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# Implementation of the Deterioration Index: a Benchmark Study

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# Implementation of the Deterioration Index: A Benchmark Study

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**Contents**

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## Executive Summary

With Intensive Care Unit (ICU) and Emergency Department (ED) beds extremely limited during this pandemic, it is time to implement an automated early warning scoring index to assist nurses in identifying clinical deterioration prior to the patient becoming clinically unstable. The goal of using this risk score is early identification of clinical deterioration, with early intervention, and thereby decreasing cardiac arrests outside of the ICU and decreasing unplanned ICU admissions. There are multiple early warning scoring tools, but they all serve one purpose, to calculate a score based upon nursing and physician assessments, lab values, and medical history that will prompt the staff to act prior to a devastating event (Pederson et al., 2015). The early warning score provides a defined set of data that aids in clear communication among care providers. Evidence shows that many patients exhibit elevated deterioration scores up to 24 - 48 hours prior to a significant event requiring rapid intervention, with approximately 40% of ICU admits being unavoidable (Gagne & Fetzer, 2018; Smith et al., 2014). Early recognition of these changes in patient condition is key to early intervention, which can improve patient outcomes (Parrish et al., 2017).

At Methodist Health System, a deterioration score runs in the background of our electronic health record (EHR) but has not been implemented at all facilities for use; Methodist Dallas Medical Center (MDMC) is one of the facilities in which no education for staff has been provided and yet the score is displayed for the team to view. Over the last year, the data has been evaluated for patients that had a Rapid Response Team (RRT) activation or those with an unexpected transfer to the ICU. In all case reviews, the deterioration index score used in our EHR met the threshold for action between 1.5 hours to 60 hours prior to the RRT activation; of

those patients, 80% were transferred to either the ICU or the Progressive Care Unit (PCU) (Methodist Health System, 2020).

This project focuses on the implementation of the Deterioration Index (DI) scoring system within Epic and how it will affect patient outcome and transfers to the ICU. It will identify nurses' knowledge of the tool, provide personalized education of the tool based upon results through the Nursing Education & Professional Development team, and then implement usage of the tool. The tool has been configured and is available for use in Epic. What is needed is the education about the tool and policy in place to utilize the tool for rapid response team activation. The MDMC Code Blue Committee reports an average cardiac arrest occurring outside of the ICU of 29.41% year to date for the current fiscal year compared with a goal of 15%. The project goal is to reduce cardiac arrest outside of the ICU and reduce unplanned ICU admissions which is consistent with MDMC strategic goals of reducing the morbidity and mortality index.

Implementation of the Deterioration Index: A Benchmark Study

The Deterioration Index in Epic is an automated early warning score that utilizes 17 different parameters to calculate a risk of patient deterioration. The DI score computes in the background of Epic every 20 minutes and uses both manually entered assessment data and automated data such as lab results and documented medical history (Epic, 2021). Prior to the development of the DI score, tools required manual calculations allowing room for error and typically required double documentation - first documentation in the appropriate flowsheets or notes for the assessments, and second - documentation in the risk calculation flowsheet. Staff do not have time to waste on duplicate documentation.

This evidence-based practice (EBP) benchmark project discusses implementing an early warning scoring (EWS) tool for use on medical surgical floors to assist nursing staff in early recognition and early intervention of potential clinical deterioration prior to a significant event. With early intervention some significant events can possibly be averted, resulting in better patient outcomes and decreased ICU admits.

## 1. Rationale for the Project

"In many hospitals, a significant portion of overall resources is devoted to identifying and treating patients who are clinically deteriorating" (Epic, 2021, p. 3). Nurses and physicians' efforts are reactive instead of proactive. Treating a patient after signs of clinical deterioration reduces chance of improvement, whereas, utilizing a DI score to proactively determine risk for clinical deterioration and actively treating prior to a significant event could improve outcomes and decrease morbidity and mortality. The Epic deterioration model has shown a 50% increase in correct identification of deteriorating patients prior to a significant event, such as cardiac arrest (Epic, 2021). It is necessary to implement usage of the DI score at Methodist Dallas Medical

Center because the evidence is clear that use of an early warning scoring system tool has shown statistical significance to predict cardiac arrest and death within 24-48 hours prior to the event (Smith et al., 2014). The PICOT question for this project is: among inpatients on a Medical Surgical unit, does the use of an early warning score in comparison to no scoring decrease transfers to the ICU over a 3-month time frame?

Because deterioration in clinical condition is often subtle, the nurse must be astute in clinical assessments since there is no one vital sign that will predict an impending significant event (Epic, 2020). With a workload of higher acuity patients on medical surgical units nurses need tools to help identify workflow priorities and trigger earlier intervention and rapid response activation (Epic, 2020; Wood et al., 2019). The DI score in Epic utilizes 17 variables and "takes into account a patient's prior data and can show trending scores to give a summarized view of the patient's condition throughout their stay, rather than only showing data about their current condition" (Epic, 2020, p. 5). Smith et al. (2014) shows there are mixed results regarding usage of the Rapid Response Teams activations. Some hospitals increased usage, while others decreased usage. The differences may result from policy guiding activations thereby increasing RRTs or earlier intervention, effectively reducing the need for an RRT.

The average rate of code blue occurring outside of the ICU at MDMC is 29.41% and RRT activations is 47 per month. Currently, MDMC does not track unplanned ICU admissions resulting from an RRT/Code Blue, percentage of RRT that deteriorates to code blue, nor does it track DI scores. The data is available but will require some manpower to abstract. In addition, the data will require manual abstraction as the facility does not utilize the Epic RRT or Code navigators. Use of the navigator would result in easier abstraction through existing reports in Epic.

### 1.1 Project Goals

There are several goals of this project. The first goal is to increase nurse awareness of the purpose and value of the DI tool. The second goal is to implement usage on a pilot unit at specified intervals with parameters to activate an RRT. Thirdly, and most importantly, is to decrease codes outside of the ICU and decrease unplanned ICU admissions. To ensure this project is well received and not viewed as "just another task to complete" staff need to be involved in the EBP process.

## 2. Literature Synthesis

A Deterioration Index score is a useful tool to help nurses identify patients at risk for clinical deterioration prior to a devastating adverse event and resulting in an unplanned admission to the Intensive Care Unit (Gagne & Fetzer, 2018; Smith et al., 2014). Despite the many different early warning scoring system (EWS) tools available consensus is that they effectively predict cardiac arrest and death and can alert the need for earlier intensive care interventions to avoid adverse outcomes (Smith et al., 2014). The Deterioration Index model is a hybrid of the Modified Early Warning Score and nursing assessment to provide a more comprehensive picture of risk (Methodist Health System, 2020). Thirteen articles were reviewed, 4 systematic reviews, 1 scoping review, 1 Delphi Consensus study, 2 retrospective observational studies, 1 quasi-experimental intervention pilot study, 1 quality improvement project, 2 descriptive studies, and 1 mixed methods study. Three themes of study were noted: predictability, effect on RRT and ICU admissions, and documentation.

"Approximately 80% of cardiorespiratory arrests in hospital are not sudden or unpredictable as there are signs of clinical deterioration several hours before" (Cherry & Jones, 2015, p. 812). Failure to rescue, or lack of recognition of clinical deterioration cues in patients, is

a complex problem with multiple reasons including poor communication, failure to respond, failure to recognize signs, failure to score EWS tools appropriately, inadequate staffing, and lack of staff confidence (Cherry & Jones, 2015; Wood et al., 2019). Cherry & Jones (2015) found upon review that 60% of cases of deterioration could have been recognized earlier with the use of an early warning scoring tool. A strong predictive value for cardiac arrest and death within 48 hours of the event was noted in several studies regardless of tool used (Al-Moteri et al., 2019; Friman et al., 2019; Parrish et al., 2017; Smith et al., 2014; Spangfors et al., 2020). Alam et al. (2014) found mixed results in all parameters, but an overall decrease in significant adverse events. It was noted in several studies that due to variation in tools and variation in the validation of these tools, it is difficult to accurately compare results and draw conclusions (Alam et al., 2014; Fang et al., 2020; Pedersen et al., 2015). It is interesting to note in the Delphi consensus study although general consensus was achieved to measure cardiac arrest, death, and admission to the ICU, there are varied additional outcomes that experts suggest should be studied, which shows there is still work to be done surrounding the effectiveness of EWS (Pedersen et al., 2015). Spangfors et al. (2020) and Montenegro and Rodrigues (2019) reviewed the predictability of EWS measured at varied intervals to determine best predictability. Assessments between 0 - 6 hours showed statistical significance for predicting cardiac arrest, death, and transfers to the ICU with higher EWS scores (Montenegro & Rodrigues, 2019; Spangfors et al., 2020). It is imperative that the EWS is used to review trends over time and not just as a one-time evaluation. Communication is another key component of successful implementation of EWS. Addressing nurse confidence in communicating results, team dynamics, and use of communication bundle improves not only compliance with EWS usage, but also an overall improvement of outcomes (Gagne & Fetzer, 2018; Parrish et al., 2017; Wood et al., 2019).

There are mixed results on the effect of EWS scores on the frequency of RRT and unplanned ICU admissions. Gagne & Fetzer (2018), Parrish et al. (2017), and Friman et al. (2019) found an overall decrease in RRT usage. This can suggest earlier intervention due to usage of the EWS which averted the need for RRT activation. Smith et al. (2014) reported mixed results for ICU admission, but other studies showed decreased unplanned ICU admissions suggesting two things, either there is earlier recognition of clinical deterioration and/or earlier treatment with EWS. Earlier recognition could prompt more RRT activations, however, depending on protocols paired with the EWS, perhaps it results in improved communication with physicians resulting in earlier treatment to avoid a significant event.

Lastly, several studies reviewed the validity and quality of the EWS tool documentation. Each study found incomplete documentation, biased documentation, and errors in calculations with manual entry of EWS scores (Alam et al, 2014; Friman et al., 2019; Pedersen et al., 2018). Friman et al. (2019) found 22.4% of EWS scores were erroneously calculated. Pedersen et al. (2018) noted that in 10% of EWS reviewed, there was incomplete data and in addition, with manual documentation there is potential for bias, as they found a disproportionate number of cases in which the documentation was just below the trigger point, suggesting a bias towards scoring values that will not produce a trigger. All suggest that electronic, or automated calculation could avert this problem (Alam et al., 2014; Friman et al., 2019; Pedersen et al., 2018). See Appendix A for synthesis table of reviewed literature.

## 3. Project Stakeholders

Evidence-based practice (EBP) by definition includes patient preferences along with research and clinicians practical experience (Long et al., 2015). Stakeholders for this implementation include nurses, physicians, patients, and family members. In addition, hospital

leadership, clinical informaticists, and risk management are key partners. It is obvious that nurses, physicians, patients, and family members directly benefit from the use of the tool as it can predict risk of a severe adverse event and as a result allow for early intervention and improved outcomes. It is assumed that when patients enter the healthcare system they are seeking optimal, research-informed care and that they expect to leave the hospital with positive outcomes. Patients are concerned with their well-being and expect staff to be competent; nurses and physicians have a professional duty to remain competent (Long, et al., 2015). The users of the DI tool however, must be involved in its development and protocols for use. Cherry & Jones (2015) found that nurses reported problems with calculation of scores, problems addressing physicians and problems with respect by physicians based upon their seniority level. By including staff in the process of developing protocols for use, problems such as these can be addressed. At Methodist, the DI score will be an electronic calculation, which can help offset the problems with documentation bias noted with manually entered data as noted by Pederson et al. (2018). Communication protocols will be developed to address actions needed based on DI score; involving nurses in the development of protocols will help to ensure improved patient outcomes.

## 4. Implementation Plan and Timetable/Flowchart

Implementation requires detailed planning, including consideration of expected challenges. The first step of any project is to determine the problem. Once this has been identified, develop a team to begin the work. A change theory should be utilized to assist with implementing and sustaining the change. Implementing EBP is not done in a vacuum. A team of people must be involved to lead the change and a team of people must be involved to implement and eventually sustain the change. When thinking about change, Kotter's 8-step theory is useful.

The steps of the process are creating a sense of urgency, forming a coalition, creating a vision, communicating the vision, empowering others to act, creating quick wins, building on the change, and institutionalizing the change (MindTools, n.d.; Small et al., 2016). Communication is crucial to addressing each step of this change model. Any change theory can be utilized, the key is to review and utilize the change theory often. It will help the team stay grounded and focused in the efforts to reach the end goal. After a change theory is selected, an implementation model should be selected. Methodist Dallas Medical Center utilizes the Plan-Do-Study-Act (PDSA) as the framework for project implementation. PDSA is a cyclic model with four stages to guide evolution of any project (Stevens, 2015). In the plan phase, evidence is appraised and implementation is planned; during the do phase, the plan is implemented on a small scale. In the study phase, the data is analyzed and reported, in addition, determination of any changes to the plan including planning implementation on a larger scale occurs, and during the act phase, implement changes to the project, if needed, to continue its success. The implementation is summarized as follows but is also shown in Appendix B as a detailed timeline and Appendix C as a flowchart.

During the plan phase, project team members should include staff nurses, nursing leadership, nursing education, clinical informatics, and physicians. Together the team will review the evidence and facility metrics from the code blue/RRT committee and develop a compelling summary for the leadership team. By the end of the first month, the team should determine key quality indicators for the project - typically decrease in cardiac arrest outside of the ICU and decreased unplanned ICU admissions. A survey should be developed to assess the medical surgical nurses' knowledge of the deterioration index scoring tool and a review of the RRT policy should occur. The team must make a recommendation regarding assessment parameters

for use of the DI. Once the surveys are collated and the RRT policy has been updated, education must commence over a 1-2 month timeframe. At month 3 of the project, the do phase begins with implementation of the DI tool. Data collection should occur concurrently for 3 months. At the sixth month of the project, or after 3 months of implementation, the study phase begins with evaluation of data through reports created by the clinical informatics team. Detailed discussion of the evaluation plan will be reviewed later in this paper. See Appendices A & B for a timetable and flowchart of implementation.

## 5. Evaluation Plan

The Plan-Do-Study-Act (PDSA) model will be used to guide the implementation and evaluation of this evidence-based project. To evaluate the effectiveness of implementation of the DI score, descriptive statistics should be used. One must evaluate the number and percentage of cardiac arrests outside of the ICU, RRT activations, and unexpected admissions ICU. Additionally, each statistic should be categorized by the DI score ranges of low, moderate, and high risk. This data should be vetted through the code blue committee. If DI scores are not evident upon review of code blue and RRT activations, then a chart review should be performed to abstract that data or the use of report from the electronic health record can be used to obtain that data.

Steps to guide the evaluation plan and collect necessary information are as follows:

- Obtain access to the Code Blue team data.
  - Ideally, request permission to join the Code Blue team.
- Determine current data collection process for:
  - Number of Code Blue outside of the ICU
  - Code Blue and RRT activations by nursing unit

- Number of RRT activations
- Number of unexpected ICU admissions
- Available reports in EHR
- Process for creating new reports in EHR for DI scores

■ Work with clinical informatics team to create reports in EHR for desired outcome measures, including DI score

■ Create dashboard for desired outcome measures

■ Publish dashboard quarterly for administrators, code blue committee, and staff

■ Meet monthly with the DI team to evaluate data and analyze data

■ Complete PDSA cycles with DI team

The DI score, although a calculation, is divided into categories of low risk, moderate risk, and high risk by range of numbers. It is not an interval or ratio measurement because the number calculated is not necessarily an equal interval nor an absolute magnitude (Polit & Beck, 2017). In addition to percentages, frequency distribution would be helpful to determine where the codes and ICU admissions occur. For example, in plotting the nursing unit per each code, RRT, or unexpected ICU admission, a trend may be noted to show that events occur more frequently in one unit than another. Frequency distribution organizes the data collected by shape, central tendency, such as mean, mode, and median, and variability (Polit & Beck, 2017). A histogram could visually depict the frequency of events per nursing unit.

## 6. Cost/Benefit Discussion

Patient average length of stay (ALOS) is the total patient days divided by discharges for a certain time frame (Penner, 2017). Patients with a higher than average length of stay increase hospital costs and decrease profits (Penner, 2017). “Reducing preventable complications is not

only good for the patient, but improves the institution's efficiency and profitability" (Penner, 2017, p. 98). ALOS for the US is 4.1 days, and for a patient who has experienced cardiac arrest is 10.3 days (Agency for Healthcare Research and Quality [AHRQ], 2016). This is a significant cost that will not be realized. With an average percentage of code blue outside of the ICU at MDMC of 29.41, and a projected decrease of approximately 40% MDMC should see a decrease in the ALOS (Epic, 2020). In addition to increased length of stay, cost of training should be considered. For this project, training costs will be nominal because the plan is to educate during staff meetings and during unit rounding. An online module will be added to the monthly updates. Overall, the improvement of patient outcomes is the goal, which cannot always be quantified.

## 7. Discussion of Results

Innovation requires an individual willingness to embrace change, an organizational culture that empowers staff to creatively solve problems, an understanding that ideas are fluid, and belief that developing solutions is a journey (Malloch & Porter-O'Grady, 2015). The use of the Deterioration Index (DI) is an innovative way to help decrease codes outside of the ICU (Smith, 2014). Although this metric is reported at MDMC, there has been no change and no working solutions to improve it as the Code Blue committee has been stagnant over the last several years due to leadership turnover in all levels of the ICU. As a benchmark project, this project has yet to be implemented, however, there has been some movement on the initiative. After meetings with the ICU Director, who now leads the Code Blue Committee, the Director of Medical Surgical Nursing, and the two ICU managers, some excitement has been generated and approval has been obtained to begin. To assist with the project, new graduate nurses at the end of their one-year residency program were recruited to help with this project as part of their evidence-based practice project. The pre-knowledge surveys to determine the medical surgical

nurses' understanding of the DI scoring model has been developed and on April 19, 2021, the residents have begun data collection (see Appendix D). The goal is to obtain 70 surveys, or 10 per nurse resident by May 3, 2021. At that time, the information will be reviewed, education developed with help from the nurse educators, and then implementation of the education will ensue on approximately May 31, 2021. Education will occur over a period of 2 weeks for one nursing unit and then a post knowledge survey will be executed and implementation of DI score usage will begin. From there, the project will follow the timeline as described previously.

## Conclusions/Recommendations

Currently, the nursing directors desire only to raise awareness of the availability and usage of the DI tool and use it as one criteria to activate an RRT. After implementation for 6 months of the DI score usage and review of outcomes, there are several recommendations for the future of this project. First, protocols should be developed for communication regarding the DI score, including electronic notifications within Epic alerting the nurse of elevated scores. Gagne and Fetzer (2018) concluded that including a communication bundle with the DI score improved compliance with usage, resulted in a decrease in RRT activations in patients with higher DI scores, suggesting implementation of early intervention, and a decrease in unplanned ICU admissions. Wood et al., (2019) noted that lack of nurse confidence and unit culture as reasons that nurses do not activate RRT which suggests that communication bundles and communication training can help alleviate this concern. Second, a protocol must be developed to set parameters for routine assessment of the DI score and to guide nursing action based upon risk levels noted. When assessed at 4 - 6 hour intervals, the DI score was statistically significant at the high risk stratification score to predict severe adverse events; this suggests that just raising awareness of the DI score is not enough to save lives (Montenegro & Rodrigues, 2019; Spangfors et al., 2020).

Lastly, the facility leadership should review the role of the RRT nurse. It would be beneficial to include in the daily assignment the review of DI scores for all patients in the hospital. Now more than ever, higher acuity patients are residing on general medical surgical units instead of the ICU and with higher patient to nurse ratios on these units, clinical deterioration can be missed (Wood et al., 2019). The free RRT nurse can be utilized to help identify patients at risk and facilitate early intervention to prevent a serious adverse event (Gagne & Fetzer, 2018). This project has much potential, and with nurse residents currently working on it, it is the hope that there will be strong buy-in from the staff and also engagement of new nurses in the EBP process.

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## Appendix A

## Synthesis Table

PICOT Question: Among inpatients on a Medical Surgical unit (P), does the use of an early warning score (I) in comparison to no scoring (C) decrease transfers to the ICU (O) over a 3-month time frame (T)?

| Studies | Design | Sample | Intervention | Outcome |
|---|---|---|---|---|
| **1** | Systematic Review | 21 articles<br>n>100,000 with combined articles | -EWS use to predict outcomes in 48h | -predicts Death within 48h<br>-predicts CA with in 48h<br>-mortality MR<br>-txfr ICU MR, increase may be due to use of EWS<br>-use of RRT – MR, increase may be due to frequent use of EWS, |
| **2** | Retrospective Observational Study | N=168,496 patients<br>N=2,835,331 records | -review of data quality of documentation of EWS | -digit preferences noted in documentation<br>-found bias in documentation – noted that manual entry of VS were documented immediately below trigger threshold – presumably to avoid additional treatment<br>-incomplete records<br>-artifact or extreme values noted |
| **3** | Delphi Consensus study | 17 experts | -determine which outcomes should be used for validating RRS & EWS | -86 items, 13 themes<br>-consensus not achieved on any item<br>-Death, CA, ICU highest rankings |
| **4** | Systematic Review | 47 studies | -examination of validation methods used of EWS and metrics | -validation data set are varied<br>-outcomes measures are varied (10 different metrics)<br>-case definition/time-intervals are varied<br>-aggregation methods are varied |

| | | | | |
|---|---|---|---|---|
| | | | -mortality<br>-CA<br>-ICU | -handling of missing data are varied<br>-difficult to interpret and compare EWS predictability due to variation |
| **5** | Quasi-Experimental Study / pre-post interrupted time series intervention pilot study | N=not listed. Reviewed all admits EWS>4 3 mos PreImplement; 21 mos PostImplement; | --EWS score<br>-communication bundle when using EWS | -RRT ↑, not sign<br>RRT with EWS>4 ↓<br>-ICU admits from MedSurg ↓<br>-ICU after RRT ↓ sign. P=0.03<br>-ICU with EWS>4 ↓ sign. P= 0.01<br>-EWS response time ↓ sign. P=0.002 |
| **6** | Quality Improvement /EBP Pre/Post Implementation project | Pre: N=21 RRT/2CA<br>Post: N= 18 RRT / 2CA | MEWS usage | -RRT calls ↓ 14%<br>-CA ↓ 2.5%<br>-RRT survival not sign.<br>-CA survival no change |
| **7** | Scoping Review | 23 articles | Use of EWS to act for pt. Safety? | 3 Themes<br>-inconsistent activation of RRT<br>-Barriers to following EWS algorithm<br>-Overreliance on scores |
| **8** | Systematic Review | 7 studies | MEWS usage | -overall mortality<br>-ICU mortality<br>-ICU admit<br>-SAE<br>-CA<br>-LOS<br>-Documentation of physiologic parameters<br>-Cost effectiveness<br>Mixed results for all outcomes. Overall trend was a decrease in all,<br>Conflicting results for LOS & CA |
| **9** | Retrospective Case Control study | N=127 cases | 6 hr Time intervals of EWS assessment 24 | -18-24h med EWS sign, high sign<br>-12-18h med EWS sig, high sig |

| | | | | |
|---|---|---|---|---|
| | | N=254 matched controls | hours preceding CA<br>Review of classification high/med/low | -6-12h, med not sig, high sig<br>0-6h, med not sig, high sig |
| **10** | predictive descriptive study | N=300 patients | MEWS every 6h | -death MEWS>4 sign<br>-CA MEWS>4 sign<br>-ICU MEWS>4 sign<br>-MEWS>4 shows high prevalence of events p<0.001, OR0.86, 95% CI, 0.81-0.91 AUC-ROC, (MEWS >4 best cut off point for evaluating) |
| **11** | Cross-sectional Point Prevalence Study (Descriptive study) | N=598pts | MEWS & RRT criteria | -prevalence of at-risk pt meeting RRT, NEWS, captures some, but not all<br>-mortality in-hospital sign<br>-mortality in 30 days sign<br>-CA in 24h sign<br>-ICU/High Dependency unit admin in 24 h not sign<br>-RRT in 24h not sign |
| **12** | Systematic review and narrative synthesis | 14 studies | Review of clinical deterioration in documentation | -failure to recognize<br>Two themes<br>-failure due to inadequate charting<br>-failure with adequate charting:<br>-poor VS charting<br>-lack of appreciate of VS<br>-judgement error-inattention-failure to interpret deterioration signs due to lack of knowledge-delay in communicating-resistance to intervention<br>Missing signs preceding SAE is global issue |
| | | | | |

Legend: 1 = Smith et al. 2=Pedersen, Rasmussen et al. 3=Pedersen, Oestergaard & Lippert 4=Fang et al. 5=Gagne & Fetzer 6=Parrish et al. 7=Wood et al. 8=Alam et al. 9=Spangfors et al 10= Montenegro & Rodrigues 11=Friman et al. 12=Al-Moteri et al., ICU=ICU txfr/admit; SAE=serious adverse event, CA=cardiac arrest, sign=statistically significant, RRT=rapid response teams/activations,

VS=vital signs, MR=mixed reviews, EWS/NEWS/MEWS=early warning scores,National Early warning scores/modified early warning scores, OR=odds ratio, CI=confidence interval, AUC-ROC=area under the curve receiver operating characteristic

Outcomes Table: Effect of EWS tool

| | 1♦ | 2 | 3 | 4♦ | 5 | 6 | 7 | 8♦ | 9♦ | 10 | 11 | 12♦ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Death in 48h | # | NE | NE | NE | NE | NE | NE | NE | NE | * | * | NE |
| CA in 24-48h | # | NE | NE | NE | NE | NC | NE | CFR | * | * | * | NE |
| Mortality | IC | NE | NE | NE | NE | NE | NE | ↓ | NE | NE | * | NE |
| ICU | MR | NE | NE | NE | NE | NE | NE | ↓ | NE | * | NS | NE |
| LOS | MR | NE | NE | NE | NE | NE | NE | CFR | NE | NE | NE | NE |
| Use of RRT | MR | NE | NE | NE | ↓ | ↓ | NE | NE | NE | NE | NS | NE |
| Health Outcomes | IC | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| RRT with EWS>4 | NE | NE | NE | NE | ↓ | NE | NE | NE | NE | NE | NE | NE |
| ICU after RRT | NE | NE | NE | NE | ↓* | NE | NE | NE | NE | NE | NE | NE |
| ICU with EWS>4 | NE | NE | NE | NE | ↓* | NE | NE | NE | NE | NE | NE | NE |
| EWS response time | NE | NE | NE | NE | ↓* | NE | NE | NE | NE | NE | NE | NE |
| Thoughts/application of nursing on EWS use | NE | NE | NE | NE | NE | NE | MR | NE | NE | NE | NE | NE |
| ICU Mortality | NE | NE | NE | NE | NE | NE | NE | ↓ | NE | NE | NE | NE |
| SAE | NE | NE | NE | NE | NE | NE | NE | ↓, plus EWS>$ had high predictive value for SAE in 5 day period after ICU DC | NE | NE | NE | NE |
| Effect on documentation | NE | NE | NE | NE | NE | NE | NE | ↑ doc compliance of VS | NE | NE | NE | MR |
| Incomplete records | NE | 10% | NE | NE | NE | NE | NE | NE | NE | NE | NE | MR |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Validation of end point metrics | NE | NE | IC | IC | NE | NE | NE | NE | NE | NE | NE | NE |

Legend: 1 = Smith et al. 2=Pedersen, Rasmussen et al. 3=Pedersen, Oestergaard & Lippert 4=Fang et al. 5=Gagne & Fetzer 6=Parrish et al. 7=Wood et al. 8=Alam et al. 9=Spangfors et al 10= Montenegro & Rodrigues 11=Friman et al. 12=Al-Moteri et al., NE= not evaluated, IC=Inconclusive, MR=Mixed Results, NC=No change ICU=transfer/admit to ICU, CFR=conflicting results, SAE=serious adverse events, NS=not significant

* = statistically significant findings

♦ = higher level evidence

# = strong predictive value

Recommendations

1. Incorporate an EWS score into nursing assessment
2. Preferably, EWS should be autocalculated with nursing assessment as one component
3. Include a protocol for usage

Of the 3 studies that review the predictive ability of EWS to suggest occurrence of death in 48 hours, 2 were statistically significant and one had a strong predictive value. Of the 5 studies that reviewed CA within 24-48 hours, 3 were statistically significant, one had a strong predictive value and one showed conflicting results. The 5 studies that reviewed transfer or admission to the ICU based upon EWS, the results were mixed. Only 2 showed a statistically significant decrease in admissions, one was decreased, but not significantly, and the others were mixed or conflicting. There are many different EWS tools and most of the studies reported limitations not only due to different tools, but different validation methods. This could explain the mixed results and the inability of the systematic reviews to report conclusive evidence. Despite this, there is evidence that EWS is a promising tool that can help predict significant adverse events if used properly.

## Appendix B

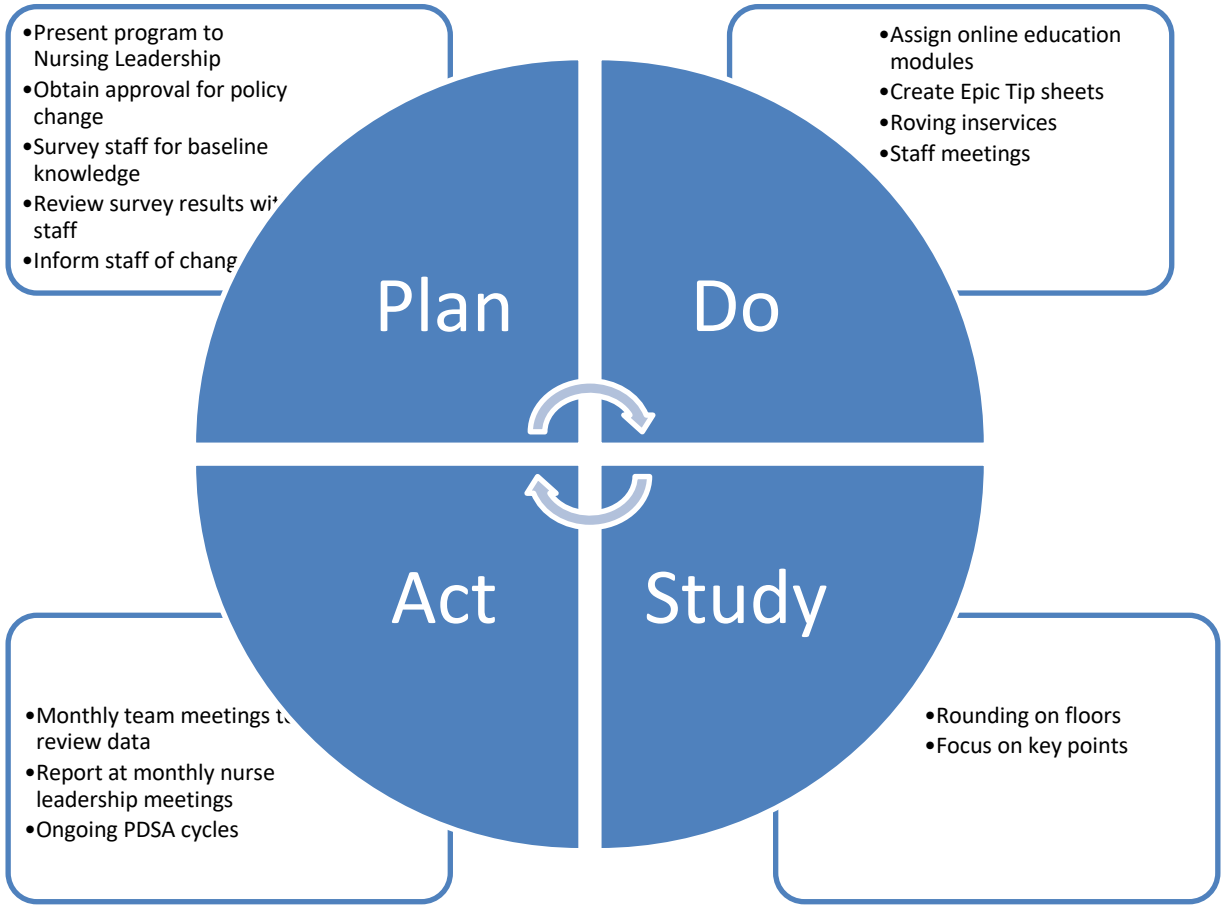
### Timeline

| **SAMPLE PLAN: Educate Medical Surgical & Critical Care nurses to utilize DI score** | | | | | |
|---|---|---|---|---|---|
| **KPI: Decreased mortality index** | | | | | |
| **Metric: Decreased code blue outside of the ICU. Decreased RRTs due to early intervention based upon DI scores.** | | | | | **Go-live Date:** |
| **Taskforce: Nursing Education & Professional Development (NEPD) Team, Medical Surgical Director, Nurse manager, staff nurse** | | | | | |
| **PDSA Action Steps** | **Responsibility** | **Timeline** | **Notes/Action Detail** | **Communication Plan** | **Due Date** |
| **Step 1: Plan** | Project Team | 1 month | 1. Select a Change Theory.<br>2. Present DI information to Nurse managers and Directors.<br>a. Show case studies and review data<br>b. Discuss build in Epic<br>c. Review ease of use of scoring<br>d. Discuss adding as criteria for calling RRT<br>3. Survey Med Surg Nurses knowledge regarding DI:<br>a. What is DI?<br>b. Do you know why it's important?<br>c. How do you use DI?<br>4. Upon completion of the survey, review results with Med Surg nurses at staff meeting<br>5. At staff meeting introduce new RRT policy to use DI as one criterion to call RRT. Solicit concerns and address | 1. Use PowerPoint at leadership meeting.<br>2. Use paper survey with med-surg unit | |

| | | | | | |
|---|---|---|---|---|---|
| | NEPD Team | 1 month | Med Surg Nurses<br>• Assign online education module<br>• Roving in-services to the units on various shifts to review DI score and how to find it in Epic, how to use it to call RRT.<br>• Involve Epic Team to create screen shots and Epic Tip sheets<br>• Education with ICU/SWAT nurses at staff meeting to inform of MS use of DI score, meaning of DI score, and expectation that RRT may be called based upon score alone. | | |
| **Step 2: Do** | NEPD team<br>Nursing Staff | 3 months | Med Surg Nurses<br>• Rounding on floors: focus on key points<br>ICU/RRT/NEPD nurses<br>• Rounding to increase awareness of DI score and use by MS nurses<br>Data Collection<br>• Epic Reports<br>• Code Blue Committee Reports<br>• Daily Review of DI scores by charge nurse | | |
| **Step 3: Study** | Project Team | 3 months | Simultaneous Data analysis from go-live date<br>• Review Code Blue & RRT records<br>o DI score<br>• Review transfer to ICU from MS for DI score | | |
| **Step 4: Act** | Project Team | 3-6 months | • Continue data collection; round on floors to reinforce use of DI | | Ongoing |

## Appendix C

## Flowchart



**Appendix D**

**Pre and Post Knowledge Survey Tool**

# Deterioration Index Project Pre-survey

What unit do you work?

What shift do you work?

AM PM

| | | |
|---|---|---|
| 1. Do you know what the Deterioration Index is on Epic? | YES | NO |
| 2. Do you use the Deterioration Index in your current practice for your patient care? | YES | NO |
| 3. Do you know what the DI score entails? | YES | NO |
| 4. Do you think the DI score is useful? | YES | NO |
| 5. How often do you use the Deterioration Index? | YES | NO |

6. How many times have you used the Deterioration Index?

| | | | | |
|---|---|---|---|---|
| Never | Once | More than once | More than 5 times | Always |

# Deterioration Index Project Post-survey

What unit do you work? What shift do you work?

| | | |
|---|---|---|
| | AM | PM |

| | | |
|---|---|---|
| 1. Do you know what the Deterioration Index is on Epic? | YES | NO |
| 2. Do you use the Deterioration Index in your current practice for your patient care? | YES | NO |
| 3. Do you know what the DI score entails? | YES | NO |
| 4. Do you think the DI score is useful? | YES | NO |
| 5. How often do you use the Deterioration Index? | YES | NO |

6. How many times have you used the Deterioration Index?

| | | | | |
|---|---|---|---|---|
| Never | Once | More than once | More than 5 times | Always |

**What are the benefits of using the Deterioration Index?**

_____

_____

_____

_____

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