Systems Engineering in the Intensive Care Unit to Reduce Patient Harms

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1 Background

- Preventable patient harms are the third leading cause of death in the United States (Sapirstein, 2016). A large number of these cases occur in the Intensive Care Units (ICU), due to the severity of illness in this patient population. The number of complex interventions required to keep these patients healthy have potential to result in harms if clinicians are not careful in following care protocol.
- Ventilators and central line catheters, are frequently needed in this population, but have potentially harmful effects, including infection if not cared for properly.
- Systems engineering provides a way for these potential issues to be addressed in the ICU and for a design, which limits and hopefully eliminates potential for patient harm (Tropello, 2013).
- Project Emerge was established in 2012 in the SICU at Johns Hopkins with the assistance of the Applied Physics Lab (APL), in attempts to integrate a systems engineering approach in reducing patient harms.

Project Emerge is a tablet app in the patient room, which addresses several potential patient harms including central line infections, delirium, ICU acquired weakness, VTE, ventilator- associated events, loss of respect and failure to align medical goals. This app uses a clock formation, which displays important patient care information for clinicians in one place. If the nurse or doctor has not addressed the harm, the area for the harm will be red, notifying the clinician or nurse that treatments or assessments need to be given to that patient. This project uses a systems engineering approach, to incorporate patient centered care and safety in the Intensive care unit at Johns Hopkins. One specific area where there was a significant reduction in patient harm was ICU acquired weakness.

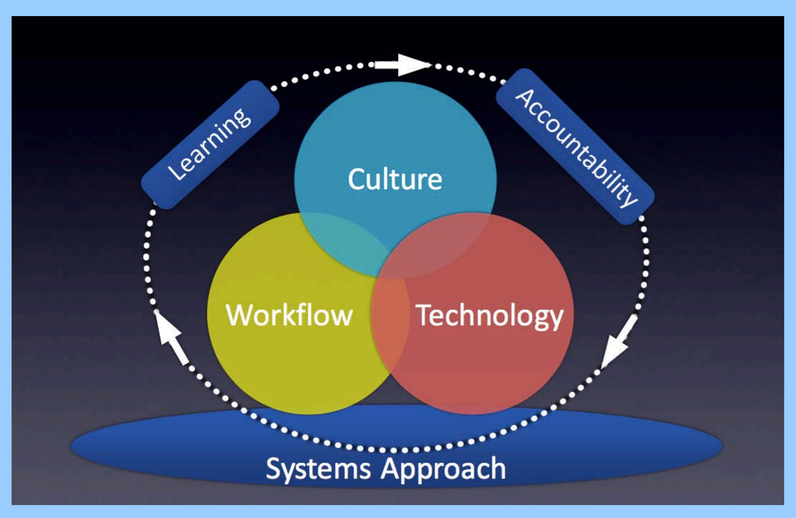

Figure 1. Systems approach integrating workflow, culture and technology to provide safe, effective care to patients in the Intensive Care Unit.

2 Methods

- Data has been collected on ICU patients regarding their mobility prior to hospital admission and after their stay in the SICU.
- Initially, barriers were evaluated surrounding patient mobility in the ICU. After these barriers were addressed, the team created objectives and ways they could create an environment where eligible patients were mobilized on a daily basis.
- The team created a screening tool to evaluate patient mobility. Rehab therapy, including physical therapists and occupational therapists were to meet with nurses to determine a HLM (highest level of mobility).
- The team met every morning to set a target for mobility of each patient and determined which team member would work with the patient, as well as what time they would be meeting with them (Sapirstein, 2016).
- When the team member had completed the patient session, the HLM would be entered and Emerge would be updated. For data collection, HLM for patients in their stay at the SICU was documented.
- Mobility prior to the patient's stay in the SICU was documented from anesthesiology notes and nurse screening assessments.

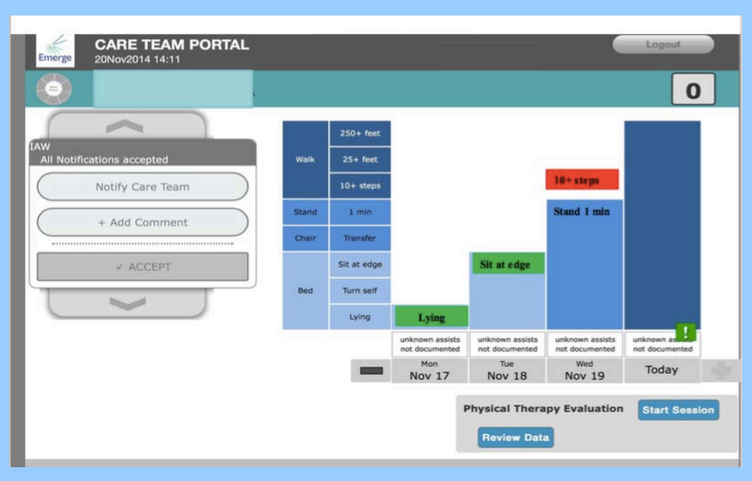

Figure 2. Emerge tablet display for patient mobility. This displays the progress made in a day, as well as progress made overtime in the ICU hospital stay.

3 Results

The data was collected and analyzed from patients baseline data, which included data prior to admission to the ICU and patient mobility was evaluated during and after the ICU stay.

- The amount of physical therapy (PT) mobility sessions with patients increased from 24% to 36% and occupational therapy mobility sessions increased from 12% to 18% (Figure 3).
- The team hit mobility target approximately half the time when working with patients.
- There was decrease in total number of patients who declined in mobility while in the ICU (Figure 4).
- Fisher's exact test two tailed p-value 0.0106 for "declined" vs. " did not decline" in mobility function (Figure 4).

	Baseline Oct 2013-Dec2013	Jul 2014 - Sep 2014	Oct 2014 - Dec 2014	Jan 2015 - Mar 2015	Apr 2015 - Jun 2015	Jul 2015 - Sep 2015	Oct-Nov 2015
Days With Patient Mobility Session Completed By Multidisciplinary Mobility Team	50%	48%	74%	62%	80%	61%	77%
Rate of compliance with setting Highest Level of Activity Target on Emerge tablet	No Targets Set pre-Emerge	88%	87%	95%	91%	83%	55%
Rate of team hitting mobility target	No Targets Set pre-Emerge	47%	62%	59%	61%	58%	45%
Days to first PT session (mean)	2.6	3.2	2.5	2.5	2.8	3.3	2.2
Days to first PT session (median)	2	1.5	1	1	2	2	1
ICU days with mobility treatment	15%	20%	22%	23%	26%	22%	25%
PT Mobility Sessions	24%	22%	38%	34%	37%	29%	36%
OT Mobility Sessions	12%	4%	14%	9%	18%	11%	18%
RN Mobility Sessions	28%	28%	20%	26%	28%	24%	29%

Figure 3. Patient mobility at baseline in 2013, compared with data from 2014 to 2015 with the use of the tablet application Emerge.

	Declined	Did not decline	Total
Baseline	45	195	240
Emerge Pd.	20	179	199
Total	65	374	439

Figure 4. Baseline vs. Emerge Q2-2015 period. "Declined" means categorical mobility function at discharge was lower than categorical mobility function upon entering the hospital. "Didn't decline" means categorical discharge function was equal to or better than function upon entering the hospital (Carolan).

4 Conclusions

Prior to the Emerge initiative to increase patient mobility, there was no target set to increase mobility in ICU patients. With the addition of Emerge and the focus on patient mobility in improving health and status of ICU patients, the providers were able to increase the number of patients working with physical therapy and assist patients in achieving daily target goals.

When taking care of patients in the ICU it was previously emphasized that this patient population was too sick to mobilize and there was a fear that moving patients would not be beneficial (Sapirstein, 2016). However, this in fact leads to more harm in the patient and mobility has a large impact on patient wellness and recovery. The significant p-value of 0.0106, in observing declined versus did not decline in mobility function, prior to admission as compared to discharge, demonstrates the ability of Emerge to improve patient mobility while in the ICU. By taking action and providing patients with daily goals along with physical therapy and occupational therapy ICU acquired weakness is reduced.

5 Future Directions

Future directions for systems engineering and the ICU include, the upcoming projects including the insulin pump and pressure ulcer prophylaxis projects. The results from this project indicate that systems engineering can improve the care of patients in the SICU and improve safety and quality of care. Improving medication administration and preventing skin breakdown in this population is another direction in improving patient care!

6 References

Sapirstein, A. (2016, May). Project Emerge – Final Report Johns Hopkins Medicine Prepared for the Gordon and Betty Moore Foundation

Tropello, S., Ravitz, A., Romig, M., Pronovost, P., & Sapirstein, A. (2013). Enhancing the Quality of Care in the Intensive Care Unit- A Systems Engineering Approach. Critical Care Clinic, 29, 113-124. Retrieved from http://www.criticalcare.theclinics.com/article/S0749-0704(12)00086-3/pdf

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