

System-Wide Evaluation of a Sepsis Bio-Surveillance Alert Application

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Introduction and Problem Statement

Age is an important risk factor of mortality for patients with sepsis (Martin-Loeches et al., 2019). Electronic Bio-surveillance systems used to track sepsis have a high sensitivity and specificity for early recognition of sepsis (Alsolamy et al., 2014). The current literature evaluating compliance and the clinical effectiveness of these applications in the older population is limited (Alsolamy et al., 2014). A multistate community hospital system implemented the SAS Insights® Bio-surveillance application in 2016 to track patients with sepsis and send EMR alerts to nurses to notify them of a patient who is at risk or has developed sepsis. The goal is that nurses will notify the provider of this alert within 60 minutes. Of the 34 acute care hospitals, the rate of nurse-provider notification varies from 19% to 81%. At this time, it is unclear what barriers impact nurse compliance to alerting the provider of the SAS Insights Bio-Surveillance alert within the multistate community hospital system. For the remainder of this paper this multistate community hospital system will be referred to as “the hospital system.”

Background

Sepsis is a considerable cause of morbidity and mortality in the United States. According to the Center for Disease Control (2020), each year 1.7 million adults in America develop sepsis with over 270,000 Americans dying (Center for Disease Control [CDC], 2020). The literature suggests that 60% of sepsis diagnoses are in the older patient population and increasing age is associated with an increased risk for mortality (Martin-Loeches et al., 2019; Nasa et al., 2012; Rowe & McKoy, 2017). Electronic Bio-surveillance applications are being used to identify early signs of sepsis which leads to initiation of early goal-directed therapy (EGDT), as recommended

by the Surviving Sepsis Campaign (SSC) (Alsolamy et al., 2014). Studies have also shown that early recognition of sepsis and implementation of early goal-directed therapy, when implemented together improve outcomes in patients with sepsis (Mcree et al., 2014; Rhodes et al., 2016). Early recognition by sepsis alert systems and early initiation of therapy is important to improve outcomes in older patient populations (Nasa et al., 2012). To date, literature reviewing the effects of these alert systems on older populations is limited. Understanding the SAS Insights Bio-surveillance application's effects on older patients at risk of developing sepsis within the hospital system, can help improve sepsis rates and mortality related to sepsis in this population.

The hospital system implemented the SAS Insights Bio-Surveillance application in 2016, allowing them to monitor 120,000 lives per month in 34 hospitals (Beall, n.d.). The Sepsis Bio-Surveillance Program combines continuous patient monitoring, big data analysis, proactive alert notifications, and tracking of process measures through a single sepsis application (SAS Insights, n.d.). The program collects data from the EMR and "uses natural language processing and a rules engine to monitor factors that could indicate a sepsis infection" (Beall, n.d.). When a patient is rated a high-probability sepsis case based on the application algorithm, the system sends an EMR notification to the primary nurse, and the primary provider is then ideally notified within 60 minutes to start early goal-directed therapy (Beall, n.d.). Since the implementation of this application, there has been significant improvement in sepsis-related mortality and ICU length of stay (Beall, n.d.). The hospital system's implementation of the SAS Insights Bio-surveillance application has decreased the average rate of severe sepsis by 14.9% and decreased the average mortality rate for all patients with sepsis by 7.25% (Brown, 2016). It

is unclear, whether this sepsis tool works equally across all age groups, particularly those above the age of 60.

Various nursing barriers to using sepsis alert systems may play a role in decreased compliance to these applications which leads to worse outcomes (Peterson et al., 2016). Because the bedside nurse is critical for initiating the first step in identifying the alert and notifying the provider, nurse compliance is essential for the success of the alerting system. Common nursing barriers related to alert systems include inadequate training, negative perceptions of the application, a culture of nonadherence, slowing workflow, alert fatigue, and negative experiences when warning the provider of the application trigger (Foley & Dowely, 2018; Harrison et al., 2016; Peterson et al., 2016; Peterson et al., 2017; Smith & Aitken, 2015). Assessing specific nurse barriers to using the SAS Insights application at the hospital system could be useful to understand ways to improve compliance with the SAS Insights application and improve outcomes and mortality related to sepsis for high-risk populations such as older patients.

Specific Aims

This project has six specific aims:

1. To determine the mortality rate of patients over 60 years of age compared to patients aged 18-58 with sepsis at 34 hospitals within the hospital system.
2. To determine associations between sepsis-related mortality rates and nurse compliance with the SAS Insights Bio-surveillance alert. Nurse compliance is defined as notifying the primary provider of the SAS Insights alert within the 60-minute mark.

3. To compare SEP-1 bundle compliance rates to sepsis-related mortality in all patients.
SEP-Bundle compliance is defined as providers who initiate the Surviving Sepsis Campaign Hour-1 bundle (measure lactate level, obtain blood culture before starting antibiotics, administer broad-spectrum antibiotics, being rapid fluid resuscitation at 30ml/kg, initiate vasopressors for hypotension to maintain MAP >65) within the 60-minute mark
4. Survey 5-6 nurses at each of the 34 hospitals to assess for nurse barriers that affect nursing compliance with the SAS Insights Bio-surveillance application. And to assess alternative methods of tracking sepsis besides the SAS Insight app (ie: paper tracking, early warning scores, etc.).
5. To compare nurse's perceived compliance rate to system-wide nursing compliance data to assess for misperceptions in perceived nurse compliance.
6. To provide a written proposal of recommendations based on findings to the hospital system.

Approach to the Conduct of the Project

Theory

This QI project will use the Donabedian Model for evaluating the quality of care of older patients with sepsis and severe sepsis. There are three components to the Donabedian model which include Structures, Processes, and Outcomes (Ayanian & Markel, 2016). Structures of the Donabedian Model refer to how care is delivered and include factors such as physical facilities, staff, and equipment utilized (Ayanian & Markel, 2016). The process component includes all actions that make up healthcare and the interaction that occurs between patients and staff

(Rupp, 2018). These include diagnosis, treatments, preventative care, and education (Rupp, 2018). Lastly, the outcome components refer to the future and current changes in the patient's health (Rupp, 2018). The specific outcome includes factors such as morbidity, mortality, cost, and quality of life (Rupp, 2018).

For this QI project, the structure measures in place are the hospital system's medical surgical and telemetry units, the SAS Insights Bio-surveillance application technology, compliance and mortality datasets, and the nurses and providers who utilize the application. The process measures include the patients admitted to the hospital, correct vitals being taken by nurses, the alert triggering, making the diagnosis of sepsis, the percent of nurses informing the primary provider that the SAS Insights alert was triggered, and the percent of primary providers that implemented the SEP-1 bundle within 60 minutes. Lastly, the outcome measures include sepsis-related mortality rates of those aged 18-59 compared to > 60 years old, older patients.

Setting

The QI project will take place in the acute care setting of 34 hospitals throughout Arizona, Nevada, California. This hospital system is a combination of large urban and small rural facilities.

Participants

The primary participants in the QI project will be medical surgical and telemetry bedside nurses overseeing patients who develop sepsis within the hospital system. These individuals were chosen because they are a part of the care team primarily overseeing patients who develop sepsis. Quarterly data will be collected from 2018 through 2019. This time period was

chosen so that the data would not be affected by COVID-19. Institutional Review Boards (IRB) from the hospital system and Oregon Health & Science University determined this project did not meet the criteria for human subject research under the purview of the IRB according to federal regulations.

Implementation of Project

Methods

Three evaluation questions were created using the Donabedian model to further evaluate the SAS Insights Bio-surveillance application. These evaluation questions were the following:

1. Evaluation Question 1: How does app compliance impact mortality rates in elderly patients? (Donabedian Model: Outcomes)
2. Evaluation Question 2: What barriers do nurses face that contribute to decreased compliance of using the SAS Insight Bio-surveillance App to help screen for sepsis? (Donabedian Model: Structures and Processes)
3. Evaluation Question 3: What other methods are individual hospitals within the hospital system using to track sepsis?

Evaluation Question 1 had three components that were assessed for statistical significance. First, a sepsis-related mortality dataset from calendar year 2019 for patients aged 18-59 was compared to sepsis-related mortality dataset for patients aged >60. The online statistical tool VassarStats (<http://www.vassarstats.net>) was used to compare means and confidence intervals between two different independent populations. A p-value of less than <0.05 was considered significant. Second, the relationship between SEP-1 Bundle compliance

and sepsis-related mortality was evaluated using overall observed/expected (O/E) mortality rates vs SEP-1 Bundle compliance rates from calendar year 2018-2019. This data was also evaluated using linear regression from the online statistical tool VassarStats (<http://www.vassarstats.net>). A p-value of less than <0.05 was considered significant. Third, nursing compliance rates from 2019 were compared to the same overall O/E mortality rates as above from 2019. This data was also evaluated using linear regression from the online statistical tool VassarStats (<http://www.vassarstats.net>). A p-value of less than <0.05 was considered significant.

Evaluation Questions 2 and 3 were answered using a Survey Monkey survey with careful evaluation of each question response (Please see Table A). These responses were then compared to evidence-based literature on common nursing barriers to implementing new projects and guidelines (Fischer et al., 2016). Please see methods sections Survey Design, Survey Distribution and Response Rates, and Survey Participation Selection below.

Survey Design

The 16 question SurveyMonkey survey was created to assess nursing barriers to using the SAS Insights Bio-surveillance application (Please see Table A). This survey was created to understand barriers that could affect nursing compliance rates at each of the hospitals. Nursing compliance was defined by how often the nurse notifies the provider that an alert had triggered.

Survey questions were created based on prior program evaluations of the SAS Insight Biosurveillance application as well as common nursing barriers related to alert systems found in the literature (Foley & Dowely, 2018; Harrison et al., 2016; Peterson et al., 2016; Peterson et

al., 2017; Smith & Aitken, 2015). Several meetings with various stakeholder members were held to discuss content validity and the creation of relevant survey questions (Tiruvoipati et al., 2010). The first three survey questions (listed in the project proposal) were used to help track which hospitals were responding to the survey and where to send follow-up emails. Survey questions 4-6 were used to track nurse knowledge and compliance to the alert system. Stakeholders determined nurses could end the survey after question 6 if they notified the physician of an alert > 90% of the time. The hospital system had previously evaluated the SAS-Insights Bio-surveillance application system and noted that nurses were inadequately trained, had poor perceptions of the alert, and experienced negative interactions with provider notification. Survey questions 7-16 were created to further evaluate these findings as well as other contributing barriers. Don Dillman's Guiding Principles for Mail and Internet Surveys was used to tailor survey design (Dillman et al., 2009).

Survey Distributions and Response Rates

The survey was distributed on February 9th, 2021 to Clinical Nurse Officers (CNOs) at each of the 34 hospitals with the goal of it being forwarded to at least 5-6 of their medical surgical and telemetry nurses (170 total nurses) for completion. There was no cost to send out the survey.

Typical organization survey response rates range from 37.2-52.7% with a survey response rate goal of >60% to limit nonresponse bias (Baruch & Holtom, 2008; Fincham, 2008). Two email reminders were sent to the CNOs with the goal of reaching 110/170 nurses from 22/34 (65%) of the hospitals. By the end date of Feb 19th, there were 60 survey responses from 17/34 (50%) of the hospitals. The survey was extended one week. On March 1st the unmodified

survey was sent again to CNOs and was closed on March 11th with 106 (62%) responses from 21/34 (62%) of the hospitals.

Survey Participant Selection

A total of 106 responses were received from 21 different hospitals. Of the 106 responses, 17 responses were not from medical surgical and telemetry nurses and 6 did not fully complete the survey, leaving 83 responses for analysis. Of the 83 respondents, 79 (95.2%) reported that they are aware of the SAS Insights Bio-surveillance alert. Seventy-four (89.2%) of participants stated they were aware of the process to be completed when the sepsis alert triggers. Sixty (72.3%) of the respondents stated they almost always (>90% of the time) notify the provider after an alert goes off, therefore the survey ended for these participants. See Figure 1 for details.

Analysis, Outcomes, and Recommendations

Evaluation Questions #1: How does SAS Insights Bio-surveillance application compliance impact mortality rates in elderly patients? (Donabedian Model: Outcomes)

O/E mortality is a risk-adjusted measure of a hospital's mortality that is commonly used to compare individual hospital mortality to expected mortality based on statistical models (Bottle et al., 2010). The hospital system currently uses Midas Risk Adjusted Model, which assigns probabilities and expected values to individual patient encounters for variables such as the following: mortality, length of stay, 30-day unplanned hospital readmissions, complications, ages, and individual relative weights (Midas Health Analytic Solution, 2017). It also creates probabilities and expected values based on the patient's age, diagnosis, gender, procedures, and comorbid conditions (Midas, 2017).

The sepsis mortality rate for patients >60 years old within the hospital system was significantly higher than those aged 18-59. (4,527/41,830 or 10.82% [95% CI 10.53% to 11.12%] v. 1,049/23,284 or 4.51% [CI 95% 4.25% to 4.78%], $P < 0.001$). The hospital system's sepsis mortality rate of 10.82% from 2018-2019 for patients aged 60 or greater is relatively lower than national mortality rates in older patients of 30-60% and up to 40-80% in those > 80 years old (Ignacio Martin Loeches et al., 2019; Nasa et al., 2012; Rowe & Mckoy, 2017). The lower mortality rate within the hospital system could be explained by the more recent initiation of the SAS-Insights Biosurveillance application.

Based on sepsis-related mortality data from 2018-2019 O/E sepsis-related mortality was also strongly correlated with quarterly Sep-1 bundle compliance ($P < 0.001$, Graph 1). However, quarterly nurse compliance data from 2019 and the O/E mortality data from 2019, demonstrated that increased nurse compliance with notifying the physician of the SAS Insights Bio-surveillance alert, only mildly trended towards a decrease in O/E sepsis mortality ($P=0.4$, Graph 2). The data comparing nurse compliance to sepsis-related mortality was not statistically significant although showed a mild trend towards improving mortality. Several reasons may explain these results.

1. SEP 1 compliance criteria may have been met when the patient was in the emergency department but the alert had not been acknowledged by the nurse.
2. The nurse did not notify the provider of the alert due to previous negative interactions with providers regarding the alert (Survey Question 13).
3. The nurse may have notified the provider but was using another sepsis tracking system (Survey Question 15).

4. The nurse may have notified the provider but the alert was not acknowledged within the appropriate time limit.
5. Improvement in mortality may depend on both nurse compliance with provider notification of an alert as well as provider compliance with implementation of SEP-1 Bundle. Provider compliance with SEP-1 Bundle was most strongly associated with mortality reduction/improvement. However, further mortality reduction may be seen with enhanced nursing compliance and timely provider notification.
6. Increasing the monitoring period for longer than one year may yield better statistical significance in results.

Although nursing compliance did not directly correlate with mortality, nursing notification to the provider appears to be a key step in the initiation of SEP-1 bundle and was correlated with improved mortality. However, nursing staff is currently underutilizing this sepsis alert tool for a variety of reasons (see findings below). Further enhancement of nursing compliance might improve sepsis-related mortality. Several recommendations are provided to improve nurse compliance, and once implemented, subsequent evaluation of how nursing compliance affects mortality rates should be analyzed.

Evaluation Question #2: What barriers do nurses face that contribute to decreased compliance of using the SAS Insight Bio-surveillance application to help screen for sepsis?

Please see analyses labeled: “System-wide Analysis” and “Individual Hospital Analysis” below.

Evaluation Question #3: What other methods are individual hospitals within the hospital system using to track sepsis?

This will be addressed within the analysis of evaluation question number 2.

System-Wide Analysis and Recommendations

Based on the survey results of the 23 nurses who do not regularly notify their provider of the SAS Insights Bio-surveillance alert and went on to complete the full survey, the following conclusions and recommendations were made. Analysis of Question 1 and 2 demonstrated that nearly 20% of nurses don't understand the primary function of the SAS Insights Bio-surveillance alert and almost 40% felt they did not have adequate training related to the alert use. (Please see Table 1 for details).

Implementation of the SAS Insight Bio-surveillance alert within the hospital system was associated with reduced sepsis-related mortality (Beall, n.d). This implementation also decreased the average rate of severe sepsis by 14.9% and the average mortality rate for all patients with sepsis by 7.25% (Brown, 2016). Improving nursing knowledge and utilization of the SAS Insights Bio-surveillance alert to >95% may further reduce sepsis-related mortality.

When implementing and attempting to increase awareness of new guidelines and protocols, the first step is to assess barriers to implementation (Fischer et al., 2016). This survey was conducted to assess nurse barriers to using the SAS Insights Bio-surveillance alert. A better-tailored implementation strategy can be conducted by understanding nursing barriers to notifying the provider of an alert (Fischer et al., 2016). The conclusions from Question 1 and 2, suggest the potential nurse barriers are *lack of awareness and lack of familiarity*.

Several methods have been shown to improve nursing and provider awareness when implementing guidelines (Fischer et al., 2016). These include dissemination of educational material through social media, staff emails, posters, flyers, and online training modules (Fischer et al., 2016; Gagliardi & Alhabib, 2015). Implementing educational meetings during nursing huddles and providing individualized feedback on group performance has been shown to increase staff awareness of new protocols (Fischer et al., 2016). It is also recommended that incentives be used like offering CME credit for staff who complete the in-person or online training (Fischer et al., 2016). Repetitive reinforcement is important to implement once staff awareness has improved (Fischer et al., 2016). The literature also suggests making protocols and guidelines simple and easily accessible (Gagliardi & Alhabib, 2015).

A recommendation based on survey responses from analysis Questions 1 and 2 is to post educational flyers which include overall hospital compliance in key staff work areas (See Sample Flyer 1). Individual nursing results should be provided confidentially to each nurse so they could compare their own results to hospital averages. Updating the hospital compliance rate on a weekly or monthly basis, and including the 95% compliance goal is also recommended (Fischer et al., 2016). (Please see Table 2 for details).

Analysis of Questions 3 and 4 demonstrated that almost half of the nurses do not believe the SAS Insights Bio-surveillance application improves patient care related to sepsis. These nurses also reported their colleagues (nurses, APP, physicians) don't believe the SAS Insights Bio-surveillance alert is associated with improved patient care related to sepsis. These findings suggest *lack of outcome expectancy* as another nursing barrier to using the SAS Insights Bio-Surveillance alert system. *Lack of outcome expectancy* is a common barrier to guideline and

protocol adherence in healthcare (Joosen et al., 2015). Nurses and providers may feel capable of performing specific protocols, but they believe it will not affect patient outcomes (Joosen et al., 2015).

The SAS Insights Bio-surveillance application is associated with improved sepsis-related mortality (Beall, n.d). Providing staff with this information would improve negative perceptions around using the application (Fischer et al., 2106). Including individual hospital-specific data on alert compliance and mortality compared to other hospitals with higher compliance would also help improve awareness and self-efficacy (Fischer et al., 2016). (Please see Table 2).

Analysis Question 5 suggests nearly a third of nurses believe their clinical judgment is superior to the SAS Insights Bio-surveillance alert. Artificial intelligence (AI) applications such as machine-driven prediction algorithms, similar to the SAS Insights Biosurveillance application, have been found to aid nursing critical thinking and have a positive impact on patient care (Carroll, 2019). Artificial intelligence applications along with nursing critical thinking work synergistically and are associated with improved speed and accuracy of changes in patient clinical status (Carroll, 2019). This information should be included in education given to nurses and their colleagues (nurses, APP, physicians) who believe their clinical judgment is superior to the alert system (Please see Table 2).

Analysis Question 6 found that over 80% of nurses felt that utilization of the alert does not negatively affect their daily workflow. Clinical information systems and AI applications can change clinical work patterns which can negatively affect nursing workflow and worsen quality of patient care (Lee & Mcelmurry, 2010). The literature suggests any adverse consequences to nursing workflow that a clinical information and alert system causes should be identified and

eliminated (Lee & Mcelmurry, 2010). Based on the results of this survey, the SAS Insight Bio-surveillance alert does not negatively affect nursing workflow therefore, this finding should be included in educational training materials to improve compliance with the application. (Please see Table 2).

Analysis Question 7 and 8 found that two-thirds of nurses experience negative interactions when informing their provider of the alert. The reasons reported were the following: trigger fatigue, provider believes their judgment is superior to the alert, provider doesn't believe alert improves patient care. The nursing barrier *lack of collaboration and alert fatigue* were identified from these findings. Alert fatigue remains a significant issue for many automated alert systems (Harrison et al., 2016). The alert frequency and deactivation process when a patient is diagnosed with known sepsis needs to be evaluated to address this barrier. Clearly written protocols on the proper documentation process to stop the alert from further "firing" once the provider has been notified should be provided (Fischer et al., 2016). Easier access to the protocols can be achieved by providing small laminated cutouts and attaching them to nursing computers and workspaces (Fischer et al., 2016) (Please see Figure 2 Sample Protocol). Eliminating the unnecessary firing of the alert in patients with known sepsis will help decrease alert fatigue for staff which will in turn improve nursing compliance (Lee & Mcelmurry, 2010).

Current literature suggests that providers are frequently reluctant to use algorithmic approaches because it takes away from their autonomy, clinical expertise, and patient values despite numerous studies that show standardized sepsis protocols significantly improve patient outcomes (Polacek et al., 2020; Surviving Sepsis Campaign, n.d). Including this evidence-based

data in teachings could help improve some provider's negative perceptions of the SAS Insights Bio-surveillance alert system. It is also important to reinforce provider education related to utilization of the alert and its positive impacts on mortality (Beall, n.d). This could be accomplished through provider-specific educational posters and flyers in workspace and break rooms, online and in person training modules with CME credit, educational review during team and change of shift huddles, and educational emails.

Effective provider-nurse communication is imperative for safe patient care (Hettinger et al., 2020). Multidisciplinary training allows each profession to better grasp the roles and responsibilities of their colleagues in comparison to their own roles and responsibilities (Lyndon et al., 2011). Provider education and reinforcement about the SAS Insights Bio-surveillance alert system should be combined with nursing education to ensure that providers understand reasons for nurses contacting them about the alert system. This may eliminate further frustration with increased nursing pages and phone calls. Early verbal communication is best practice as it allows for a two-way conversation as opposed to signing a note (Hettinger et al., 2020; Lyndon et al., 2011). Providers should not assume electronic orders substitute for verbal communication. Nurses prefer to be updated verbally if possible (Hettinger et al., 2020). (Please see Table 2).

Analysis Question 9 found that almost 40% of the nurses reported using other sepsis tracking methods "very often" or "sometimes." Increased employee awareness of the SAS Insights Bio-surveillance alert and its benefits would likely eliminate the use of other tracking methods and improve nursing compliance. (Please see Table 2).

Analysis Question 10 found that nurses reported some providers are not aware of the alert or how to respond to the alert. I recommend reinforcing socialization and education around alert systems and provider roles (APP and physicians) once an alert has triggered. Future studies of the barriers to APP and physician use of the alert in a separate quality improvement project would be beneficial. (Please see Table 2). Analysis Questions 11-13 was a free comment box with responses that reiterated common survey themes such as alert fatigue, unclearly written protocols, and providers not fully educated on how to respond to the nurse informing them that the alert has triggered. *Lack of clear interventional goals* was a nursing barrier found from these analysis questions. Recommendations are listed in Table 2 based on these findings.

Individual Hospital Analysis and Recommendations

The following data is a summary of the individual hospital analysis summarized in Table 3: Perceived Nurse Compliance v. Actual Individual Hospital Compliance Data. The hospital's names are not listed to ensure confidentiality.

Overall, the average perceived nurse compliance to the alert (Column 4 of Table 3) was not significantly different from the average actual hospital compliance to the alert (Column 5 from Table 3) (80% v. 68%, $p=0.23$). This suggests that the survey results reasonably reflect the hospital system as a whole. Of the 13/34 hospitals that did not respond to the survey, their system-wide nursing compliance data was lower than the hospitals whose nurses completed the survey (58% compliance v. 68%, $p=0.29$). This could suggest that these hospitals may benefit from the recommendations stated in the System-Wide Analysis and Recommendations. Low compliance and low participation in the survey could suggest lack of knowledge and

awareness of the SAS Insights Bio-surveillance application function and therefore further education to these hospitals would be beneficial. The nurses perceived compliance was higher than the actual individual hospital compliance in 7 of the hospitals (highlighted in red in Table 3). The nurses responding to the survey in these 7 hospitals may not accurately represent that individual hospital's composite nursing population because the number of survey responses is limited.

Discussion

Since implementation of the SAS Insights Bio-surveillance application in 2016, the hospital system demonstrated a decrease in the rate of severe sepsis by 14.9% and a decrease in the risk-adjusted (O/E) mortality rate for all patients with sepsis by 7.25% (Brown, 2016). Sepsis is a disease process that commonly affects the older population and prior to this project, the effects of the SAS Insights Bio-surveillance application on the older population had not been previously studied at the hospital system. This QI project found that data comparing sepsis-related mortality in those aged 18-59 compared to those aged 60 or greater, found that sepsis mortality was significantly higher in the older population group ($p < 0.001$).

A common problem identified by this QI project was a large variation in nursing compliance with provider notification of the sepsis alert at each hospital, ranging from 19% to 81%. Data analysis comparing nursing compliance to mortality rates within the hospital system found that increased nursing-provider notification was associated with a weak trend towards a decrease in O/E sepsis mortality rates ($P = 0.4$). As expected, data also showed that increasing sepsis SEP-1 bundle compliance decreased the O/E sepsis mortality ($P < 0.001$). Based on this data it is likely that eliminating nursing barriers to using the SAS Insights Bio-surveillance alert

would improve SEP-1 Bundle compliance which is significantly associated with improved sepsis-related mortality in all ages including those aged 60 and older.

A short 16 question survey was created to understand potential nursing barriers to using the SAS Insights Bio-surveillance application. The survey results showed that the SAS Insights Bio-surveillance application was well received by the nurses who use it, although a few common barriers were noted. These barriers included lack of awareness and familiarity, lack of outcome expectancy, lack of collaboration, lack of clear interventional goals, and alert fatigue (Fischer et al., 2016; Joosen et al., 2015; Lee & Mcelmurry, 2010). A barrier that was hypothesized but not noted in this study was negative effects on workflow. Several recommendations are made based on the findings of this QI project combined with evidence-based literature (See Table 2).

Another goal of this survey was to compare nursing perceived compliance to the system-wide nursing compliance data at each individual hospital. This survey suggests that nursing perceived compliance was consistent, albeit slightly higher (80% v. 68%, $p=0.23$) with the system-wide nursing compliance data. This finding suggested that the survey results should reasonably reflect the hospital system as a whole. Some limitations of this study include a relatively small sample size, lack of control over which nurses received the survey, and lack of survey response from 13/34 hospitals. Another limitation of this QI project is that O/E mortality data was used. O/E mortality can be altered based on hospital documentation practices (Bottle et al., 2010). However, O/E mortality is beneficial because it can correct for changes in mortality rates throughout different seasons (flu season, etc.), and adjust for factors such as age and comorbidity (Bottle et al., 2010). Another strength of using O/E mortality in this project

is that it was a system-wide approach using a single data abstraction company with standardized methodology for all sites.

Nursing compliance was expected to be correlated with improving sepsis mortality, although the data analysis showed a weak non-significant trend. Possible reasons for this finding include SEP-1 bundle criteria was met in the emergency department prior to the patient arriving on the floor, nurses improperly documented or turned off the alert, nurses used alternative sepsis tracking methods, and nurses did not notify the provider in the appropriate time limit (60 minutes). Other reasons could include that nursing compliance alone is not enough to improve mortality and must be followed by SEP-1 bundle compliance. It is also possible that including data from multiple years would have yielded less variation in the results.

To improve nurse compliance data, the recommendations summarized in Table 2 should be implemented. These recommendations include educational workshops and training sessions, displaying educational materials (posters and flyers) in key working areas, and including hospital compliance goals to current compliance on these educational materials. Other recommendations included creating clear protocols on laminated cutouts easily accessible at workstations and on computers, providing hospital and individualized nursing compliance feedback, and combining nursing-provider education together to promote teamwork (please see Table 2). Reevaluation of nursing compliance should be done to assess for improvement in statistical significance after implementation of these recommendations.

Conclusion

The findings of this quality improvement project allow for evidence-based implementation of recommendations to further improve nursing compliance around the SAS Insights Biosurveillance application which would likely improve sepsis-related mortality in all ages including those aged 60 or greater. It is recommended that a similar survey and analysis be done to answer questions and considerations that have been brought up in this quality improvement project.

References

- Alsolamy, S., Salamah, M., Thagafi, M., Al-Dorzi, H., Marini, A., Aljerian, N., ... Arabi, Y. (2014). Diagnostic accuracy of a screening electronic alert tool for severe sepsis and septic shock in the emergency department. *BMC Medical Informatics and Decision Making*, 14(1). <https://doi.org/10.1186/s12911-014-0105-7>
- Ayanian, J. Z., & Markel, H. (2016). Donabedian's Lasting Framework for Health Care Quality. *New England Journal of Medicine*, 375(3), 205-207. doi:10.1056/nejmp1605101
- Baruch, Y., & Holtom, B. C. (2008). Survey response rate levels and trends in organizational research. *Human Relations*, 61(8), 1139–1160.
<https://doi.org/10.1177/0018726708094863>
- Beall, A.-L. (n.d.). *Big data in health care How three organizations are using big data to improve patient care and more*. SAS Insights.
https://www.sas.com/en_us/insights/big-data/what-is-big-data.html.
- Borgert, M., Binnekade, J., Paulus, F., Goossens, A., Vroom, M., & Dongelmans, D. (2016). Timely individual audit and feedback significantly improves transfusion bundle compliance—a comparative study. *International Journal for Quality in Health Care*, 28(5), 601–607. <https://doi.org/10.1093/intqhc/mzw071>
- Bottle, A., Jarman, B., & Aylin, P. (2010). Strengths and weaknesses of hospital standardised mortality ratios. *BMJ*, 342(jan21 1), c7116–c7116. <https://doi.org/10.1136/bmj.c7116>

Brodts, E., Skelly, A., Dettori, J., & Hashimoto, R. (2014). Administrative Database

Studies: Goldmine or Goose Chase? *Evidence-Based Spine-Care Journal*, 05(02), 074–076. <https://doi.org/10.1055/s-0034-1390027>

Brown, P. (2016). *Partnering for prevention: Dignity Health and SAS combat sepsis.*

<https://blogs.sas.com/content/sascom/2016/08/31/partnering-for-prevention-dignity-health-and-sas-work-to-combat-sepsis/>.

Carroll, W. M. (2019). Artificial Intelligence, Critical Thinking and the Nursing Process. *Journal of Nursing Informatics*, 23(1). <https://doi.org/10.1891/9780826146519.0003>

Center for Disease Control. (2020, February 14). Sepsis. Centers for Disease Control and Prevention. <https://www.cdc.gov/sepsis/datareports/index.html>.

Dillman, D., Smyth, J. & Christian, L. (2009). *Internet, Mail, and Mixed-Mode Surveys: The Tailored Design Method*, New York: Wiley

Fincham, J. E. (2008). Response Rates and Responsiveness for Surveys, Standards, and the Journal. *American Journal of Pharmaceutical Education*, 72(2), 43.

<https://doi.org/10.5688/aj720243>

Fischer, F., Lange, K., Klose, K., Greiner, W., & Kraemer, A. (2016). Barriers and strategies in guideline implementation—a scoping review. *Healthcare*, 4(3), 36.

<https://doi.org/10.3390/healthcare4030036>

- Foley, C., & Dowling, M. (2018). How do nurses use the early warning score in their practice? A case study from an acute medical unit. *Journal of Clinical Nursing, 28*(7-8), 1183–1192. <https://doi.org/10.1111/jocn.14713>
- Gagliardi, A. R., & Alhabib, S. (2015). Trends in guideline implementation: a scoping systematic review. *Implementation Science, 10*(1). <https://doi.org/10.1186/s13012-015-0247-8>
- Gavriellov-Yusim, N., & Friger, M. (2013). Use of administrative medical databases in population-based research: Table 1. *Journal of Epidemiology and Community Health, 68*(3), 283–287. <https://doi.org/10.1136/jech-2013-202744>
- Harrison, A. M., Gajic, O., Pickering, B. W., & Herasevich, V. (2016). Development and Implementation of Sepsis Alert Systems. *Clinics in Chest Medicine, 37*(2), 219–229. <https://doi.org/10.1016/j.ccm.2016.01.004>
- Hettinger, A. Z., Benda, N., Roth, E., Hoffman, D., Iyer, A., Franklin, E., ... Bisantz, A. M. (2020). Ten Best Practices for Improving Emergency Medicine Provider–Nurse Communication. *The Journal of Emergency Medicine, 58*(4), 581–593. <https://doi.org/10.1016/j.jemermed.2019.10.035>
- Joosen, M. C. W., van Beurden, K. M., Terluin, B., van Weeghel, J., Brouwers, E. P. M., & van der Klink, J. J. L. (2015). Improving occupational physicians' adherence to a practice guideline: feasibility and impact of a tailored implementation strategy. *BMC Medical Education, 15*(1). <https://doi.org/10.1186/s12909-015-0364-8>

- Lee, S., & McElmurry, B. (2010). Capturing Nursing Care Workflow Disruptions. *CIN: Computers, Informatics, Nursing*, 28(3), 151–159. <https://doi.org/10.1097/ncn.0b013e3181d77d3e>
- Lyndon, A., Zlatnik, M. G., & Wachter, R. M. (2011). Effective physician-nurse communication: a patient safety essential for labor and delivery. *American Journal of Obstetrics and Gynecology*, 205(2), 91–96. <https://doi.org/10.1016/j.ajog.2011.04.021>
- Martin-Loeches, I., Guia, M. C., Vallecocchia, M. S., Suarez, D., Ibarz, M., Irazabal, M., ... Artigas, A. (2019). Risk factors for mortality in elderly and very elderly critically ill patients with sepsis: a prospective, observational, multicenter cohort study. *Annals of Intensive Care*, 9(1). <https://doi.org/10.1186/s13613-019-0495-x>
- Mcree, L., Thanavaro, J. L., Moore, K., Goldsmith, M., & Pasvogel, A. (2014). The impact of an electronic medical record surveillance program on outcomes for patients with sepsis. *Heart & Lung*, 43(6), 546–549. <https://doi.org/10.1016/j.hrtlng.2014.05.009>
- Midas Health Analytics Solutions. (2017). *Midas DataVision and CPMS Midas Risk Adjustment Model 2.0 Methodology Quick Start Guide* [Brochure]. Tucson, AZ: Author.
- Nasa, P., Juneja, D., Singh, O., Dang, R., & Arora, V. (2012). Severe Sepsis and its Impact on Outcome in Elderly and Very Elderly Patients Admitted in Intensive Care Unit. *Journal of Intensive Care Medicine*, 23(3). <https://doi.org/10.1177/0885066610397116>
- Petersen, J. A., Antonsen, K., & Rasmussen, L. S. (2016). Frequency of early warning score assessment and clinical deterioration in hospitalized patients: A randomized trial. *Resuscitation*, 101, 91–96. <https://doi.org/10.1016/j.resuscitation.2016.02.003>

- Petersen, J. A., Rasmussen, L. S., & Rydahl-Hansen, S. (2017). Barriers and facilitating factors related to use of early warning score among acute care nurses: a qualitative study. *BMC Emergency Medicine*, 17(1). <https://doi.org/10.1186/s12873-017-0147-0>
- Polacek, C., Christopher, R., Man, M., Udall, M., Craig, T., Deminski, M., & Sathe, N. (2020). Healthcare professionals' perceptions of challenges to chronic pain management. *The American Journal of Managed Care*, 26(4). <https://doi.org/10.37765/ajmc.2020.42841>
- Rhodes, A., Evans, L. E., Alhazzani, W., Levy, M. M., Antonelli, M., Ferrer, R., ...Dellinger, R. P. (2017). Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock: 2016. *Intensive Care Medicine*, 43(3), 304–377. <https://doi.org/10.1007/s00134-017-4683-6>
- Rowe, T. A., & Mckoy, J. M. (2017). Sepsis in Older Adults. *Infectious Disease Clinics of North America*, 31(4), 731–742. <https://doi.org/10.1016/j.idc.2017.07.010>
- Rupp, M. (2018). Assessing Quality of Care in Pharmacy: Remembering Donabedian. *Journal of Managed Care & Specialty Pharmacy*, 24(4), 354--356.
- SAS Insights. (n.d.). *Using analytics to prevent deadly infections*. SAS Insights. https://www.sas.com/en_us/insights/articles/analytics/using-analytics-to-prevent-sepsis.html.
- Sendelbach, S., & Funk, M. (2013). Alarm Fatigue: A Patient Safety Concern. *AACN Advanced Critical Care*, 24(4), 378–386. <https://doi.org/10.1097/nci.0b013e3182a903f9>

- Smith, D. J., & Aitken, L. M. (2015). Use of a single parameter track and trigger chart and the perceived barriers and facilitators to escalation of a deteriorating ward patient: a mixed methods study. *Journal of Clinical Nursing, 25*(1-2), 175–185. <https://doi.org/10.1111/jocn.13104>
- Surviving Sepsis Campaign. (2014). *Society of Critical Care Medicine, 42*(1). <https://doi.org/10.1097/ccm.000000000000192>
- Taherdoost, H. (2016). Validity and reliability of the research instrument; how to test the validation of a questionnaire/survey in a research. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3205040>
- Tiruvoipati, R., Ong, K., Gangopadhyay, H., Arora, S., Carney, I., & Botha, J. (2010). Hypothermia predicts mortality in critically ill elderly patients with sepsis. *BMC Geriatrics, 10*(1). <https://doi.org/10.1186/1471-2318-10-70>

Table A: Survey Questions (1-16)

Survey Question #	Survey questions	Survey Answer Options	Rational
1	Please confirm that you are a floor nurse that works on med/surg or telemetry unit.	a. Yes, I am a floor nurse who works on a med/surg or telemetry unit b. No, I am not a floor nurse who works on a med/surg or telemetry unit	<i>This question was included to ensure those completing the survey are nurses from the med/surg or telemetry unit. Those that clicked "No, I am not a floor nurse who works on a med/surg or telemetry unit had the survey shut off.</i>
2	Which hospital do you work at?	Each of the 34 hospitals names were be listed.	<i>This question was added to ensure proper tracking of which survey response came from which hospital.</i>
3	Which unit do you work on?	a. Medical/Surgical b. Telemetry c. Comment box	<i>This question was added to track which units the nurses responding to the survey were from</i>
4	I am aware of the Bio-Surveillane Sepsis alert and that it is used to track patients at increased risk of developing sepsis.	a. Yes b. No c. Sometimes d. Unsure	<i>This question was included to understand nurse awareness of the alert and the process they must complete when an alert triggers.</i>
5	I am aware of the process to be completed when the Bio-Surveillane Sepsis alert triggers.	a. Yes b. No c. Unsure	<i>This question was included to understand nurse awareness of the alert and the process they must complete when an alert triggers.</i>
6	If the Bio-Surveillane Sepsis alert triggers, how often do you notify the physician after an alert goes off.	a. Unknown b. <50% c. 50-60% d. 60-70% e. 70-80% f. > 90%	<i>This question can be used to compare the quarterly nurse communication rate data that the dashboard provides with what the individuals at the hospital believe happens during their workday. This will also provide information on how informed the nurse assistant nurse managers and charge nurses are on their organization's compliance with the application.</i>

7	I understand how the Bio-surveillance Sepsis alert uses patient information to create an alert signifying that a patient has an increased risk of developing sepsis.	<ul style="list-style-type: none"> a. Strongly Disagree b. Disagree c. Neutral d. Agree e. Strongly Agree 	<p><i>This question was chosen because if the survey results indicate that the individuals didn't feel they understood how the app works or how to use the app it could be a great opportunity to provide training on the use of the app to these hospitals. Poor training is a common barrier to nurse compliance of track and trigger applications (Peterson et al., 2017; Smith & Aitken, 2015).</i></p>
8	I have adequate training on how to respond if the Bio-Surveillance Sepsis alert triggers.	<ul style="list-style-type: none"> a. Strongly Disagree b. Disagree c. Neutral d. Agree e. Strongly Agree 	<p><i>This question was chosen because if the survey results indicate that the individuals didn't feel they understood how the app works or how to use the app it could be a great opportunity to provide training on the use of the app to these hospitals. Poor training is a common barrier to nurse compliance of track and trigger applications (Peterson et al., 2017; Smith & Aitken, 2015).</i></p>
9	I believe the Bio-Surveillance Sepsis alert improves patient care and outcomes by notifying the care team of a patient's potential risk of developing sepsis earlier than without the use of the alert.	<ul style="list-style-type: none"> a. Strongly Disagree b. Disagree c. Neutral d. Agree e. Strongly Agree 	<p><i>This question was chosen because if the individual stated they disagree it could be a great opportunity to provide teaching on the positive impacts of the app and the reduction in mortality it has for patients who develop sepsis. The literature suggests that often nurses perceive tracking apps as a task rather than a tool that assists in recognizing deteriorating patients and often nurses don't perceive these tools as important (Foley & Dowely, 2018; Peterson et al., 2016).</i></p> <p><i>The hospital system's implementation of the SAS Insights Bio-surveillance applications has decreased the average severe sepsis rate by 14.9% and decreased the average mortality rate for all patients with sepsis by 7.25% making it an essential tool in detecting patients at risk of developing sepsis early (Brown, 2016).</i></p>
10	My colleagues (nurses, physicians, APPs) believe that the Bio-Surveillance Sepsis alert improves patient care and outcomes and want to know	<ul style="list-style-type: none"> a. Strongly Disagree b. Disagree c. Neutral d. Agree e. Strongly Agree 	<p><i>This question was chosen because if the individual feels their colleagues don't believe the app improves patient care, it could be another great teaching opportunity. The literature suggests that a culture of nonadherence to these apps plays a large role in decreased nurse compliance and assessing the culture around adherence to the app could help the hospital better understand what teaching points need to be addressed (Foley & Dowely, 2018).</i></p>

	when a positive alert has triggered.		
11	I believe my clinical judgment is superior to the Bio-Surveillance Sepsis alert at identifying if a patient is at risk of developing sepsis.	a. Strongly Disagree b. Disagree c. Neutral d. Agree e. Strongly Agree	<i>This question was chosen because the literature suggest nurses often perceive their “gut feeling” and nurse intuition/clinical judgment as superior to tracking methods (Foley & Dowely, 2018; Harrison et al., 2016; Peterson et al., 2016)</i>
12	The Bio-Surveillance Sepsis alert negatively affects my daily workflow.	a. Strongly Disagree b. Disagree c. Neutral d. Agree e. Strongly Agree	<i>This question was included because the literature supports that a common barrier to using different tracking methods to predict patient deterioration negatively affects daily workflow leading to decreased nurse compliance with these tracking systems (Peterson et al., 2016; Smith & Aitken, 2015)</i>
13	On average, I have had <u>positive</u> interactions with my provider(s) when I inform them that the Bio-Surveillance Sepsis alert has triggered the alert.	a. Strongly Disagree b. Disagree c. Neutral d. Agree e. Strongly Agree	<i>This question was chosen stakeholders were concerned that a large barrier to nurses using the app is that they often have negative interactions when notifying the physicians/providers that the app was triggered. This could lead to nurses not wanting to alert providers that the app has triggered. This question is also supported in the literature which suggests a common barrier to nurses using early warning scores or track and trigger alert systems is due to negative experiences in notifying the provider (Foley & Dowling, 2018; Peterson et al., 2016; Peterson et al., 2017)</i>
14	If you responded to question 13 with “Neutral, Disagree, or Strongly Disagree” please answer Question 14 (If not please select N/a): What are the reasons your experience was not positive when notifying the healthcare	a. The provider believes the alert triggers too often. b. The provider doesn’t believe the alert helps improve patient care. c. The provider believes that their clinical judgment is superior to the alert at determining if a patient has sepsis d. N/a e. Comment box:	<i>This question was included because these responses are frequently cited reasons for non-compliance to tracking applications (Harrison et al., 2016; Peterson et al., 2016; Peterson et al., 2017; Foley & Dowling, 2018; Smith & Aitken, 2015). Leaving a comment box will further allow nurses to explain what reasons physicians/providers are less receptive to being aware of the app trigger. This will allow the organization to provide more specific education based on survey results.</i>

	provider of the positive Bio-Surveillance Sepsis alert. Select all that apply:		
15	How often do you use other sepsis assessment methods (such as paper checklists or other tools) to identify potential septic patients? If so, please list your other methods below:	a. Never b. Rarely c. Sometimes d. Very often e. Almost always f. Comment box:	<i>This question was included because stakeholders stated, some organizations use other tracking methods and providers may be more accustomed to the use of other tools besides the SAS Bio-surveillance app. If this is true it may explain some hospital's low compliance with using the app. Education could be provided to these low compliance hospitals on the accuracy of the data tracking app vs using paper tracking or other methods.</i>
16	Is there any other information that you think would be important for the hospital system to know to help improve outcomes in patients with suspected sepsis?	Comment box:	<i>This additional question allows the individual to provide us with any barriers to the app that we may have missed or not discussed in the survey. This question could allow the organization to further investigate (in either another follow-up survey or focus group interviews) to further address any other information provided by this question. .</i>

Table 1: Results from survey response group (n=23) that most likely offers a potential opportunity for improvement

Analysis Question Number*		Results	Conclusion and Recommendations
1	Nurses who understand the alert is used to identify patients at risk of developing sepsis.	19/23 (82.6%)	C: Nearly 20% don't understand the primary function of the SAS Insights Bio-surveillance alert.
2	Those who felt that they had adequate training on	14/23 (60.9%)	C: Almost 40% felt that they did not have adequate training related to the alert's use.

	use of the Bio-surveillance alert.		
3	Nurses agreed that the alert improves sepsis-related patient care	13/23 (56.5%)	C: Almost half of the nurses do not believe the app improves patient care related to sepsis.
4	Nurses who state their colleagues believe the sepsis alert improves patient care.	9/23 (39.1%)	C: Relative to themselves, nurses in this cohort, feel that even less of their colleagues (nurses, APP, physicians) think that the SAS Insights Bio-surveillance alert is associated with improved patient care related to sepsis.
5	Nurses who believe their clinical judgment is superior to the alert.	7/23 (30.4%)	C: Nearly a third of nurses believe their clinical judgment is superior to the SAS Insights Bio-surveillance alert.
6	Use of the SAS Insights Bio-surveillance alert does not negatively affect their workflow	19/23 (82.6%)	C: Over 80% of nurses who do not regularly notify their provider of the SAS Insights Bio-surveillance alert felt that utilization of the alert does not negatively affect their daily workflow.
7	Nurses who report a negative interaction with their provider when informing them that the alert triggered.	15/23 (65.2%)	C: Two thirds of nurses experience negative interactions when informing their provider of the alert. The reasons reported were the following: trigger fatigue, provider believes their judgment is superior to the alert, provider doesn't believe alert improves patient care (see Question 8 below).
8	Nurse reasons for negative interaction with the provider.	a) The provider believes the alert triggers too often (34.8%). b) The provider believes that their clinical judgment is superior to the alert (26.1%).	C: Three common reasons were trigger fatigue, provider believes their judgment is superior to the alert, provider doesn't believe alert improves patient care

		c) The provider doesn't believe the alert helps improve patient care (17.4%).	
9	Participants that sometimes or often use other sepsis assessment methods. These methods were identified as "sepsis flowsheets."	9/23 (39.1%)	C: Almost 40% of the responders reported that may use other sepsis tracking methods "very often" or "sometimes."
10	Other themes: Provider unaware of the alert system	Comment box	C: Nurses reported some providers are not aware of the alert or how to respond to the alert.
11	Other themes: Alert continues to trigger in patients with known sepsis which leads to alert fatigue.	Comment box	C: Alert fatigue appears to be a negative contributor to nursing compliance.
12	Other themes: "More education is needed on protocols for sepsis alerts," (2 comments)	Comment box	C: Written and clear protocols are not provided to staff.
13	Other themes: "Need more focus on physician education so they understand sepsis bundle compliance" (2 comments)	Comment box	C: Nursing staff feel that their providers (APPs and physicians) are not fully educated on how to respond if a nurse notifies them that an alert has triggered.

***Additional survey questions were not included in this table as they were demographic in nature.**

Table 2: Recommendations based on results from Table 1

Recommendations for Analysis Question number	Recommendations
Questions 1 and 2	<ul style="list-style-type: none"> • Analysis Question 1 and 2 suggest a potential nurse barrier to using the alert system is <i>lack of awareness and lack of familiarity</i>. • Increasing dissemination of educational material through social media and staff emails, as well as through online educational training modules (Fischer et al., 2016). • Use incentives (offering CME credit) for staff who complete the in person or online training (Fischer et al., 2016). • Make protocols and guidelines simple, easily accessible • Display educational posters/flyers in nursing work stations and break rooms (Gagliardi & Alhabib, 2015). (See Sample Flyer 1). • Implement educational meetings during nursing huddles • Provide individualized feedback on group performance (Fischer et al., 2016). • Provide individual nursing results compared to individual hospital nursing averages. • Update hospital compliance rate on a weekly or monthly basis. • Include the 95% compliance goal to inform staff nurses on how much improvement is still needed (Fischer et al., 2016).
Questions 3 and 4:	<ul style="list-style-type: none"> • Use education training sessions, educational sessions during change of shift staff meetings, and posters/flyers to improving perceptions of the Bio-surveillance alert system's improvement in patient care (Fischer et al., 2016). • Include individual hospital specific data on alert compliance and mortality compared to other hospitals with higher compliance to improve awareness and self-efficacy (Fischer et al., 2106). • Refer to recommendation number 6 (below) and including this in the educational information to reinforce that nursing workflow will not be negatively affected by compliance to the alert system (Lee & Mcelmurry, 2010).
Question 5:	<ul style="list-style-type: none"> • Include additional education to reinforce the combination of nursing critical thinking and the value added with AI alert systems to the educational material in question 3 and 4
Question 6:	<ul style="list-style-type: none"> • In educational material listed in Question 3 and 4 include this survey finding that nurses felt the the SAS Insights Bio-surveillance alert does not negatively affect workflow.
Questions 7 and 8:	<p>8a)</p> <ul style="list-style-type: none"> • Reassess alert frequency during individual nursing work periods and the protocol for the deactivation process when a patient is diagnosed with known sepsis to prevent repetitive firing and decrease alert fatigue. • Have simple, easily accessible protocols with clearly set goals (Fischer et al., 2016). • Provide written and clear protocols, in email and in person reeducation to nursing staff on the proper documentation process to stop the alert from further "firing" once the provider has been notified (Fischer et al., 2016). • Provide small laminated cut outs of the protocol and attaching them to nursing computers / work spaces for easier access (Fischer et al., 2016). (See Figure 2

	<ul style="list-style-type: none"> • Eliminating the unnecessary firing of the alert in patients with known sepsis will help decrease alert fatigue for staff which will in turn improve nursing compliance (Lee & McElmurry, 2010). <p>8b) and 8c):</p> <ul style="list-style-type: none"> • Implement provider specific education related to sepsis care. • Reinforce education related to utilization of the SAS Insights Bio-surveillance alert and its positive impacts on mortality (Beall, n.d). • Implement similar educational materials to the recommendations in Question 1 and 2 (educational posters and flyers in workspace and break rooms, online training modules with CME credit, educational review in team and change of shift huddles, educational emails). • Include evidence-based data on sepsis protocols significant in improving patient outcomes in teachings could help improve provider’s negative perceptions of the SAS Insights Bio-surveillance alert system. • Include educational training on effective provider-nurse communication • Combine provider education and reinforcement about the SAS Insights Bio-surveillance alert system with nursing education (Lyndon et al., 2011). • Key components of effective nurse-provider communication include: <ul style="list-style-type: none"> ○ Transparency on changes to patient health status, care plans, and new treatments/orders (Hettinger et al., 2020). ○ Early communication to allow early planning for care plan changes in a timely manner (Hettinger et al., 2020). ○ Verbal communication is best practice (Hettinger et al., 2020; Lyndon et al., 2011). ○ Avoid communicating through signing a note (Hettinger et al., 2020). ○ Providers should not assume putting in electronic orders substitutes for verbal communication to the nurse on changes in care plans ○ Use closed loop communication (Hettinger et al., 2020; Lyndon et al., 2011). ○ Encouraging providers to ask if the nurse has any questions at the end of their conversation to allow nurses to have a designated to get unanswered questions (Hettinger et al., 2020).
<p>Question 9:</p>	<ul style="list-style-type: none"> • Increased employee awareness of the SAS Insights Bio-surveillance alert and its benefits would likely eliminate the use of other tracking methods and improve compliance with the SAS Insights Bio-surveillance alert system. (See recommendation for Question 1 and 2 on strategies to increase socialization and awareness).
<p>Question 10:</p>	<ul style="list-style-type: none"> • Reenforce socialization and education around alert systems and provider roles (APP and physicians) once an alert has triggered. • I recommend further analysis of barriers to APP and physicians use of the alert in a separate quality improvement project (See recommendation for question number 1 & 2, 3 & 4, and 8b & 8c)

Question 11:	<ul style="list-style-type: none"> Please see recommendation 8a above.
Question 12:	<ul style="list-style-type: none"> See recommendation for question number 8a above.
Question 13:	<ul style="list-style-type: none"> See recommendation for question number 4, 8b, and 8c above.

Table 3: Perceived Nurse Compliance v. Actual Individual Hospital Compliance Data

Hospital (34)	# of Survey Responses	Perceived Nurse Compliance	Average of Perceived Nurse Compliance (in column 3)	Actual Individual Hospital Compliance to the Alert (data from calendar year 2019)
Hospital A	7 (8.4%)	6: >90% 1: Unknown	$77 = (90 * 6) / 7$ total responses	74%
Hospital B	2 (2.4%)	2: >90%	90	70%
Hospital C	1 (1.2%)	1: 60-70%	65	62%
Hospital D	6 (7.2%)	3: >90 3: 50-60	72	70%
Hospital E	6 (7.2%)	3: >90% 1: 70-80 1: 60-70 1: 50-60	77.5	72%
Hospital F	1 (1.2%)	1: >90%	Not in data set	
Hospital G	5 (6%)	5: >90%	90	81%
Hospital H	1 (1.2%)	1: >90%	90	52%
Hospital I	4 (4.8%)	4: >90%	90	63%

Hospital J	3 (3.6%)	2: >90% 1: 70-80%	85	69%
Hospital K	6 (7.2%)	3: >90% 1: 70-80 2: 50-60%	66.6	45%
Hospital L	7 (8.4%)	5: >90% 2: 70-80%	85.7	68%
Hospital M	3 (3.6%)	1: >90% 1: 50-60 1: <50%	56.7	67%
Hospital N	4 (4.8%)	4: >90%	90	72%
Hospital O	2 (2.4%)	2: >90%	90	61%
Hospital P	4 (4.8%)	3: >90% 1: 70-80%	86.3	80%
Hospital Q	2 (2.4%)	2: >90%	90	71%
Hospital R	15 (18.1%)	11: >90% 2: 70-80% 1: <50% 1: unknown	77.7	60%
Hospital S	2 (2.4%)	1: >90% 1: 70-80%	82.5	77%
Hospital T	1 (1.2%)	1: >90%	90	80%
Hospital U	1 (1.2%)	1: 50-60%	55	60%
			Average 80.35	Average 67.7 p=0.23
Hospitals who did not Respond to the Survey				
Hospital V	0			60%

Hospital W	0			19%
Hospital X	0			70%
Hospital Y	0			43%
Hospital Z	0			63%
Hospital AA	0			60%
Hospital BB	0			52%
Hospital CC	0			37%
Hospital DD	0			57%
Hospital EE	0			67%
Hospital FF	0			74%
Hospital GG	0			73%
Hospital HH	0			73%
				Average 57.7% P=0.29

Figure 1:

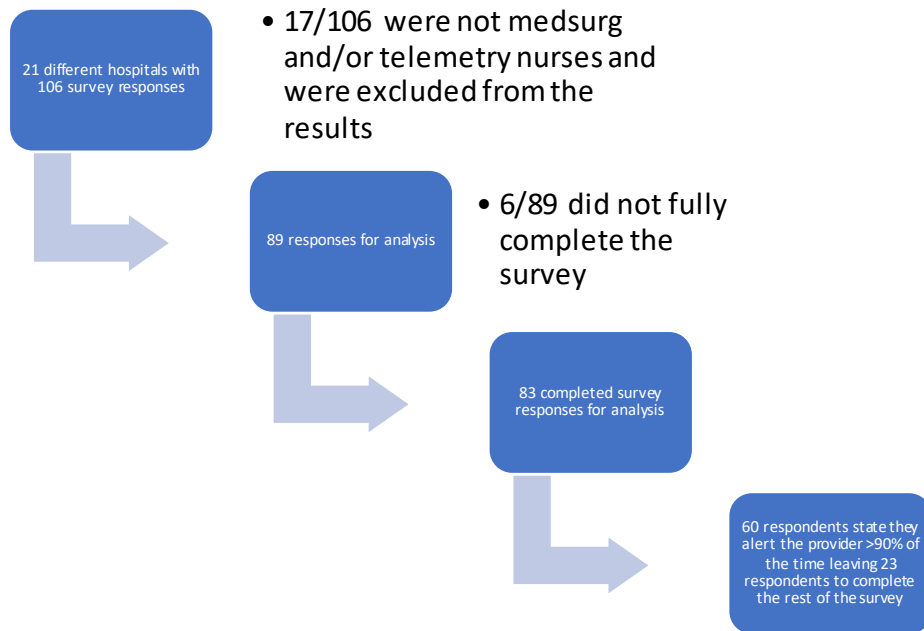
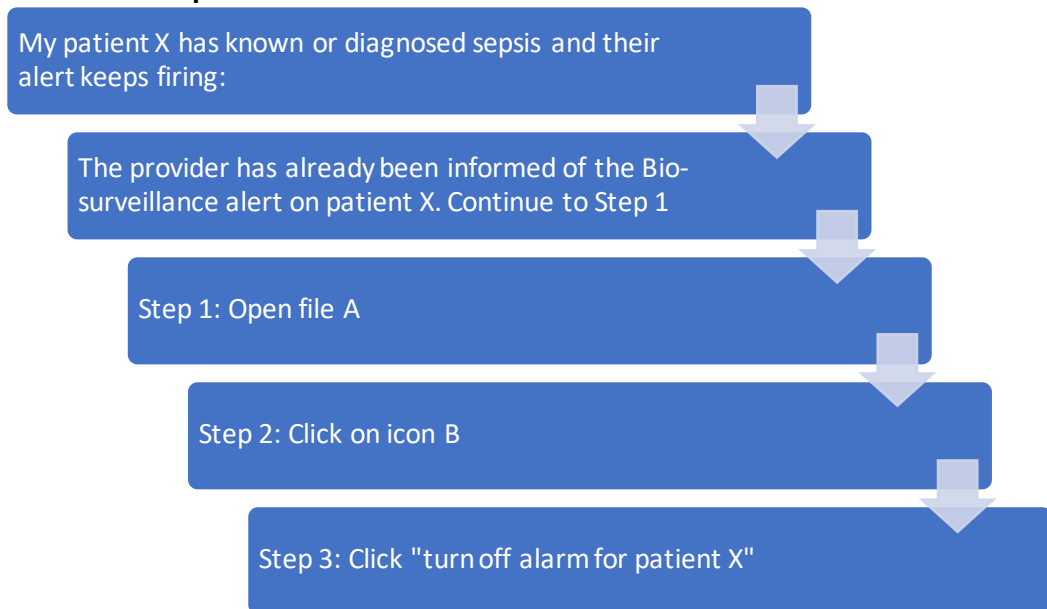
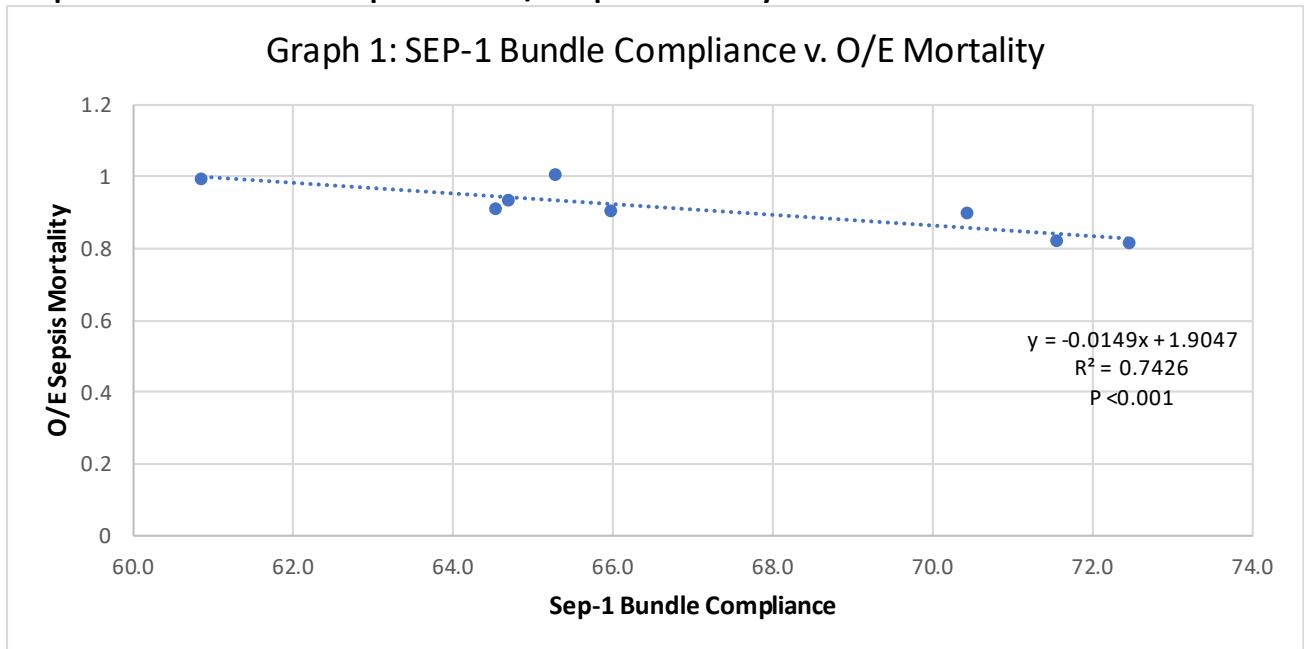


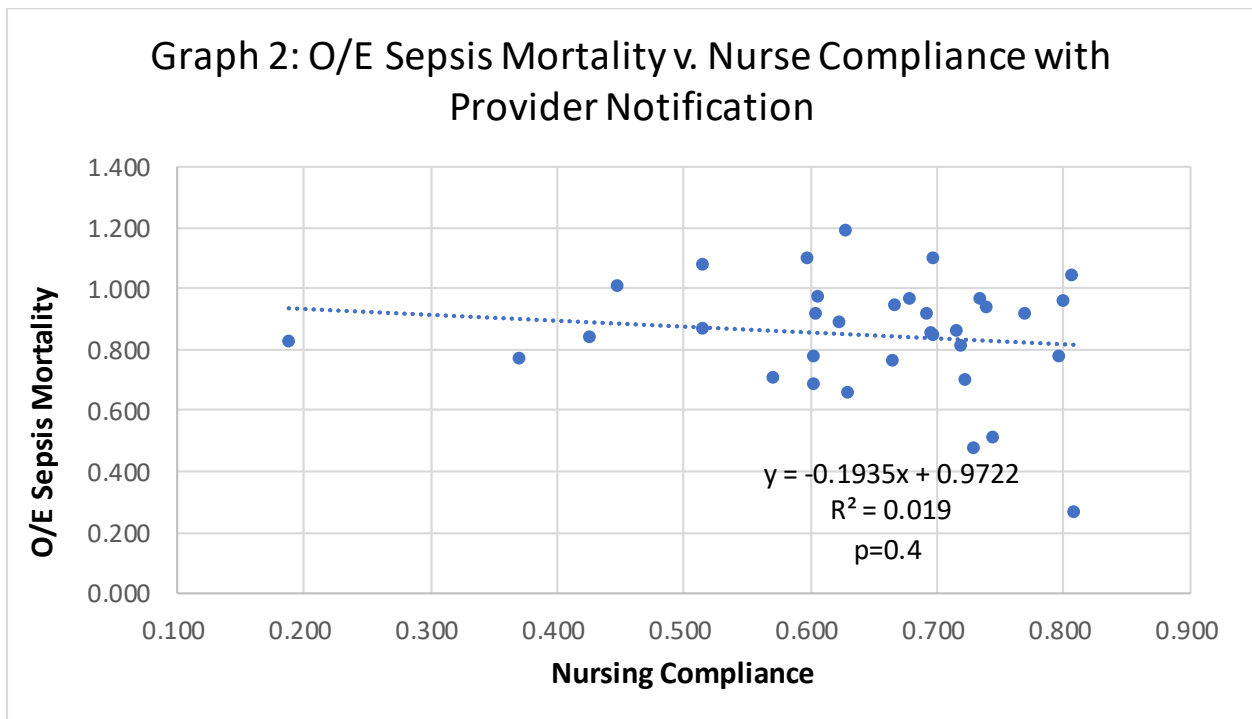
Figure 2 Sample Protocol: Laminated cutout example on how to deactivate alarm in patients with known sepsis.



Graph 1: SEP-1 Bundle Compliance v. O/E Sepsis Mortality



Graph 2: O/E Sepsis Mortality v. Nurse Compliance with Provider Notification



Sample Flyer 1:

Looking to Improve Sepsis Related Patient Care?

- Since implementation of the Bio-surveillance alert system our hospital system has had a decreased rate of severe sepsis by 14.9% and a decreased risk adjusted mortality rate for all patients with sepsis by 7.25%!!



Our goal is to increase nurse compliance to >95%!!

- Do your part by alerting your provider within 60 minutes when a Bio-surveillance alert is triggered

Our hospital nurse compliance for March 61%

Systemwide compliance rate for March 70%



- All thanks to the hard work of our nurses!

