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Title: Sepsis management for the 21st century: How the marriage of clinicians and technology creates breakthrough change

Areas of Focus:
Patient Safety: Early identification and prevention of avoidable code blues, with a focus on sepsis
Quality Improvement: Improving and sustaining performance and outcomes using classic Performance Improvement strategies and cutting edge technologies.

Executive Leader Statement:
On behalf of the John Muir Health system, I am honored to support this submission for the Hospital Quality Institute’s 2019 C. Duane Dauner Quality Award. As System Chief Nurse Executive, sepsis mortality reduction has been a top priority of mine and our Executive Leadership team as we work across the system to improve the quality of care we provide, reduce patient harm, and save lives.

The Sepsis Transformation team successfully implemented multiple interventions targeted at reducing the mortality rate of septic patients and significantly impacted all-cause mortality. The multi-disciplinary team used Lean/PI methodologies, change management techniques, and industry best practices to develop an innovative technologically enhanced nurse driven process which accomplished a relative 35% reduction in all-cause Code Blues (reducing from an average of 20 Code Blues per month to 13 Code Blues post intervention) and a 13.9% reduction in Sepsis related mortality through 2018.

The C. Duane Dauner Quality Award would bring much deserved recognition to this team and ensure national dissemination of the innovative work the team has begun, providing a model for implementation as technology creates new opportunities in healthcare.

Thank you for your consideration of our submission.

Sincerely,
Michelle Lopes, MSN, RN, NEA-BC
Senior Vice President and System Chief Nurse Executive
John Muir Health
Executive Summary

Sepsis is a life and limb threatening condition arising from the body’s response to infection, and remains the leading cause of death in US hospitals despite years of national effort. Early identification and bundle compliance reduces mortality by half, but the window for effective intervention is counted in hours and no simple and unambiguous clinical or laboratory criteria can definitively identify a septic patient, making early identification highly problematic on units where sepsis is uncommon. Without a clear “clinical trigger,” lifesaving bundle compliance is less likely to occur until after the patient’s condition deteriorates into shock.

Given the devastation Sepsis causes, John Muir Health set improvement as a Transformation Initiative goal and implemented an entirely new, predicative analytics approach to identify and manage patients. When comparing 2017 and 2018 mortality rates, analysis found at least 54 lives were saved that otherwise would have succumbed to sepsis in our previous state, with a 35% reduction in all-cause code blues. These results demonstrate the impact we can have when we tap into the power of staff driven change in conjunction with cutting edge technology.

Background

38 Sepsis patients require amputations every day in the US, while a sepsis related death occurs every 3.6 seconds world-wide1 despite years of education and best practice bundles in use in hospitals across the US. Awareness building campaigns have been somewhat effective, however without solving the first critical driver of timely identification, efforts to reduce mortality remain elusive. Improvement is further hampered by the fact that sepsis can be difficult to identify amongst the many other clinical presentations encountered in a typical med-surg unit, with septic patients typically declaring themselves definitively far too late to change outcomes.

Historically the committee focused on patients triaged in the ED with Sepsis present on admission (ED-POA), making substantial gains using classic approaches advocated in improvement literature. However, the system struggled to identify and intervene on patients who develop sepsis during their hospital stay. John Muir’s pre-transformation process was comparable to most hospitals in the US: all patients were screened once a shift using a tool

1 https://www.worldsepsisday.org/ retrieved 3/1/2018
embedded in the electronic record which triggered a BPA (Best Practice Advisory) when certain conditions were met.

Despite continuing education and performance monitoring, this process never achieved the harm reduction goals sought. Case reviews determined bundle elements were typically applied late, often after shock had set in which lead to mortality rates above national benchmarks. With the many conflicting priorities nurses face, sepsis screens were not always performed and when the BPA did fire, it was dismissed approx. 80% of the time without action. Staff articulated significant discomfort with answering the BPA triggering questions of "Is there new or worsening infection" which felt subjective and too much like a medical diagnoses. Further, interviews found very few medical-surgical nursing staff could articulate what caused the Best Practice Advisory (BPA) to fire, what the bundle requirements were, or the varied ways sepsis presents. Clearly, there were multiple opportunities to improve care.

Scope
Data driven analysis and a shared leadership model was employed to inform all decisions, including the shift of improvement focus to inpatient sepsis and decision to implement eCART (electronic Cardiac Arrest Triage, an AgileMD product) in medical-surgical and rehabilitation environments across two acute care facilities. We additionally determined that palliative care (defined as patients who transition to comfort care within 24 hours of admission) would be “out of scope” for this phase of work.

Process
The Sepsis Transformation Initiative’s primary goal was to reduce sepsis mortality from 11.84% to 10.95% by 12/31/2018. At the same time, an EMR add-on product called eCART was undergoing limited testing on several med-surg units. eCART is a real-time early warning system much like MEWS, but significantly more complex and individualized. eCART’s predictive algorithm analyzes ~30 clinical variables to produce a summary risk assessment on whether a patient is showing signs consistent with critical condition change, including sepsis progression. The interface includes a graph which tracks cumulative risk over time, the values upon which risk was based, and nurse and physician care pathways with embedded order sets. Prior to being accepted for unit trials, the product was tested using a year’s worth of retrospective data,
appearing to pick up risk as far as 30 hours in advance with a sensitivity to sepsis progression far outpacing other methods.

A needs assessment to identify potential areas of focus was completed, including rounding on units to talk directly with frontline staff on their knowledge of sepsis and sepsis related protocols, barriers encountered, and suggestions for improvement. In-depth flow mapping including ancillary department turnaround times revealed clear opportunities in the inpatient world where High Reliability strategies could be applied. This information was synthetized and formed the basis of all work to come as the team took every driver and gap in care and implemented an associated strategy to improve.
The team developed 2 main aims and multiple supporting interventions:

**Aim 1:** Improve early recognition of all forms of sepsis

- **eCART**’s predictive analytics abilities was found during trials to reduce Code Blues by half when paired with effective Nursing and Medical response. For many months, frontline staff, unit leadership, Quality, and vendor collaborated closely to test workflows and respond to frontline feedback, ultimately making changes to the product itself. The unit’s trialed an audacious and somewhat frightening idea: that patients showing no signs of instability do not require q shift sepsis screening, and that the time liberated could be redirected towards those who are showing serious signs of impending condition change.

Ensuring nurses’ work at the top of their license was a primary design specification as we attempted to move the moment of sepsis identification as early as possible. Sepsis screening was built inside the AgileMD/eCART tool itself, with workflows and verbiage designed by frontline staff to be simple and intuitive and order sets embedded inside care pathways for ease of use. Activation of Rapid Response Team (RRT) was directly embedded into care pathways, and floor staff were encouraged to consider activation every 4 hours during elevated risk. Apart from being a highly reliable means to prompt sepsis screening, this nurse driven process ensured the caregivers closest to the patient had the information needed to identify and intervene in impending deterioration.

**eCART** functionality was rolled out in July 2018 to all med-surg, stepdown and rehab areas alongside intensive educational offerings on sepsis identification and bundle requirements. Posters, screen savers, articles, and a Sepsis Symposium was held with hundreds of floor staff in attendance, while unit based staff champions were educated to support the roll-out. By tying sepsis improvement with cutting edge technological improvements, the system was able to engage nursing staff in a new and exciting model of care with profound results.

**Aim 2:** Improve bundle element performance

- **eCART** mediated sepsis screening became our “clinical time zero”, creating an unambiguous trigger for beginning the treatment bundle or activating additional resources. Flow mapping indicated multiple additional opportunities, such as the need to update standard order sets to be applicable everywhere and force STAT ordering of
antibiotics as well as required fluid volumes. In addition, we placed the most frequently ordered antibiotics in every unit Pyxis to remove the lag time pharmacy preparation routinely contributed. While challenges remain in initial 3 hour compliance as measured by the SEP-1 core measure, after intervention the system scored its highest ever compliance score with antibiotics within 3 hours of 93% (11/18) and bundle compliance rose to 62% from 50% post-intervention.

Clinical floor staff were integral partners at all points, directly contributing to opportunity assessment, interface design, development of workflows, implementation, and post-implementation management. eCART’s nursing pathway empowered RN driven lactate collection at the first signs of sepsis as well as provided a protocolized path to activation of resources including RRT and Medical Staff. eCART’s ability to surface patients demonstrating true risk allowed strategic targeting of nursing and medical resources, making it both a highly reliable intervention as well as a significant improvement in resource management. Early and consistent adoption of eCART and care pathways additionally provided the ability to eliminate sub-performing Epic mediated sepsis screens on patients not showing risk, liberating floor staff to spend more time in the provision of direct patient care and who were encouraged to spend this time with those patient’s showing risk profiles consistent with imminent deterioration.

Frontline staff provided invaluable insights on opportunities & barriers
Results

- **2017**: 257 overall deaths (11.41% mortality rate); 197 ED-POA deaths (9.45% mortality rate); 60 IP-not POA deaths (36% mortality rate)
- **2018**: 221 overall deaths (9.66% mortality rate); 176 ED-POA deaths (8.41% mortality rate); 45 IP-not POA deaths (23% mortality rate)

The team exceeded its initial goal of 10.95% mortality rate for 2018, achieving a relative reduction of 13.9% in sepsis mortality. Post-intervention, the incidence of missed initial lactate draws in sepsis patients dropped to 1/zero from a pre-intervention performance monthly average of 3.8 misses, while code blues in general dropped across the house. Sepsis early management bundle compliance additionally rose from 50% to 62%.

*Please see supplemental materials for all data and examples.*

**Strategies for Success**

The first remarkable driver of the team’s success was the willingness to consider a totally re-designed process supported with cutting edge technology (aka sepsis screening for the 21st century). Redesigned sepsis identification and workflow improvements were implemented on multiple units on both campuses and our success has inspired additional areas to begin implementation in applicable populations (eg. Mom’s in the post-partum period). Critical to the team’s success was the “grass roots” approach taken at all stages from pilot through implementation. Post-implementation a team consisting of unit managers, unit supervisors, ITS, Clinical Informatics, Data-analytics, vendor representatives, and transformation members met regularly to evaluate real-time eCART performance, successes and misses, and further opportunities as they were identified. This kept focus on this new way of practice, spread internal best practices as they emerged, and kept momentum and enthusiasm high. “Focus groups” made up of frontline staff continued the conversation directly and were an important communications avenue.

Much of the team’s early efforts went into developing a robust, real-time Health Catalyst dashboard based on CMS sepsis measures for POA and NPOA populations. This early intervention proved invaluable as additional opportunities and interventions were pursued, and included both process and outcome measures. Effective real time data tracking mechanisms are a requirement for large scale improvement efforts.
To support implementation, new communications pathways to reach unit staff were developed called “Huddle Tips”. These 1 page “small bite” pieces of education were read aloud during each shift’s starting huddle each week, serving to boost sepsis and slowly introduce eCART in the month before and after implementation. All participating units additionally received Rounding-To-Influence visits as well as multiple post-implementation educational presentations supporting the tool’s efficacy. These avenues served to surface additional concerns and ideas to improve.

Work continues with the implementation of Code Sepsis which will parallel processes in place for STEMI’s and Stroke. Additional best practice inspired changes include the trial and launch of a sepsis checklist which we are currently working to transform into a real time post-sepsis transfer review tool for use by frontline staff. Our expectation is routine use will cement bundle requirements in staff minds and offer additional opportunities to communicate barriers and opportunities back to the transformation team.
Challenges

The primary challenge the team faced was the scope of work this project entailed. In some ways this represents a truly new vision of sepsis screening, one where focused and accurate assessments are prioritized higher than the “one size fits all” routine sepsis screenings most hospitals employ. Due to a lack of perceived value with routine screening in stable patients, staff tended to superficially comply without the critical thinking the screen was intended to facilitate, and far too many opportunities to intervene prior to shock were lost. Sepsis was simply not “top of mind” for many caregivers, and many lacked real world experience in its identification given its relative rarity in med-surg units. eCART had not been implemented via a nursing driven model and across multiple units, however John Muir’s success and strategies are now being spread across many AgileMD institutions. The team went to extraordinary lengths to test work flows and messaging in order to find the clearest and easiest ways to express new concepts as well as engage the imagination of caregivers as we built something truly innovative.

The marriage of clinical acumen with technology created tremendous opportunities to support the care we provide and the team relentlessly seeks the next improvement, never satisfied with the status quo. The quest for excellence was supported by a highly responsive vendor, with the 2 parties creating something truly new and pioneering. But without effectively engaging clinicians at all levels both before and after implementation, we would not have enjoyed the degree of success achieved.

Sustainability

Our workgroup continues to meet bi-weekly to review process and outcomes measures, with team members and clinical leadership collaborating to identify additional opportunities. Most importantly, sepsis remains a visible priority across the system with unparalleled support from senior executive leaders and strong frontline engagement.

Like all major improvements, as barriers are overcome additional barriers are identified. At present we are reviewing care opportunities from the intersection between the ED to Inpatient and between inpatient units. The team is even exploring whether we can impact care prior to arrival, outreaching to EMS and area SNF’s to support earlier identification and initiation of lifesaving treatment even before they arrive at our doors. We continue to engage staff in standardization initiatives such as the Sepsis checklist and the soon to be launched Code Sepsis to further impact bundle compliance and improve continuity of care.
Significance

Our story is one of collaboration from the frontline all the way through to high tech vendors, working together to fulfill the dream of reduced mortality. We are extremely proud of the transformative culture change that continues to manifest in the way staff has embraced change and their demonstrated increased awareness of septic patients. The shift from reactive to proactive management and ability for nurses to work at the top of their license has clearly facilitated early recognition and management, but also positively impacted the working life of staff and nursing satisfaction. While new technology was instrumental to results, it was the active adoption by caregivers led by frontline nurse champions which made the project so effective.

Lessons Learned

Leading breakthrough change is challenging, and introducing an entirely new way method of clinical management to thousands of staff held unique hurdles. Workflows respected nursing time and contribution to early identification and bundle compliance, and was successful primarily because the tool had significant perceived value to users. Risk was mitigated through careful data driven trials and close collaboration between administration, staff, and vendors. Communications and education were critical drivers of success with multiple rounds of education, the use of staff champions, and a start to finish effort to involve the frontline in every aspect. The improvements experienced are the result of extraordinary creativity and courage, and a willingness to explore new ideas in service to our patients. Further, it demonstrates the transformative effect technology will have in healthcare in the coming years and how we can embrace them.

John Muir’s experience provides a powerful model on how to manage massive change in clinical technology while minimizing staff change intolerance and maximizing opportunities for improvement. Truly amazing things are possible when a system remains connected to the frontline while exploring the power of technology to transform lives.
2019 C. Duane Dauner Quality Award

Supplemental materials on John Muir Health’s road to sepsis mortality reduction
Strategic planning

Guiding Principles
- Increasing early recognition & treatment in the "golden hour" is the #1 way to decrease mortality*
- RNs work at the top of their license via protocols / defined care pathways
- Patient centered processes (workflows are pt needs based / not unit based)
- Treats all forms of Sepsis as a medical emergency; designed to be proactive & halt progression from infection – sepsis – severe sepsis – septic shock
- Empower all staff levels to act
- Prompt every critical action

GOAL: Reduce mortality through improved compliance (focusing on essential process)

Driver 1 (Improve Early Recognition)
- Implement new process (e.g. early recognition, prompt assessment, recognition)
  - Explore eCART / BPA
  - Improve access to BPA
  - Design intervention at unit level
  - Connect trigger as needed with clinical pharmacist
    - Consider:  RRT order
    - Consider Sepsis protocol
    - Consider Continuous lactate monitoring
  - Raise staff awareness
    - Sepsis is included in hospital’s Top 5 QIs
    - Staff trained to run and STATs housed on unit

Driver 2 (Support Rapid Response)
- Mortality effecting interventions
  - Broad spectrum IV Abx ordered and given as needed after culture results return
  - Improve Pharmacy communication
    - Unit based pharmacist STAT stocks on unit
    - Educate that ok for NURSEs
  - MD process supports
    - MD / Hospitalist edu needs
    - MD order set

Driver 3 (Education & Communications)
- Correct amount (50 mL / kg) of crystalloid administered within 30 minutes of recognition of hour of recognition
  - BPA / eCART calculates the correct amount under consideration
  - MD order sets
  - RRT working by protocol
  - Supportive education to MDs for effective protocol

And lactate is drawn within 3 hours of recognition (2), anywhere in hospital:
  - RRT draws 2nd lactate via STAT (review per protocol)
  - ≥2 initial lactate triggers action as per protocol
  - Wherever pt may be / include as ordered
  - 3 hour lactate BPA (if high or if pt needs more hours)

- VS taken after fluids end (if still hypotensive / lacs ≥4, severe sepsis / shock bundle is triggered):
  - BPA or other automatic trigger prompts repeat VS and beginning of 6 hour bundle (Repeat exam and Vasopressors administered)
  - Suspected Sepsis checklist in hard chart
  - RRT called and pt considered for transfer to higher level of care
  - BPA triggered in Epic / eCART pathway

Improvement in process

Target of opportunity

- Process steps (6 hour bundle – severe / shock):
  - SMART phrase or MD note type to drive MD exam required elements (Corr/realtime, cap refill, pulse, perfusion (skin / color))
  - Vasopressors ordered (include in MD order set) – norepinephrine preferred
  - IP referral end / or transfer to higher level of care part of severe sepsis order set
  - CVP or other invasive monitoring initiated – order set

Nearly complete

* World-Sepsis-Day.org
All Cause Code Blue volume (2014 – 2019)

- Pre-transformation performance = Avg. of 20 codes per month
- Post-transformation performance = Avg. of 13 codes per month
Sepsis related mortality 2018-2019

Discharges & Mortality Rate

7/18: eCART

Year-Month

Discharges  Mortality Rate

proprietary and confidential
Early Management bundle in Septic Shock (SEP-1)

Post interventions (7/18 and after): 62% avg. compliance rate
Pre-interventions (6/18 and earlier): 50% avg. compliance rate
Initial lactate compliance pre and post eCART

% of initial lactate not in 3 hours per cases sampled

Improvement = down