidence related to pediatric care.
Citation 8: Remick, K., Gausche-Hill, M., Joseph, M.M., Brown, K., Snow, S.K., & Wright, J.L. (2018). Pediatric Readiness in the Emergency Department. *Pediatrics, 142*(5), p.1-4., https://doi.org/10.1542/peds.2018-2459					**Level and Quality** **Level IV** **Quality B**
Purpose/ Hypothesis	**Design**	**Sample – Population, Size, Setting**	**Intervention/Procedures**	**Primary Outcome/Measures**	**Results/Conclusions**
"These updates recommend ations are intended to serve as a resource for clinical and administrat ive leadership in the ED	**Research or Practice:** Practice **Study design:** Clinical Practice Guidelines	**Sampling Technique:** N/A **Setting:** Clinical guidelines written by a group of pediatric experts from all over United States. Many of the physicians on the committee hold positions on American Academy of Pediatrics, Committee on Emergency Medication, American College of Emergency Physicians Pediatric Medicine Committee, and Emergency Nurses Association Pediatric Committee. Many Universities and hospitals	**Control: N/A** **Intervention: N/A**	**DV:** N/A **State the instrument, reliability, and measurement procedure:** N/A	**Statistical Results: N/A** **Clinical Significance** • Clinical guidelines help to standardize care and ensure patient safety. • These recommendations are intended to apply to all EDs that care for children. • 20% of all ED visits are children in the US. • Children have unique anatomic, physiologic, developmental and medical needs that differ from those of adults. **Recommendations that pertain to project:** • Need for QI plan in ER. The potential framework for QI efforts may be focused on the effectiveness of structural elements, processes, and clinical

as they strive to improve their readiness for children of all ages" (p.1),		throughout United States are also represented in the committee creating the guidelines. **# Eligible:** N/A **# Accepted:** N/A **# in control:** N/A **# in intervention:** N/A **Power analysis:** N/A			outcomes relative to pediatric emergency care. The QI plan of the ED shall include pediatric specific indicators. • A policy and procedure should exist for "documentation of a full set of vital signs, including core temperature, respiratory rate, pulse oximetry, heart rate, blood pressure (including manual conformation), pain and mental status when indicated" (p. 6). This policy should also include "identification and notification of the responsible provider if abnormal vital signs (age or weight based" (p.6).
Citation 9: Seiger, N., Maconochie, I., Oostenbrink, R., & Moll, H. A. (2013). Validity of different pediatric early warning scores in the emergency department. *Pediatrics*, *132*(4), e841–e850. https://doi-org.proxy-hs.researchport.umd.edu/10.1542/peds.2012-3594					**Level and Quality** **Level III** **Quality B**
Purpose/ Hypothesis	**Design**	**Sample – Population, Size, Setting**	**Intervention/Procedures**	**Primary Outcome/Measures**	**Results/Conclusions**
"The goal of this study was to compare the validity of different PEWS in a pediatric ED" (p. e841).	**Research or Practice:** Research **Study design:** Large Prospective Cohort Study	**Sampling Technique:** Specific Criteria **Inclusion:** Children under 16 years old who presented to the ED at a Erasmus MC-Sophia Children's Hospital in the Netherlands between August 2009- June 2012 **Exclusion:** None mentioned **# Eligible:** 17,943 **# Excluded:** None **# Accepted:**. 17,943 **# in control:** N/A **# in intervention:** N/A **Power analysis:** Not discussed. **Setting:** Large, inner-city university hospital in Netherlands. • Pediatric ED received about 8000 children per year. • Multi-socioeconomic population • Multiethnic population. **Power analysis:** Not discussed. **Group Homogeneity:**	**Control: N/A** **Intervention:** PEWS score for pediatric patients presenting to ED. Different PEWS were evaluated using the same large cohort of patients presenting to ED. The PEWS were based off vital signs collected during triage assessment. PEWS scores that were tested were chosen based on PubMed Literature Search. • **Inclusion:** PEWS, children between 0-18 years old, publication date within past 10 years.	**DV:** Correct prediction of ICU admission or hospitalization by PEWS score. **State the instrument, reliability, and measurement procedure:** • Multiple different PEWS were analyzed in this study.	**Statistical Results:** • The sensitivity and specificity of the PEWS at optimal cut off levels varied widely. • When ICU admission was used, the sensitivity of the different PEWS ranged from 61.3% to 94.4% and for specificity, it ranged from 25.2% to 86.7%. • When hospital admission was used the sensitivity of the PEWS ranged from 36.4% to 85.7% and the specificity ranged from 27.1% to 90.5%. • None of the PEWS tools had BOTH a high sensitivity and specificity. • The discriminative ability of the PEWS (area under the ROC curve) were moderate to good for ICU Admission (range: 0.60-0.82) and poor to moderate for admission to the hospital (range: 0.56- 0.68). **Clinical Significance** • PEWS is better suited to identify more acute patients- this will be helpful in identifying patients needing transfer out of community PED. **Conclusions:** • PEWS can be used to detect children presenting to the ED that need to be admitted to the ICU.

		Patient group was well distributed in terms of gender with 41% identifying as female. The average age of the group was 4.2 years old. Most patients presented for trauma (25%) and were classified as "urgent" by the MTS scoring (44%). 16% of these patients required hospital admission, 2% required ICU admission.	• **Exclusion:** Study does not address PEWS, original research on PEWS , or children • A total of 10 PEWS were chosen for analysis. **Patient Outcomes measured:** • ICU Admission • Hospital Admission		• A scoring system that summarizes parameters into a numeric value were better able to identify patients at risk of deterioration when compared to trigger systems.

University of Maryland School of Nursing

Evidence Synthesis Template

PICO Question: In a community Pediatric Emergency Department (PED), does the implementation of the Pediatric Early Warning System (PEWS) compared to current practice improve documentation of vital signs and decrease adverse events in patients waiting to be transferred to higher level of care?

Category (Level Type)	Total # of Sources/Level	Overall Quality Rating	Synthesis of Findings
Level 1 - Experimental study · Randomized Controlled Trial (RCT) · Systematic review of RCTs with or without meta-analysis	1	**Quality C** This study by Jensen and colleagues (2019) did not have a sufficient sample size as demonstrated by power analysis. Many participants were eliminated from the study due to nursing non-compliance with vital signs and PEWS. There were no statistically significant results, which made conclusions difficult to draw.	Jensen et al. (2019) performed a randomized controlled trial with the aim of proving that the Central Denmark Region (CDR) Pediatric Early Warning System (PEWS) was superior to the original Bedside PEWS in terms of reducing the number of unplanned transfers to higher level of care. The overall numbers of unplanned transfers decreased after implementation of PEWS in both groups. However, there were no significant findings to prove one PEWS was superior to the other. Out of 22 unplanned transfers captured, 14 were in the Bedside group and 8 were in the CDR group. These findings were not statistically significant ($p=0.20$). This was the first RCT used to compare PEWS. While it demonstrated that PEWs is useful in predicting transfer to higher level of care, it concluded that there was no significant difference in tools. This study supports using the Bedside PEWS in this implementation project. This study also supports that using PEWS will decrease the number of unplanned transfers.
Level II · Quasi-experimental studies · Systematic review of a combination of RCTs and quasi-experimental studies, or quasi-experimental studies only, with or without meta-analysis	0	N/A	N/A
Level III · Non-experimental study · Systematic review of a combination of RCTs, quasi-experimental, and non-experimental studies, or non-experimental studies only, with or without meta-analysis · Qualitative study or systematic review of	4	**Quality B** In all four studies, sample size was sufficient or resulted in thematic saturation. Results among these studies are consistent with reasonable conclusions explained. Each study	Four out of nine studies for this literature review were rated a level III. Each one used a different study design to evaluate different aspects of PEWS used in clinical practice (Bonafide et al., 2013; Gold et al., 2014; Lambert et al., 2017; Seiger et al., 2013). Bonafide and colleagues (2013) used a qualitative approach to examine ways that PEWS aides clinicians is decision making. The thematic results demonstrated that PEWS facilitates patient safety, prompts critical thinking, aides less-experienced nurses and, empowers

qualitative studies with or without meta-synthesis		included a sound literature review and provided recommendations for future research and current practice.	nurses to overcome escalation barriers. While PEWS might not be as useful in stable patients, both nurses and providers agreed that PEWS is valuable in identifying deterioration and overcoming hierarchal barriers (Bonafide et al., 2013). This study demonstrates positive perceptions of PEWS from both the provider and nurse perspective, and proves that implementation of PEWS improves patient outcomes as well as nursing outcomes. Two level three studies found PEWS to be useful in encouraging safety culture and improving patient outcomes, but agree that PEWS should not be used independently (Gold et al., 2013 & Lambert et al., 2017). Gold and colleagues (2013) used a prospective 12-month observational study design to examine PEWS usefulness in determining need for ICU admission from the pediatric emergency department (PED). The authors concluded that an elevated PEWS is associated with the need for a direct ICU admission from the PED. However, it was determined that PEWS should not be the sole test used to determine patient disposition (Gold et al., 2013). Lambert and colleagues (2017) performed a systematic review aimed at evaluating PEWS ability to detect clinical deterioration and the effect this had on timely response. After synthesis of 90 studies, their conclusions demonstrated positive patient outcomes and a encouragement of safety culture among multidisciplinary teams. Lambert et al. (2017) specifically concluded that PEWs be embraced as a part of a larger multifaceted safety framework and not used independently. These studies prove positive patient and staff outcomes from the use of PEWS, one study specifically in the PED setting. These studies verify that PEWS will help to determine if patients require transfer to higher level of care. According to this evidence, PEWS is only a piece to the puzzle when it comes to patient safety and improved outcomes. This complements the proposed implementation study, which will include using PEWS in addition to a policy change, and electronic health record (EHR) alerts. Another prospective study by Seiger et al. (2013) decided to focus on the validity of different PEWS tools used in the PED. Like the Gold et al. (2013) study, the conclusions found that in general, PEWS can be used to detect children presenting to the PED that require an ICU admission. While none of the PEWS scores had both high sensitivity and specificity ratings, it was concluded that scoring systems summarizing patient parameters into a numeric scores were better able to identify patients at risk of clinical deterioration (Seiger et al., 2013). This study also proves

			usefulness of PEWS specific to the implementation study setting of the PED.
Level IV · Opinion of respected authorities and/or reports of nationally recognized expert committees/consensus panels based on scientific evidence	1	**Quality B** This clinical practice guideline (CPG) is officially sponsored by multiple professional and public organizations. There is little discussion of literature search or review but the references include multiple academic sources and reputable journals. This CPG was developed four years ago. Recommendations are thorough and references are used throughout to support recommendations. The authors listed demonstrate national expertise in their field both clinically and academically.	This CPG by Remick et al. (2018) provides recommendations for clinical and administrative leaders to ensure that all emergency departments are properly equipped and managed to safely care for children. This CPG is from the American Academy of Pediatrics (AAP) and the committee consists of many pediatric providers and experts from all over the United States. The CPG is sponsored by numerous professional and public organizations. For the purpose of this implementation project, it is important to note that the recommendations include policy and procedure for vital sign documentation, assessment and notification of the provider (Remick et al., 2018). At this time the PED for this implementation study does not have a policy or procedure pertaining to these elements of pediatric emergency care. The CPG reinforces the importance of a new policy and standardized procedure for obtaining vital signs including the addition of a PEWS score.
Level V · Evidence obtained from literature reviews, quality improvement, program evaluation, financial evaluation, or case reports · Opinion of nationally recognized expert(s) based on experiential evidence	3	**Quality B** All three implementation studies were performed at single settings. All studies include clear objectives and goals. Each study included a discussion of framework and methodology for education, implementation and evaluation. All three studies discussed primary and secondary outcomes. All recommendations are consistent with current literature**.**	All three of the level V studies included in this review are implementation studies or quality improvement. Each study implemented an early warning system. Two studies focused on the pediatric early warning system (PEWS) in the setting of the pediatric emergency department (PED) (Frascogna et al., 2021; McElroy et al., 2019). One study focused on the National Early Warning System (NEWS) for inpatient adults (Huff et al., (2019). In addition to NEWS, the study by Huff et al. (2019) also implemented a vital sign alert system (VSA) with the hopes of improving documentation of vital signs (VS) as one of the measured outcomes. Overall, the study concluded that the implementation of VSA and NEWS improved length of stay and mortality rates in addition to improving VS documentation to 98% of patient charts. (Huff et al., 2019). While it was not a goal of the study, McElroy et al. (2019) also found that by implementing PEWS in the PED, documentation of VS as well as documentation of provider notification increased. This study collected

			both quantitative and qualitative data. Both sets of data concluded that it is feasible to implement multicomponent PEWS in a busy PED, and that by doing so patient and nursing outcomes improve (McElroy et al., 2019). Frascogna et al. (2021) also examined the use of PEWS in the PED and aimed to see if PEWS at time of admission to PED would reduce the number of emergency response calls within six hours of admission. The results showed a 55% decrease in emergency calls within 6 hours of admission after the implementation of PEWS in the PED ($p=0.0070$). This study demonstrates effectiveness of PEWS in the PED and indicates the possibility for less adverse events with routine PEWS throughout ED stay.
Recommendations Based on Evidence Synthesis: Overall, this body of literature provides good and consistent evidence for a practice change.			

Appendix B

Vital Sign Monitoring for High Acuity (Level 1-3) Patients in the Pediatric Emergency Room
Summer 2022

Scope: Pediatric Patients 0-17 years old with a triage level of 1-3 in the Pediatric Emergency Department (PED).
Purpose: The purpose of this policy is to establish guidelines, standards, and expectations for the appropriate and safe vital sign monitoring and acuity assessment for high acuity patients in the pediatric emergency department (PED).
Definitions:
1. Pediatric Patients: A patient who is a full-term infant that is least 28 days to 17 years of age.
2. High Acuity: Patients that require a triage level of 1-3 for resources needed for care in the PED.
3. Vital Signs (VS): "Clinical measurements, specifically pulse rate, temperature, respiration rate, and blood pressure. These measurements indicate the state of a patient's essential body functions. Vital signs are the evidence of the current physical functioning of the body. They provide critical information that is 'vital' for life, and so they are called vital signs" (Sapra et al., 2022).
4. Continuous Cardio-Respiratory Monitoring (CRM): "Continuous cardiorespiratory (cCR) and continuous pulse oximetry ($cSpO_2$) monitoring of children who are hospitalized may identify deterioration in patients who are unstable. Clinicians commonly use monitors to measure the heart rhythms, heart rates, respiratory rates, and oxyhemoglobin saturation levels of children who are hospitalized. Alarms will sound for abnormal values notes on the monitor" (Schondelmeyer et al., 2020)
5. Pediatric Early Warning Score (PEWS): "Pediatric Early Warning Scores (PEWS) have been advocated as a mechanism to aid healthcare professional's recognition of children 'at risk', prompting increased monitoring and escalation to staff with the appropriate emergency and critical care skills. Although there is no universally agreed definition, PEWS are generally a composite of a number of vital signs and other clinical indicators indicating organ dysfunction (Chapman & Maconochie, 2019).
Policy Statements:

1. **Responsibility**
    a. **Provider (MD, NP, PA)**
        i. Utilize PEWS score documented by RN to determine appropriate vital sign monitoring order set.
        ii. Document vital sign monitoring orders in EHR. Change orders based on change in clinical presentation of patient.
        iii. Check vital signs and PEWS to monitor patient clinical presentation.
        iv. Respond appropriately to RN communication about PEWS or Vital sign Changes. See the PEWS Response Algorithm attachment.
    b. **Registered Nurse (RN)**
        i. Obtain and document vital signs (VS) and PEWS on patient at triage.
            1. If PEWS is 3D/4 or higher at triage, notify provider immediately.

- **ii.** Obtain and document vital signs and PEWS per vital sign monitoring orders.
    1. **1.** All patients with a PEWS of 3D/4 or higher, VS must be taken by RN and NOT support staff.
- **iii.** Communicate abnormal vital signs or changes in PEWS score to provider. Use clinical judgement and PEWS response algorithm to guide communication (See attachment).
    1. **1.** Document communication in nursing note.
- **iv.** Initiate Continuous Cardio-Respiratory Monitoring per orders.
    1. Placement of patient on monitor
    2. Data Validation per orders (Q1 hr, Q 30 min, Q 15 min, etc.)

c. **Patient Care Technician (PCT), Certified Nursing Assistant (CNA), Student Nurse**
- i. Obtain and document VS for patients with a PEWS score of 1-3C only.
    1. RN must complete PEWS based on documented VS. Nursing support staff may NOT document a PEWS in the EHR.
- ii. Communicate abnormal VS to RN immediately.

2. **Indications for Policy**
    a. Pediatric patients (0-17 years old) with a triage score of 1-3 at triage.
    b. Patients in the Pediatric Emergency Department
3. **Exclusion Criteria**
    a. Pediatric patients (0-17 years old) with a triage score of 4-5.
    b. Patients in the Pediatric inpatient unit.
    c. Patients with a triage score of 2 due to mental health needs.

Procedures:

1. **Triage RN**
    a. Obtain and document VS on patient.
    b. Document Triage Level
    c. Document PEWS
        i. If PEWS is 3D/4 or higher notify provider IMMEDIATELY.
2. **Pre-Populated Order Sets**
    a. Providers will document vital sign monitoring order based on PEWS score.
        i. These orders will be updated with changes in PEWS.
3. **Vital Sign Monitoring in the PED**
    a. RN and RN support staff will monitor, and document VS based on orders.
    b. RN will assess and document PEWS based on orders.
    c. RN will monitor and data validate VS from continuous cardio-respiratory monitoring based on orders.
4. **EHR and Documentation**
    a. Vital Sign Alert (VSA)
        i. Alerts will be present in the patient chart and on the patient bed board.
        ii. These alerts will notify staff when a patient is due or overdue for VS monitoring.

b. **RN Documentation**
    i. Triage VS and PEWS
    ii. Routine VS and PEWS based on orders.
    iii. Communication with provider regarding VS and PEWS.

c. **Provider Documentation**
    i. Vital sign monitoring orders
    ii. Communication with RN regarding VS and PEWS
    iii. Reassessment of patient due to change in PEWS.

5. **Continuous Cardio-Respiratory Monitoring (CRM)**
    a. **Pre-Populated Order Set**
        i. If the patient is required to be on a CRM, an order should be placed in the EHR by the provider.
    b. **Equipment**
        i. All rooms are equipped with Phillips Cardio-respiratory monitors.
        ii. Follow attached instruction sheets to correctly initiate monitoring.
    c. **Data Validation**
        i. Data validation should be completed by RN based on orders.

6. **Communication**
    a. The PEWS response algorithm will guide necessary communication between RN and providers. (See attachment)
        i. This does NOT take the place of clinical judgement.
        ii. Abnormal VS are based on normal pediatric VS parameters published by the American Heart Association's (AHA) Pediatric Advanced Life Support (PALS) course. (See attachment).
    b. ALL communication should be documented by RN or provider notes in the EHR.
        i. If a provider is performing a reassessment due to communication from the RN, this reassessment should also be documented in the provider's EHR note.