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## Evaluating Adherence to the Sepsis Bundle and the Effectiveness of Best Practice Alerts

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DNP Final Project Report

Evaluating Adherence to the Sepsis Bundle and the Effectiveness of Best Practice Alerts

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November 30, 2017

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### Dedication

My doctoral work is for my parents, who have always made education a priority and supported me in every possible way. Thank you for all of your love and encouragement and for always being there for whatever I need. This is for my sister, Mallory, my biggest cheerleader and my personal, 24-hour technical support. Thank you for all of the perfectly timed “good luck” texts, baked goods waiting for me at home, and for preventing one, maybe two, nervous breakdowns. This is for Neil, who could always distract me from homework with sarcastic jokes, which were usually at my expense. Thank you for all the little things you have helped me with over the past three years. This is for Kim Forsythe, who gave me my first big girl job and who was the first person who told me I could be successful in this program. I will never forget your encouragement and motivating words. You continue to be an amazing mentor and you will be my forever friend.

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# EVALUATING ADHERENCE TO THE SEPSIS BUNDLE

## Abstract

**PURPOSE:** To evaluate the adherence to the CMS sepsis recommendations and sepsis bundle used by the study health system before and after the implementation of Best Practice Alerts (BPAs) and assessing the effect of these alerts on patient outcomes.

**METHODS:** The study was a single-center, process evaluation through a retrospective chart review within a southwest healthcare system. The sample consisted of 73 patients for the pre-implementation period (May 1, 2016-September 7, 2016) and 75 patients for the post-implementation period (September 8, 2016-April 30, 2017).

**RESULTS:** No major differences were found between the two groups with regard to patient age, ethnicity, and time of admission. The post-implementation group had a higher incidence of timely antibiotic administration ( $p=.008$ ) with 38% receiving initial antibiotic administration in 45 minutes or less of meeting sepsis criteria versus 21% in the pre-implementation group. In the post-implementation group, 89% of patients met sepsis criteria versus 67% in the pre-implementation group. The post-implementation group also collected blood cultures in 30 minutes or less in 61% of patients versus 41% in the pre-implementation group ( $p=.03$ ). No significant difference was found in regard to antibiotic selection, mortality, or length of stay.

**CONCLUSION:** The post-implementation group achieved more timely antibiotic administration and blood culture collection; however, there was no significant improvement in appropriate antibiotic choice, length of stay, or mortality. BPAs were inconsistent with the time that patients met sepsis criteria. After years of research and protocol changes, outcomes have not improved, indicating a great need for consideration of alternative treatments to improve the care and outcomes of sepsis patients.

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## **Background**

More than 1.6 million Americans are diagnosed with sepsis annually, which is equal to one person every 20 seconds, according to the Sepsis Fact Sheet (2016). In addition, the incidence of sepsis is rising 8% each year and is currently the leading cause of death in hospitalized patients. Globally, 26 million people are affected by sepsis annually and the disease has become the largest killer of children around the world, claiming the lives of more than five million children every year (Sepsis Fact Sheet, 2016). It has been estimated that 258,000 Americans die from sepsis each year; this is one person every two minutes, surpassing deaths from prostate cancer, breast cancer, and AIDS combined (Chong, Dumont, Francis-Frank, & Balaan, 2015; Sepsis Fact Sheet, 2016).

Sepsis has been a leading cause of death and a frequent reason for hospital admissions for decades, despite multiple attempts at developing protocols and bundles aimed at improving outcomes. In 1999, the mortality rate from sepsis was estimated to be between 40 and 60% (Alia et al., 1999). Sixteen years later this estimate was still high at 50%, indicating the urgent need to improve the care and treatment of sepsis patients (Rusconi et al., 2015).

Many patients who survive sepsis are left with debilitating physical and mental conditions. For example, according to the Sepsis Fact Sheet (2016), thirty-eight amputations are performed every day as a result of sepsis. In addition, patients who have been treated for sepsis have a shortened life expectancy, are likely to have a decreased quality of life, and are 42% more likely to commit suicide. Sepsis is also the cause of more than 75,000 maternal deaths each year worldwide and is an increasing cause of death during pregnancy in the United States (Sepsis Fact Sheet, 2016).

According to Cawcutt and Peters (2014), sepsis is responsible for approximately 2% of all hospital admissions, with 50% of these patients requiring care in the ICU. Moreover, 10% of these patients are considered to have severe sepsis. In patients who are admitted to the ICU due to sepsis, the mortality rate is more than 20% and reaches close to 50% in patients with septic shock (Rusconi et al., 2015).

Sepsis also places a financial strain on the healthcare system. In 2009, sepsis was ranked as the sixth most common primary diagnosis for patients admitted to the hospital with an estimated \$15.8 billion in healthcare costs (Chong et al., 2015). The current estimate is greater than \$24 billion, making this disease the number one cost of hospitalization in our country

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(Sepsis Fact Sheet, 2016). Each sepsis admission costs approximately \$18,400, which is double the average cost for other diagnoses. Sixty-two percent of patients treated for sepsis are readmitted to the hospital within 30 days of discharge (Sepsis Fact Sheet, 2016). The readmission rate for sepsis patients surpasses those of all four medical conditions for which CMS currently tracks and penalizes healthcare systems, which include myocardial infarction, heart failure, pneumonia, and chronic obstructive pulmonary disease (COPD). In 2013, analysis of data obtained from the Nationwide Readmission Database, which consists of 49% of U.S. inpatients, revealed the readmission rates for sepsis (12.2%), myocardial infarction (1.3%), heart failure (6.7%), pneumonia (5.0%), and COPD (4.6%). (“Sepsis Trumps CMS’s Four Medical Conditions,” 2017). The estimated mean cost for a sepsis readmission was \$10,070 per patient, also surpassing the readmission rates for the four previously mentioned diagnoses (Mayr et al., 2017).

Given the significant human and financial consequences of sepsis, it is crucial that healthcare providers identify and begin treatment of sepsis as soon as possible. Research has shown that screening for sepsis at the first sign of infection can lead to timely, goal-directed therapy (Miller, 2014). A decrease in mortality in patients who are identified and treated in the early stages of the disease process, specifically before the patient advances to severe sepsis or septic shock has also been found. Early administration of antibiotics, intravenous fluids, source control, and hemodynamic support are key to preventing complications, such as acute respiratory distress syndrome, septic shock, and death (Perez, 2015). For example, in a study published in 2015, researchers examined the time from blood culture collection to antibiotic administration in patients diagnosed with severe sepsis and septic shock. They found that the time to antibiotic administration was “an independent determinant of post-infection ICU and hospital length of stay” (Zhang, Micek, & Kollef, 2015, p. 2133).

### **Centers for Medicare and Medicaid Services Guidelines**

The Centers for Medicare and Medicaid Services (CMS) is a branch of the Department of Health and Human Services, which administers programs such as Medicare, Medicaid, and the Children’s Health Insurance Program (CHIP). CMS sets standards of care for specific conditions in which organizations have to prove compliance in order to receive full reimbursement. When reimbursement is dependent on a facility’s compliance, these are called core measures. At this time, sepsis is not a core measure; however, it is expected to be in the near future making it even

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more important for facilities to work towards compliance with standards and improvement of patient outcomes (“CMS Covers 100 Million People,” 2017).

In 2016, CMS released recommendations for the treatment of sepsis with time intervals in which each component should be completed. CMS also provided a list of approved broad spectrum antibiotics which are considered appropriate to empirically treat patients who are septic until definitive blood culture results are available (Specifications Manual, 2016; CMS Sepsis Core Measure Algorithm, 2015/2016). CMS has made multiple revisions to the recommendations over the years, with little to no improvement in outcomes and mortality. In fact, sepsis is now the number one killer of hospital patients (“Sepsis Trumps CMS’s Four Medical Conditions,” 2017).

### **Best Practice Alerts**

The identification, treatment, and management of sepsis in recent years has moved towards a protocol or “bundle” approach. Members of the Surviving Sepsis Campaign performed extensive research and developed a bundle for the early treatment and management of sepsis (Miller, 2014). However, each facility must screen and recognize septic patients early and begin treatment immediately. One strategy to aid in early recognition of sepsis is the use of Best Practice Alerts (BPAs). BPAs are programs built into the Electronic Medical Record (EMR) which can be programmed to notify a provider when a patient’s charted information meets specific criteria. In the case of sepsis, when a patient’s clinical data charted in the EMR meet the set criteria for sepsis, each provider is notified when the patient’s chart is opened, signaling to providers that the sepsis protocol may need to be initiated. Sepsis BPAs were implemented within the healthcare system in 2016 with the goal of early recognition and treatment initiation to improve outcomes for sepsis patients.

### **Purpose**

The purpose of this study was to evaluate adherence to the current CMS sepsis recommendations and sepsis bundle being used by the healthcare system prior to and after the implementation of Best Practice Alerts (BPAs). Specific questions to be answered within the study include:

1. Did the use of BPAs affect compliance to variables of the sepsis bundle?
2. Were appropriate antibiotic choices made for sepsis patients?
3. Did the use of BPAs play a role in outcomes?

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### Methods

The study was a single-center, process evaluation through a retrospective chart review of the adherence to the sepsis bundle pre and post BPA implementation at one of the health system hospitals. The pre-implementation period (May 1, 2016 to September 7, 2016) and post-implementation period (September 8, 2016 to April 30, 2017) were compared with an emphasis on timely blood culture collection, antibiotic administration, and appropriate antibiotic choice. The sepsis bundle was originally implemented in December 2015.

### Setting

The healthcare system serves the southeast United States with five hospitals, urgent care clinics, and numerous primary care services. The study site is an acute care facility and has 382 licensed beds. This facility was chosen as the focus for the study due to the high volume of sepsis patients treated annually.

### Sample

The population of interest was both male and female patients discharged from the hospital with a diagnosis of sepsis. Inclusion criteria encompassed: patients discharged with a diagnosis of sepsis and patients ages 18-65. Exclusion criteria included: patients less than 18 years of age, patients greater than 65 years of age, and patients who had cardiac or respiratory arrested within 30 days of admission. The patients who met inclusion criteria during the pre-implementation and post-implementation periods were randomly selected from the Norton Audubon database to reach the original target sample size of 150 patients. Two patients originally in the pre-implementation group failed to meet inclusion criteria.

### Measures

**Time of admission.** The time of patient admission was based on whether the admission occurred from 0700-1859 or 1900-0659.

**Meeting of sepsis criteria.** Patients were designated as meeting sepsis criteria if they met either full sepsis criteria or SIRS criteria within a six hour time frame (See Appendix A).

**Blood culture collection time.** The result time of the first set of blood cultures collected on each patient was collected from the EMR. The number of minutes from the patients' sepsis start time was calculated and categorized into intervals including 0-30 min, 31-59 minutes, 60-90 minutes and greater than 90 minutes.

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**Antibiotic administration time.** The number of minutes from the patient's sepsis start time was calculated to the first antibiotic given and categorized into intervals including 0-45 minutes, 46-119 minutes, 120-240 minutes, and greater than 240 minutes.

**Antibiotic selection.** Based on the antibiotics considered appropriate by CMS for first-line, empiric therapy for sepsis patients, the study healthcare system narrowed the selection and created a formulary based on microorganisms frequently associated with sepsis patients in this facility. The first antibiotic given was coded as either appropriate or inappropriate. (See Appendix B).

**Time of first BPA firing.** The exact time of the first sepsis specific BPA fired was extracted from the patient's chart. The difference in time between the first sepsis BPA firing and the patient's sepsis start time was calculated and categorized into intervals including 0-30 minutes, 31-180 minutes, 181 minutes to 6 hours, 6 hours and 1 minute to 18 hours, 18 hours and 1 minute to 24 hours, 24 hours and 1 minute to 72 hours, and greater than 72 hours.

**Mortality.** If the patient died during the hospital stay or within 30 days of discharge, the patient was coded as expired.

### **Data Collection**

Prior to the start of data collection, a letter of support was granted from the healthcare system office of research and approval was obtained from the University of Kentucky Institutional Board (IRB). The study was a retrospective chart review in which charts were obtained from an electronic database of discharged patients. Charts were selected randomly based on the specified time frames and the ICD code for sepsis. Patient charts were accessed using medical record numbers and data were extracted based on the variables included in the sepsis bundle along with demographic data, including age, sex, race, and time of admission.

### **Data Analysis**

Analysis of demographic data was conducted by using descriptive statistics, including frequency distributions, or means and standard deviations as appropriate. Independent Sample *t*-tests were used to compare continuous variables between the two groups (pre-implementation of BPAs vs. post-implementation) while ordinal and non-normally distributed variables were analyzed using the Mann-Whitney *U*-test. To compare categorical variables between the two groups, the chi-squared test was used. All data analysis was conducted using SPSS version 24 with an alpha level of .05 used for statistical significance.

## Results

### Sample Characteristics

The final sample consisted of 73 patients prior to BPA use and 75 patients after the initiation of BPAs. The mean age of both groups was 50 years of age (SD=11.7; see Table 1) with 54% of the total sample being male. The majority of the sample was white (82%) or African American (16%) and had been admitted during dayshift hours (62%). There were no differences in demographic characteristics between the two groups (See Table 1).

The post-implementation group demonstrated a significant difference in whether patients met sepsis criteria ( $p=.001$ ), with 89% meeting criteria versus 67% in the pre-implementation group. This group also had a higher incidence of timely antibiotic administration ( $p=.008$ ), with 38% receiving antibiotics in 45 minutes or less of meeting sepsis criteria versus 21% of the patients in the pre-implementation group. Timeliness of blood culture collection was also significantly different, with the post-implementation group having blood cultures collected in 30 minutes or less in 61% of patients, versus 41% in the pre-implementation group ( $p=.03$ ). The time of BPA firing were inconsistent with the time in which patient's met sepsis criteria. BPAs only fired within 3 hours of meeting sepsis criteria in 39% of patients and in 32.2% of patients, the BPA fired 24 hours or more after meeting criteria. A sepsis BPA never fired in 14 of the 73 patients studied. There was no significant difference between groups for appropriate antibiotic selection, mortality, or length of stay (Table 2).

## Discussion

Though there was no difference in patient outcomes between the two groups, there was a significant improvement in timeliness of blood culture collection and antibiotic administration in the post-implementation group. The rate of appropriate antibiotic choice increased after the implementation of BPAs; however, this did not change the mortality rate in the post-implementation population. The timing of BPAs was not consistent and many times, the system did not fire an alert to the provider in a timely manner. Treatment was frequently initiated by a provider's judgment based on clinical data and a thorough physical assessment rather than a BPA. Because no significant differences were found in outcomes, the differences that were found were likely due to frequent reeducation of providers around the sepsis bundle within the facility and continuous audits by an APRN who presents adherence data at monthly meetings.

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Similar findings resulted from a single-center, before-and-after study assessing the efficacy of BPA use in septic patients presenting to the ED (Narayanan, Gross, Pintens, Fee, & MacDougall, 2016). The study included 111 patients prior to BPA implementation and 103 patients post implementation. A higher proportion of patients in the post implementation group received antibiotics in less than 60 minutes. The same group also had a significant decreased length of stay. However, as in our study, there was no significant change in mortality between the two groups (Narayanan et al., 2016).

Every sepsis patient is unique with respect to presentation, source of infection, and rate of progression. Care must be individualized and providers must pay attention to detail in order to detect and treat developing sepsis in a timely manner. These factors also play an important role in the choice of antibiotics. Some patients may have a clear and obvious source of infection at presentation; however, the ideal antibiotic may not be included in the list of recommended empiric antibiotics. This may lead a provider to prescribe an empiric antibiotic first, in order to follow hospital and CMS protocols, instead of prescribing what is appropriate for the patient. This delays effective treatment.

Identifying and controlling the source of sepsis, though a difficult task, is one of the few ways shown to improve patient outcomes and decrease mortality. Initial investigation into the source of the infection should not stop after blood cultures are drawn. A thorough physical assessment can lead to multiple differential diagnoses which should be followed by associated diagnostic tests. For example, a patient with severe abdominal pain may need a CT of the abdomen and pelvis, which could lead to the finding of an abscess requiring emergent surgical intervention. Delaying these tests and treatments may lead to septic shock and death. Even with appropriate and timely antibiotics and fluid resuscitation, patients with certain causes of sepsis will not improve without immediate source control (“Sepsis: Early Recognition, Assessment, and Early Management,” 2016).

### **Limitations**

Specific limitations of this study were identified. First, the study sample is small, making it difficult to show significant statistical differences between groups. The study data was also obtained from a single facility, making the results difficult to generalize. Also, due to the majority of the study population being Caucasian, the results may not be generalizable to minority populations. Because the data was collected through retrospective chart reviews, there

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was no way to validate the accuracy of the information. Data may have been entered incorrectly into the EMR, which would alter the study findings. During a patient admission and hospital stay, numerous providers and staff are charting information in the EMR, which leaves significant room for error.

The role in which comorbidities may have played in length of stay and outcomes was not accounted for in the study. Long-term morbidities which resulted from sepsis were not assessed. There have also been changes to CMS sepsis guidelines and recommendations since the completion of this study, with additional modifications expected as soon as January 1, 2018. Norton Healthcare also discontinued the use of BPAs after data collection was completed and began the use of a new strategy to screen patients for sepsis. BPAs were found to be dismissed frequently, due to providers using his or her own clinical judgment and assessment of data before deciding to initiate the sepsis order set. Also, when a BPA signals to a provider that sepsis criteria has been met, the provider is unable to view the patient's chart prior to selecting an option from the BPA. Hypothetically, providers bypass the BPA and if the patient was found to be septic, the sepsis order set may not be searched for and initiated. After assessing the effectiveness of BPAs, the system made the decision to discontinue the use and implement a new sepsis screening tool which requires nursing staff to assess vital signs, labs, and physical assessment findings while incorporating clinical judgment as to whether or not a patient appears to be septic. Patients are screened at the same time intervals as physical assessments are conducted.

### **Recommendations for Future Studies**

Future study recommendations include studying a larger sample size in order to show more significant differences between groups. A multi-center study would also increase generalization. A study which took into consideration comorbidity burden in regard to outcomes could be beneficial, along with studying patient outcomes based on the clinical cause of sepsis. Due to the importance of timely fluid administration, a study assessing the timeliness of this variable and outcomes would be beneficial. A study focused on readmission rates and reasons for readmissions may help guide treatment for sepsis patients in the future. The time between when a patient presents to the Emergency Department (ED) and when he or she is seen by a provider can lead to significant delays in treatment. Patients are also frequently admitted to 23-hour observation units before a diagnosis is made and aggressive treatment is started. Initiation of

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fluid and antibiotic administration falls outside of the recommended time frames and can lead to poor outcomes. Research into the occurrence of these delays and potential solutions could bring about changes to how patients are triaged and treated when presenting to the ED with sepsis related symptoms. Successful treatment of sepsis is time dependent. Valuable time is often lost due to a delayed diagnosis of sepsis, impacting effectiveness of treatment, prognosis, and long-term outcomes. Specifically within the Norton Healthcare system, a study assessing the effectiveness of the new nurse screening tool and comparing it to other facilities' strategies could lead to improvements to the screening tool or another change in practice in order to improve patient outcomes in the setting of sepsis.

Providers around the world have used alternative treatments for septic patients which have resulted in positive outcomes. Unfortunately, these treatment modalities and findings are rarely shared in a way that could benefit the entire population because the treatments do not follow the current protocols and are not evidence based. Often these providers fear coming forward and presenting their treatment choices and outcomes to colleagues for these very reasons. Healthcare providers need to be more tolerant of alternative treatment options and support further research and trials in order to find more effective treatments for this population. A study coordinating monthly round table discussions between providers around the nation about alternative treatments that have been effective within his or her practice could lead to new protocols and treatment recommendations. While individual providers may have found treatment methods that are successful, overall the statistics are not improving.

### **Conclusion**

The purpose of this study was to assess adherence to the sepsis bundle before and after the implementation of BPAs. Though after the implementation of BPAs the timeliness of antibiotic administration and blood culture collection improved, there was no significant improvement in appropriate antibiotic choice, length of stay, or mortality. BPAs were also found to be inconsistent, frequently firing days after the patient met sepsis criteria. In some cases, a BPA did not fire at all. However, these findings have led to further questions and study recommendations which could lead to future research into the effectiveness of current treatment protocols and alternative treatment modalities.

After decades of research and countless modifications to treatment protocols, sepsis remains a leading cause of mortality in the United States with a rate as high as 50% and has a

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readmission rate which surpasses that of heart failure, myocardial infarction, pneumonia, and COPD (Rusconi et al., 2015; “Sepsis Trumps CMS’s Four Medical Conditions,” 2017). In the future, healthcare providers need to be more tolerant of alternative treatment options in order to find effective strategies to improve outcomes for sepsis patients. Multidisciplinary discussions of successes and failures could finally lead to decreased morbidity and mortality of this relentless diagnosis.

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**Table 1.** *Patient Characteristics of the Study Sample*

	Total sample (n= 148)	Pre-implementation (n=73)	Post- implementation (n=75)	p
	Mean (SD) or n (%)	Mean (SD) or n (%)	Mean (SD) or n (%)	
Age	50.4(11.7)	50.7 (10.7)	50.2 (12.7)	.29
Sex				.63
Male	80(54.1%)	38 (52.1%)	42(56.0%)	
Female	68(45.9%)	35(47.9%)	33(44.0%)	
Race				.34
White	121(81.8%)	58(79.5%)	63(84.0%)	
African American	25(16.2%)	13(17.8%)	11(14.7%)	
Hispanic/Latino	1(0.7%)	0(0.0%)	1(1.3%)	
Asian	0(0.0%)	0(0.0%)	0(0.0%)	
Other	2(1.4%)	2(2.7%)	0(0.0%)	
Time of admission				.71
Day 0700-1859	91(61.5%)	46(63.0%)	45(60.0%)	
Night 1900-0659	57(38.5%)	27(37.0%)	30(40.0%)	

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**Table 2.** Comparison of Pre and Post BPA Implementation Groups

	Pre-implementation (n=73)	Post-implementation (n=75)	p
	Mean (SD, n (%)) or Median (range)	Mean (SD, n (%)) or Median (range)	
Sepsis Criteria Met			
Yes	49(67.1%)	67(89.3%)	.001
No	24(32.9%)	8(10.7%)	
Time of Blood Culture Collection	n=68	n=75	.03
1-30 min	28(41.2%)	46(61.3%)	
31-59 min	8(11.8%)	4(5.3%)	
60-90 min	11(16.2%)	10(13.3%)	
>90 min	21(30.9%)	15(20.0%)	
Time of ABX administration	n=70	n=73	.008
1-45 min	15(21.4%)	28(38.4%)	
46-119 min	14(20.0%)	17(23.3%)	
120-240 min	14(20.0%)	12(16.4%)	
>240 min	27(38.6%)	16(21.9%)	
Antibiotic selection	n=70	n=73	.94
Appropriate	56(80.0%)	58(79.5%)	
Inappropriate	14(20.0%)	15(20.5%)	
Time of BPA Firing	N/A*	n=59	N/A*
<30 min		15(25.4%)	
31-180 min		8(13.6%)	
181min- 6 hrs		10(16.9%)	
6hrs1min-18 hrs		7(11.9%)	
18hrs1min-24hrs		0(0.0%)	
24hrs1min-72 hrs		6(10.2%)	
>72 hrs		13(22.0%)	
Mortality			
Expired	6(8.2%)	10(13.3%)	.32
Alive	67(91.8%)	65(86.7%)	
Length of stay	6 (0-45)	7 (1-30)	.97

\*The pre-implementation group data was pulled prior to the use of BPAs, therefore there are no BPA firing times for this group.

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### Appendix A. Sepsis Criteria

#### **Vital Sign Abnormalities (must have two)**

- Temperature  $>38.3$  C or  $<36.0$  C
- Heart rate  $>90$  beats/min
- Respiratory rate  $>20$  per/min
- White blood cell count  $>12,000$  or  $<4,000$  or  $>10\%$  bands

#### **Presence of Suspected Infection**

Any indication of suspected infection noted by MD, APRN, PA, Pharmacist, or RN

#### **Organ Dysfunction (must have one)**

- Systolic blood pressure (SBP)  $<90$ , or mean arterial pressure  $<65$ , or a SBP decrease of more than 40 mmHg from the last previously recorded SBP considered normal for that specific patient
- Creatinine  $>2.0$ , or urine output  $<0.5$  mL/kg/hour for 2 hours
- Bilirubin  $>2$  mg/dL (34.2 mmol/L)
- Platelet count  $<100,000$
- INR  $>1.5$  or a PTT  $> 60$  sec
- Lactate  $> 2$  mmol/L (18.0 mg/dL)
- Respiratory failure (must be documented by an LIP or RN)

(CMS Sepsis Core Measure Algorithm, 2015)

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### **Appendix B.** *Broad Spectrum Antibiotics*

cefepime (Maxipime)

levofloxacin (Levaquin)

piperacillin-tazobactam (Zosyn)

aztreonam (Azactam) + Vancomycin

ceftriaxone (Rocephin)

meropenem (Merrem)

metronidazole (Flagyl) only counts if the patient has *Clostridium difficile* infection

Vancomycin only counts if the patient has *Clostridium difficile* infection

(Healthcare Organization's Formulary of Sepsis Antibiotics)

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