Executive Summary

Hawaii Pacific Health is a not-for-profit health care network of hospitals, clinics, physicians and care providers dedicated to the mission of improving the health and well-being of the people of Hawaii and the Pacific Region. Anchored by its four hospitals—Kapi‘olani, Pali Momi, Straub and Wilcox—Hawaii Pacific Health includes more than 50 convenient locations and service sites statewide. All inpatient and ambulatory facilities are supported by a single instance of the Epic electronic health record.

In 2012, Hawai’i Pacific Health identified early identification and treatment of sepsis as a major area of focus for improving care and reducing average lengths of stay. Subsequently, sepsis teams comprised of physicians, nurses, quality specialists, data abstractors, information technologists, lab specialists, and statisticians were formed at three of our hospitals to drive improvements through order sets and alerts under the direction of our clinicians using the best practices algorithms from High Value Healthcare Collaborative.

After much focused effort, length of stay (LOS) for all sepsis patients improved from 11.32 days in 2012 to 9.74 days in 2016 (p<0.0003). We saw similar positive trends for severe sepsis and septic shock patients, with a LOS decrease from 15.33 days in 2012 to 12.80 days in 2016 (p<0.0029). Raw mortality for all sepsis patients decreased from 13.75% in 2012 to 9.89% in 2016 (p<0.0001). Similarly, for severe sepsis and septic shock patients, raw mortality decreased from 31.37% in 2012 to 22.91% in 2016 (p<0.0001). While the decrease in rates is significant, we find it more compelling to recognize that the improved care resulted in 275 people who survived their sepsis event, who would not have survived if the improvements had not been implemented.
Background Knowledge

In 2008, Hawai‘i Pacific Health (HPH), as part of a corporate strategic initiative to transform health care in Hawai‘i, set a 5 year goal of creating an accountable care organization in partnership with our largest local commercial insurance company. The goal would be to improve quality of care while mitigating increasing medical costs. A necessary outcome would be reducing unnecessary utilization.

To offset the costs of implementation and the lost revenue from reduced utilization in a largely fee for service market, HPH committed to aggressive goals of reducing CMI-adjusted average lengths of stay for all hospitals. In evaluating options for achieving this, sepsis treatment was identified as a key initiative as we had reports identifying it as a target with higher than expected lengths of stay.

Local Problem

Sepsis in adults is responsible for nearly 1 million admissions to United States hospitals annually. It accounts for 20% of all intensive care unit (ICU) admissions and up to 50% of all deaths in the ICU. It is likely the third most common cause of death in our country and is the admission diagnosis with the highest cost. Importantly, time sensitive interventions can dramatically improve patient outcomes, thus mandating proper sepsis care. Due to the magnitude of the problem, the Center for Medicare and Medicaid Services (CMS) sharpened their focus on sepsis care by instituting the first sepsis-related core measure on October 1, 2015. However, even prior to this, hospital engagement collaboratives such as the High Value Healthcare Collaborative (HVHC), of which Hawai‘i Pacific Health has been a member since 2012, instituted the Surviving Sepsis Campaign’s 3-hour bundle (which includes prompt administration of fluids, antibiotics after blood culture, and measurement of lactic acid levels) in order to improve the care provided to septic patients.

When we began this work in 2012, we identified issues with our sepsis length of stay and mortality rates, both of which needed improvement. [Figures 1 & 2]
Upon examining our workflow with sepsis patients, several process issues were revealed. For instance, documentation of total volume of fluid ordered for patients in the Emergency Department (ED) with suspected sepsis as well as documentation of actual amount of fluid infused was difficult to consistently locate in the patient chart. In addition, the timeliness of completion and adherence to all elements of the 3-hour bundle was a challenge. Although we could measure blood culture, lactic acid, and antibiotic administration, we found we could not

Figure 1. Average length of stay for all sepsis discharges prior to inception of sepsis work.

Figure 2. Raw mortality rates for all sepsis discharges prior to inception of sepsis work.
accurately measure compliance with the complete bundle within 3 hours. In addition, while most of the severe sepsis/septic shock patients were located in the ED at the time of meeting sepsis criteria, even if the sepsis care was appropriately started in the ED, sepsis care plan components were sometimes lost when the patient was transferred to the ward or intensive care unit (ICU).

**Design and Implementation**

In order to provide the best care for our sepsis patients and to address issues of compliance with sepsis bundles, a sepsis initiative was developed at the system level. Subsequently, sepsis teams were formed at three of our hospitals. The inter-professional teams were comprised of physicians, nurses, quality specialists, data abstractors, Information Technologists (IT), lab specialists, and statisticians.

Initial sepsis work began with the development of order sets at the direction of our clinicians using the best practices algorithms from HVHC. However, we did not see significant change in practice due to limited early adoption. [Figure 3]

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**Figure 3.** Timeline of process improvement effort milestones to improve care for sepsis patients at Hawai‘i Pacific Health. UTI=urinary tract infections, PNA=pneumonia, Cell=cellulitis.
In order to monitor progress with implementation, the multidisciplinary Clinical Data Reporting team (CDR) extracted data, developed and refined data marts/dictionaries and facilitated regular reporting to clinicians and others involved in the process in parallel. Our timely change cycles as part of the CDR process captured information about current practice. The data was then used to inform and motivate our teams, allowing improvement of the frontline tools in an iterative fashion. The work performed by the CDR was a truly collaborative effort, combining the expertise of many disciplines from our organization: clinicians, inpatient business analysts, Health Information Management (HIM), reporting teams, and patient safety and quality experts working together in real time. This approach facilitated efficient and effective communication, problem-solving, and decision making. [Table 1 and Figure 4]

Table 1. Roles of Clinical Data Reporting team members mapped to steps of process.
How Health IT Was Used

Our first IT tool to improve sepsis care was sepsis specific order sets, designed to deliver best practice care. We had been in the habit of creating order sets for various clinical conditions, so our clinicians naturally chose this approach. Although the order sets created were expected to be useful, we found there was very little adoption in spite of communication about their availability. Analysis revealed that infection specific order sets that had not been modified for sepsis care were chosen instead. Ultimately, we modified all of the commonly used infection-specific order sets to include best practices for sepsis care and that led to some success with adoption.

During the initial planning phase and while the teams were being developed, an innovative use of an EHR functionality allowed us to measure our true performance related to identification of potential sepsis patients as well as workflow issues and barriers to providing and measuring best care practices. We developed EHR-imbedded Best Practice Alerts (BPA) triggered by early sepsis criteria for patients in the Emergency Department (i.e. vital signs, mental status, and lab results). [Figure 5]. These BPAs were initially “run” in the background only and front line clinicians did not receive alerts until we were assured of clinical validity, a process that took several months. Running the BPAs in the background allowed a small team to trial using blood culture orders as a marker for suspicion of infection, and to see how different vital sign thresholds or other clinical markers performed in terms of accuracy compared to final diagnosis of the patient. This process allowed us to identify differences in practices among the hospitals within the system, which led to learning and willingness to improve. For example, initially, one of the sites did not utilize a
“suspected infection” screening question on ED triage; the accuracy of BPA firing for sepsis and severe sepsis patients at this site was notably less than for the other sites (e.g. for sepsis, 29.4% vs. 50.4 and 63.3% for the other two sites). Based on this data, the site modified the workflow in triage to include the “suspected infection” screening question. Fine-tuning alerts prior to activation helped to avoid alert fatigue and promoted clinician acceptance of prompts for best practice. [Appendix Figure 1, titled “Sepsis Protocol Flowchart”]

Once assured the BPAs were clinically accurate, we made them visible to clinicians caring for patients who met criteria for sepsis or severe sepsis. Reporting the results [Table 2] to clinicians promoted initial willingness to use the tools provided. The data indicated that the BPAs were firing more accurately for our severely septic patients than the sepsis patients, though both groups had good sensitivity/specificity and positive predictive value/negative predictive value. Our strong results were likely due to the continuous process improvement efforts made by the sepsis and CDR teams.

Figure 5. Emergency Department Best Practice Alert

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Value-derived/Outcomes

Length of stay (LOS) for all sepsis patients improved from 11.32 days in 2012 to 9.74 days in 2016 (p<0.0003) [Figure 6]. In addition to results demonstrated in Figure 6, we saw similar positive trends for severe sepsis and septic shock patients, with a LOS decrease from 15.33 days in 2012 to 12.80 days in 2016 (p< 0.0029) [Figure 7]. Raw mortality for all sepsis patients decreased from 13.75% in 2012 to 9.89% in 2016 (p<0.0001) [Figure 8]. Similarly, for severe sepsis and septic shock patients, raw mortality decreased from 31.37% in 2012 to 22.91% in 2016 (p<0.0001) [Figure 9]. Diligent efforts continue to decrease sepsis mortality even further.

Multiple factors contributed to improving the care of sepsis patients at our hospital since instituting the 3-hour bundle as part of the HVHC work begun in 2012. The true improvement occurred after we fully implemented tools in the EHR (both the order sets and the BPAs). Full implementation of the order sets and the BPAs enabled our front line providers to provide the timely evidenced-based care that saved the lives of patients with sepsis, as evidenced by our improved mortality rates.

<table>
<thead>
<tr>
<th>BPA Firing Accuracy</th>
<th>Sepsis</th>
<th>Severe Sepsis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity: BPA fired when patient had sepsis</td>
<td>69.3%</td>
<td>79.6%</td>
</tr>
<tr>
<td>Specificity: BPA didn’t fire when patient didn’t have sepsis</td>
<td>98.9%</td>
<td>98.2%</td>
</tr>
<tr>
<td>Positive Predictive Value: when BPA fired patient had sepsis diagnosed</td>
<td>50.3%</td>
<td>67.9%</td>
</tr>
<tr>
<td>Negative Predictive Value: when BPA didn’t fire sepsis was not diagnosed</td>
<td>99.8%</td>
<td>99.9%</td>
</tr>
</tbody>
</table>

Table 2. Firing accuracy of the Best Practice Alerts for sepsis and severe sepsis patients (as determined by prediction of final discharge diagnoses).
Figure 6. Average length of stay for all sepsis patients in the pre-intervention and post-intervention periods.

* Pre vs. post ALOS rate = 11.32 vs. 9.74, p<0.0003

Figure 7. Average length of stay for severe sepsis and septic shock patients in the pre-intervention and post-intervention periods.

* Pre vs. post ALOS rate = 15.33 vs. 12.80, p<0.0029
Figure 8. Raw mortality data for all sepsis patients in the pre-intervention and post-intervention periods.

* Pre vs. post mortality rate = 13.75 vs. 9.89, p<0.0001

Figure 9. Raw mortality data for severe sepsis and septic shock patients in the pre-intervention and post-intervention periods.

* Pre vs. post mortality rate = 31.37 vs. 22.91, p<0.0001
Lessons Learned

Our focus on sepsis began when we were looking for clinical areas in need of improvement in length of stay. We had information that demonstrated that we had opportunities in sepsis care. Length of stay was a target because we were looking for opportunities to improve our margin to assist with the change from fee for service to population-based care. In addition, our mortality rates were poor compared to those reported by leaders in the field.

We had previously created a clinical leadership structure, called the Clinical Guidance Committee, for our four hospitals that was useful to charter a system-wide improvement in the area of sepsis care improvement. This gave us the ability to start at a system-wide level as we created effective tools to be used at all hospitals. This approach varied from those reported by other healthcare facilities where individual units were used to pilot best sepsis care. We thought that all of our patients deserved to benefit from the improvements as soon as possible.

We started the improvement process by trying to understand our current care of sepsis patients. We were disappointed to uncover some very basic problems in documentation that needed to be fixed before we could have accurate measurement. Variation among our sites was useful in motivating change. Once we had the basics in place, we used the silent, behind the scenes measurement of timely identification of potentially septic patients using the Best Practice Alerts. Teamwork between front line clinicians, quality improvement staff, and IT experts allowed us to make changes and efficiently measure the impact of those changes.

We found that being able to present information about our own practice compared to best practice was at a minimum intriguing and in the best case, convincing. When desired, the front line clinicians reviewed patient charts to confirm the clinical accuracy of the data being presented. This culture of inquiry got us past the hurdle of “Do we need to change?” and promoted teamwork to effect improvement.

Once we had buy-in from the clinical teams who were involved early on, we then had each hospital charter and manage a facility-specific team to look at their own unique workflow and process issues (e.g. there were variations in nursing roles, how labs were drawn and resulted, and in transfer of patients from ED to the inpatient units). The hospital teams used the same data sources and tools to inform and improve their work. In order to hard-wire the process improvements, we have both system-wide and facility specific meetings to monitor, sustain, and fine-tune the improvements with regular reporting back to the clinical guidance committee and the executive leadership team.

Financial Considerations

The investment of health IT and the electronic health record infrastructure was already in place prior to this work. No new financial outlays were made to support this work. Clinical staff and others who worked on improvement teams contributed to this work as part of their usual clinical duties.

Analysis of our sepsis patients in the pre-intervention period of 2012 and 2013 revealed positive margins of an average $9500 per patient. In the post intervention period (2014 - 2016), the average per patient margin was $13,300. This improved margin is because most of our
payments are DRG-based so reducing our internal costs through shorter hospital length of stay improves the net margins. This reduction in length of stay was presumably caused by quicker clinical recognition, appropriate level of care, and evidence based interventions. Our reduction in mortality gives us reassurance that patients clearly benefitted from our interventions. During this period, we demonstrated a nearly 60% increase in the number of sepsis patients identified by administrative data. This increase reflects a national trend in the incidence of sepsis. It also reflects an increased clinical recognition of sepsis in patients who were previously thought to have a limited infection (such as pneumonia) but who in fact met the criteria for sepsis, and are now recognized and appropriately treated for their more severe condition.
Appendix Figure 1
Sepsis Flow Chart

LEGEND
- Green: Start of Pathway
- Blue: IT Process
- Orange: End of Pathway

Patient Arrives as a Walk-In

RN Performs Triage

Did the Vitals BPA trigger?

YES

Initiate RN Sepsis Protocol

Blood Culture CBC w/Diff Lactate results are returned

Did the Sepsis BPA Trigger?

YES

Clinician Responds: Diagnosis Unlikely BPA off: 3 days

Clinician informs attending clinician about sepsis alert

Patient Treated Accordingly

NO

Clinician Responds: Treatment Underway BPA off: 7 days

Clinician Responds: Will Evaluate Patient BPA off: 3 hour

Clinician Responds: Initiate Recommendations BPA OFF 7 days

Does clinician believe patient is septic?

YES

Is patient septic?

YES

Sepsis orders set with pre-selected ABX, Fluid and transfer orders

Patient is treated accordingly

NO

Patient Treated Accordingly

Patient treated for sepsis

Patient is treated accordingly

NO

Does RN suspects sepsis?

YES

Patient is accessed further

NO