Evaluation of an Interprofessional Emergency Department Sepsis Quality Improvement Initiative

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Abstract

Introduction: Utilizing the 2016 Surviving Sepsis Campaign guidelines to frame appropriate interventions, the purpose of this quality improvement project is to evaluate the outcomes of an interprofessional sepsis quality improvement initiative in the Emergency Department. The quality improvement project was conducted at a rural, academic, safety-net, level 1 trauma center with approximately 60,000 ED visits per year.

Methods: A prospective, descriptive project design evaluating the effect of the sepsis quality improvement initiative over six months. The interprofessional, ED quality improvement team consisted of 11 professionals, who collaborated through 6 formal meetings in a 6-month period. Data were collected retrospectively. The primary measures were 1) adherence to the 3-hour bundle elements of care and 2) all-cause in-hospital mortality.

Results: Between July and December 2017, the Emergency Department had 525 patients ages 18 years and older with a sepsis alert activated. Over the project period, the mean door to sepsis alert time decreased by 37 minutes. Adherence improved to 3 of the 4 major elements of the 3-hour sepsis management bundle. Month-to-month analysis of mortality data did not demonstrate any significant changes during the project period.

Discussion: This quality improvement initiative empowered emergency nursing staff to screen patients for sepsis, activate sepsis alerts, and initiate bundled care as appropriate. The improvements in bundle adherence might be attributed to the interprofessional approach to ED sepsis optimization. This approach provided information regarding potential barriers to sepsis identification and management, as well as methods to address these obstacles.

Contribution to Emergency Nursing Practice

- The purpose of this practice improvement project was to evaluate the implementation of an interprofessional Emergency Department Sepsis Quality Improvement Initiative using the 2016 Surviving Sepsis Campaign Guidelines as a framework.
- The primary outcome of this practice improvement project was 3-hour bundle compliance and all-cause in-hospital mortality.
- Key implications for emergency nursing practice based on this project are Emergency Nurses are valued members of the interprofessional team that can directly influence sepsis management through direct clinical practice, participation in QI, and execution of QI initiatives.

Introduction

Sepsis is a complex clinical syndrome that requires expedited, sequenced, and evidence-based clinical interventions to decrease the risk of poor clinical outcomes and mortality. Nationally, according to death certificates between 1999 and 2014 over 2.4 million or 6% of all deaths were sepsis-related (Epstein, Dantes, Magill, & Fiore, 2016). Furthermore, the Hospital Care and Utilization Project (HCUP) determined that, among inpatient visits in 2013, sepsis was the most common reason for admission and the costliest diagnosis (Torio & Moore, 2016).

In March of 2017 the “Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock: 2016” were published (Rhodes et al., 2017). The guidelines focus on the management of sepsis with attention to early identification, fluid resuscitation, source control, lactate measurement, and antimicrobial therapy within one hour of recognition. The guidelines also recommend sepsis screening and performance improvement programs as methods to increase adherence with bundled sepsis care and reduce mortality (Rhodes et al., 2017).

Currently, gaps in knowledge and practice exist regarding the implementation of the new SEP-3 definitions, clinical criteria, and the 2016 Surviving Sepsis Campaign (SSC) guidelines. Further complicating the gaps is a lack of congruent expectations between research, professional organizations, and regulatory agencies. Despite their advocacy, many of these professional organizations continue to utilize the former definitions of sepsis for their initiatives.

The Emergency Department, which served as the QI practice site desired to optimize the care of septic patients in the ED. A cohort of leaders determined that a QI initiative was an appropriate method to improve ED sepsis care. Published QI initiatives from the Emergency Department setting demonstrate the benefits of an interprofessional approach to sepsis optimization. Quality Improvement (QI), a variation of PI, examines patient care and system-level processes with the intention of improving patient outcomes (Hickey & Brosnan, 2017). Utilizing the 2016 SSC guidelines to frame appropriate interventions and outcomes, the purpose of this QI initiative is to evaluate the implementation of an interprofessional sepsis QI initiative in the Emergency Department.

Methods

The quality improvement process was prospective and descriptive. Quantitative data regarding sepsis identification, bundle adherence, and mortality was analyzed to determine the effect of the intervention over time. The sample was the electronic medical records of ED patients, 18 years of age and older, who had a sepsis alert initiated between July and December 2017 (n=525).

The research setting was a rural, academic, Level I trauma care center in the southeast U.S that serves a safety-net hospital. The hospital also serves as a National Cancer Institute (NCI) and transplant center. The 41 bed ED can expand to 56 beds. Annually, the ED serves approximately 63,000 patients. Approval for this project was granted from the Institutional Review Board (IRB # 20087).

In the spring of 2017, an ED Sepsis Coalition was formed consisting of an Attending Physician, 3rd-year Resident, Quality Data Coordinator, Pharmacist, Quality Improvement

Systems Administrator and Analyst, a performance improvement coach, a medical informaticist, 2 nursing informaticist, an RN, and a DNP student.

The Interprofessional Quality Improvement Initiative.

Utilizing elements of lean methodology including an A3 format, the ED sepsis QI initiative aimed to improve the processes that impacted the clinical care. An A3 is a written format design for QI that structures the process (Jimmerson, 2007). Between July and December 2017, the Sepsis Coalition met on 6 occasions for approximately 1 hour. While attendance varied from meeting to meeting, important decisions were not made unless key stakeholders were present.

The interprofessional sepsis coalition was able to complete the following interventions to improve sepsis care: qualitative assessment of sepsis management, improved text paging notification to physician staff, revision of the sepsis order set, creation of a QI visual management system, revision of the ED sepsis procedure, development and implementation of a sepsis screening instrument for triage, standardization of the thermometer equipment, and revision of the EMR tracking board. Despite the achievements of the sepsis coalition, the following items remain actionable: revision of the EHR Best Practice Alert (BPA), improved text paging notification to the nursing staff, and an automated sepsis report.

Retrospective data collection was completed for each sepsis alert between July and December 2017. To be considered adherent to the standard an intervention must have been completed within the exact prescribed timeframe. Cumulatively, data were compiled into monthly reports to reflect the departmental adherence to the standards of care.

Acknowledging that the SSC identifies time zero as the time of triage, the decision was made for this QI initiative to identify time zero as the time of ED arrival. The metric door-to-alert was created to account for the difference between the time of arrival and the time of the alert. This accounts for the lag between ED arrival and triage, which can vary depending on the census, acuity level, and human factors. The median door to alert time was reported on a monthly basis to the sepsis coalition and ED department staff.

The bundle elements that were analyzed included: 1) blood culture collection prior to antibiotic administration, 2) antibiotic administration within 1 hour, 3) lactate measurement, and 4) administration of a 30ml/kg crystalloid bolus for sepsis-induced-hypo-perfusion. The bundle elements were further divided to determine adherence to the standards of care. An example of this is the blood culture collection element of the bundle, which was then divided into the collection of blood culture #1 and blood culture #2. The antibiotic administration element of the bundle was divided similarly.

Due to limitations with data abstraction, the administration of a 30ml/kg crystalloid bolus was evaluated to determine if it was administered throughout the entire ED length of stay rather than in a 3-hour period. Adherence was achieved if the patient received within 100ml of the calculated 30ml/kg bolus. The patients documented actual body weight was utilized to calculate the required crystalloid bolus.

The bundle elements were summarized into 6 monthly adherence reports. Descriptive statistics were used to compute the data reported to the sepsis coalition and ED staff. Inferential statistics were used to determine differences in adherence from month-to-month. Assistance with inferential statistics was provided by a statistician. IBM® SPSS® version 24 was used to analyze the data.

Results

Demographics

The demographic data month-to-month analysis included the following comparisons: 1) July to August 2) August to September 3) September to October 4) October to November 5) November to December (Tables 2 & 3). Inferential statistics established that there was no statistically significant differences in data when analyzed month to month (Table 4).

Mortality

Between July and December, 24 patients died during their hospital admission (Table 2). A Fisher's exact test established that there was no statistically significant differences in mortality from month-to-month (Table 3).

Door-to-Alert Data

The month-to-month analysis included the following comparisons: 1) July to August 2) August to September 3) September to October 4) October to November 5) November to December and 6) July to December. The sixth comparison, July to December, was added to the initial month-to-month analysis.

The mean and median door to alert times were calculated for each month (Figure 1). Levene's test of homogeneity of variances resulted with statistical significance, $p = .000$. As a result, a Kruskal- Wallis test established that the distribution of the door-to-alert time was the same across the categories of month, $p = .225$.

The Bundle Elements

Blood Cultures.

No statistically significant differences in blood culture collection were calculated between the months July to August, August to September, September to October, October to November, and November to December (Table 4). In July 81% of the patients had blood culture #1 collected prior to antibiotic administration, compared to December when adherence was calculated as 96% (Figure 2). Chi-Square statistics comparing July and December established that there was a statistically significant difference in the collection of blood culture #1 prior to antibiotic administration, $\chi 2$ (1, n= 168) = 8.43, *p* = .004 (Table 4). Comparing July to December, an improvement was noted in blood culture #2 collection, rising from 66% to 84% and Chi-Square analysis determined that there was a statistically significant difference in blood culture #2 collection, $\chi 2$ (1, n = 168) = 7.23, *p* = .007 (Figure 2).

Fluid Resuscitation.

This analysis focused on 249 patients that either had any MAP < 65mmhg or initial lactate >2 during their ED stay (Figure 3). Over the 6-month period, Chi-square analysis established there was no statistically significant differences in the adherence of fluid administration between the months (Table 4).

Intervention from Time-of –Alert

In July 76% of the patients had a lactate result within one hour, compared to 90% in December (Figure 4). Using Chi-Square statistics, it was determined there was no difference in lactate results within one hour of alert between July to August, August to September, September to October, October to November, and November to December (Table 4). When July and December were compared, it was determined there was a statistically significant difference in lactates resulted within one hour, $\chi 2$ (1, n = 168) = 5.52, p = .019.

The administration of the first and second antibiotic within one hour of the alert was analyzed. Any patient alerted that was then treated for viral illness, such as influenza, or any other non-infectious process was removed from the sample (n = 518). In July adherence was 81%, it peaked in October at 95%, and was 91% in December (Figure 5). Chi-Square statistics determined that there was no statistically significant difference in the administration of the first antibiotic within 1 hour of alert when evaluated from month-to-month (Table 4).

If a second antibiotic was not ordered, then that patient was removed from the total sample (n = 351). The administration of the second antibiotic was achieved 53% of the time in July, peaked in October at 69%, and at the conclusion of the project in December was 68% (Figure 5). Chi-Square analysis determined there was no statistically significant differences in the administration of the second antibiotic within 1 hour of alert from month-to-month (Table 4).

Intervention from Time-Zero

In July 84% of the patients had a lactate resulted within 3 hours of time zero, compared to 96% in December (Figure 3). Chi-Square analysis established that there were statistically significant differences in the adherence to this standard when the months of July and December were compared, $\chi 2$ (1, n = 168) = 6.31, *p* = .012. Further month-to-month analysis did not reveal any statistically significant differences.

The administration of the first antibiotic within one hour of arrival was 36% adherence in the month of July and increased to 51% in December. Month-to-month analysis did not reveal any statistically significant differences when using Chi-Square statistics. However, the comparison of July and December was approaching statistical significance, $\chi 2$ (1, n = 166) = 3.741, *p* = .053.

The administration of the second antibiotic within one hour of arrival increased from 18% in July to 37% in December. This result was statistically significant when July and December were compared, $\chi 2$ (1, n = 115) = 4.88, *p* = .027 (Table 4) (Figure 6). Additional month-to-month comparisons did not result in any statistically significant differences in administration of the second antibiotic within 1 hour of time zero.

Discussion

Summary

The implementation of an interprofessional ED sepsis QI initiative improved adherence to 3 of the 4 major elements of the 3-hour sepsis management bundle. The 3 major elements that improved included lactate measurement, blood culture collection before antibiotic administration, and the delivery of antibiotics within one hour. Fluid resuscitation element was the only element that did not improve.

Fluid resuscitation was a difficult data point to abstract due to the assessment of multiple variables and time constraints. Challenges include the manual extraction of data from multiple locations in the EHR and inconsistent documentation practices. Despite recommendations, adherence to fluid administration guidelines varied due to independent clinical decision-making. Anecdotally, confounding factors included hesitation when caring for patients with heart failure, end-stage renal disease, and pulmonary infections. It is also pertinent to consider that the QI process did not focus any specific efforts on adherence to this metric, as other metrics were prioritized during the QI process. Furthermore, the sepsis order set did not display fluid orders in the format of 30ml/kg but rather had 2 separate liter volume orders that could be selected by the provider.

The demographic variables that were collected and analyzed revealed a homogenous sample. This provided a good baseline to assess intervention adherence. November had the most sepsis alerts of any month, n = 110. As a result, many of the bundle elements demonstrated decreased adherence during this month. Potential factors that could have contributed this are increased patient volume and clinician workload.

The QI initiative did not change the incidence of all-cause in-hospital mortality for sepsis alerted patients over the course of the project period. This could be attributed to the seasonal variation of the project period. Future analysis of sepsis mortalities might be more meaningful if it was compared to the prior annual year.

Early recognition of sepsis, a clinically essential action, provides an opportunity for clinicians to deliver time-sensitive interventions to septic patients swiftly. The interprofessional QI initiative built upon sepsis procedures that were already in place, including the "sepsis-alert" process. To capture the lag between ED arrival and the action of initiating a sepsis alert the door-to-sepsis-alert metric was created. Preferably, sepsis would be recognized during the first contact with a clinician, such as a triage RN, to facilitate early intervention. Although not statistically significant, over the 6-month project period the decrease in the door-to-sepsis-alert metric was clinically significant. Five patients in the sample were sepsis-alerted by EMS during transport to the hospital. This notification could eliminate delays in care for septic patients. Future QI work should consider including EMS personnel in the interprofessional team. Consistently throughout the project period, there was a focus on encouraging the practice of obtaining rectal temperatures. This educational focus, combined with the standardization of equipment in each exam room may have influenced earlier recognition of sepsis throughout the project period.

The delivery of antibiotics within 1-hour of sepsis alert peaked in October. In November, decreased adherence could have been related to an increased patient volume, increased clinician workload, or changes in the distribution of antibiotics within the hospital. Changes in the distribution of antibiotics within the hospital was the result of conservation efforts related to a large-scale natural disaster that occurred at the site of antibiotic production, thus leading to supply concerns regarding antibiotic availability.

Currently, the ED does not have an automated report that gathers information from the EHR. To remain a sustainable initiative, an automated report is required. With less time focused on data abstraction, more time will be available for interventions to address gaps in clinical practice and knowledge. It is recommended that institutions consider creating sepsis visual management systems that readily display progress reports to staff members concerning guideline adherence.

Some limitations regarding the sample should be considered. The first limitation is it only includes patients that were sepsis-alerted in the ED. The ED sepsis alert process is not the same as being diagnosed with sepsis. The second consideration is that not all septic patients may have been sepsis alerted due to human factors and independent decision-making. The practice of treating a patient for sepsis and not initiating a sepsis-alert was strongly discouraged by the QI team throughout the project period but nevertheless occurred.

In summary, from July to December, the QI initiative demonstrated improved adherence to the 3-hour bundle in 8 of 9 established metrics. Five of these improvements were statistically significant. The improvement might be attributed to the interprofessional approach to ED sepsis optimization. This approach provided information regarding potential barriers to sepsis identification and management and methods to address these obstacles.

Implications for Emergency Department Nursing

Adherence to evidence-based sepsis guidelines has the potential to reduce morbidity and mortality from sepsis. This quality improvement initiative empowered nursing staff to screen patients for sepsis, activate sepsis alerts and initiate bundled care as appropriate. The evaluation of the quality improvement process identified interventions that were successful at improving adherence to the standards.

This QI initiative demonstrates the value of robust data collection by a nurse familiar with the workflow in the Emergency Department. Potentially, the Emergency Department environment, staff, and patients could benefit from a nurse dedicated to monitoring sepsis management. It is recommended that institutions consider developing a Sepsis Coordinator position that is highly involved in the Emergency Department. Sepsis Coordinators could assist with the collection of meaningful data, providing feedback to the staff, and translating new research into practice.

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Table 1

Emergency department sepsis alert mean age by month, 2017 (n = 525)

Month	n	Mean	Standard Deviation
July	80	56.4	17.9
August	84	56.4	16.9
September	79	62.4	18.7
October	84	61.0	18.5
November	110	58.5	17.4
December	88	61.2	16.2

Table 2

Emergency Department Sepsis Alert Demographic Information, 2017 (n = 525)

Characteristic	July n (%)	August n (%)	September n (%)	October n (%)	November n (%)	December n (%)
Number of Sepsis Alerts	80	84	79	84	110	88
Sex						
Male	33 (59)	40 (48)	44 (56)	39 (46)	63 (57)	51 (58)
Female	47 (41)	44 (52)	35 (44)	45 (54)	47 (43)	37 (42)
Emergency Severity Index						
Level 1 and 2	53 (66)	55 (66)	58 (73)	65 (77)	82 (75)	66 (75)
Level 3 and 4	27 (34)	29 (35)	20 (25)	19 (23)	27 (25)	22 (25)
Level Missing			1 (1.3)		1 (0.9)	
Hospital Admission	76 (95)	77 (92)	72 (91)	80 (95)	103 (94)	82 (93)
ICU Admission	18 (24)	12 (16)	15 (21)	15 (19)	21 (20.4)	10 (12)
Mortality	3	4	4	5	3[b]	5

Note: [a]Emergency Severity Index Level is a triage categorization provided by nursing staff to indicate the patient's acuity level, a level 1 patient is the most critically ill while a level 5 is the least critically ill. [b]One medically complex patient remained hospitalized in February 2018.

Table 3

Chi-Square statistics for demographic variables, July to December 2017[a] *(n = 525).*

Characteristic	July to Aug		Aug to Sept		Sept to Oct		Oct to Nov		Nov to Dec	
	χ^2	*p*	χ^2	*p*	χ^2	*p*	χ^2	*p*	χ^2	*p*
Gender	0.673	.412	1.063	.302	1.399	.237	2.246	.134	0.009	.923
ESI Level[b]	0.11	.917	1.513	.219	0.202	.653	0.121	.728	0.001	.970
Disposition[c]	0.908	.341	0.146	.702	1.087	.297	0.228	.633	0.16	.898
ICU Admission[d]	1.592	.207	0.691	.406	0.104	.747	0.076	.782	2.197	.138
Mortality[e]		1.000		1.000		1.000		.243		.245

Note: [a]All degrees of freedom equal 1. [b]Compared groups are ESI Level 1 and 2 to ESI Level 3 and 4 patients, n = 523. [c]Compared admitted patients to discharged patients, n = 523. [d]Of admitted patients compares monthly ICU admissions, n = 490. [e]Mortality was analyzed using an Fisher's exact test.

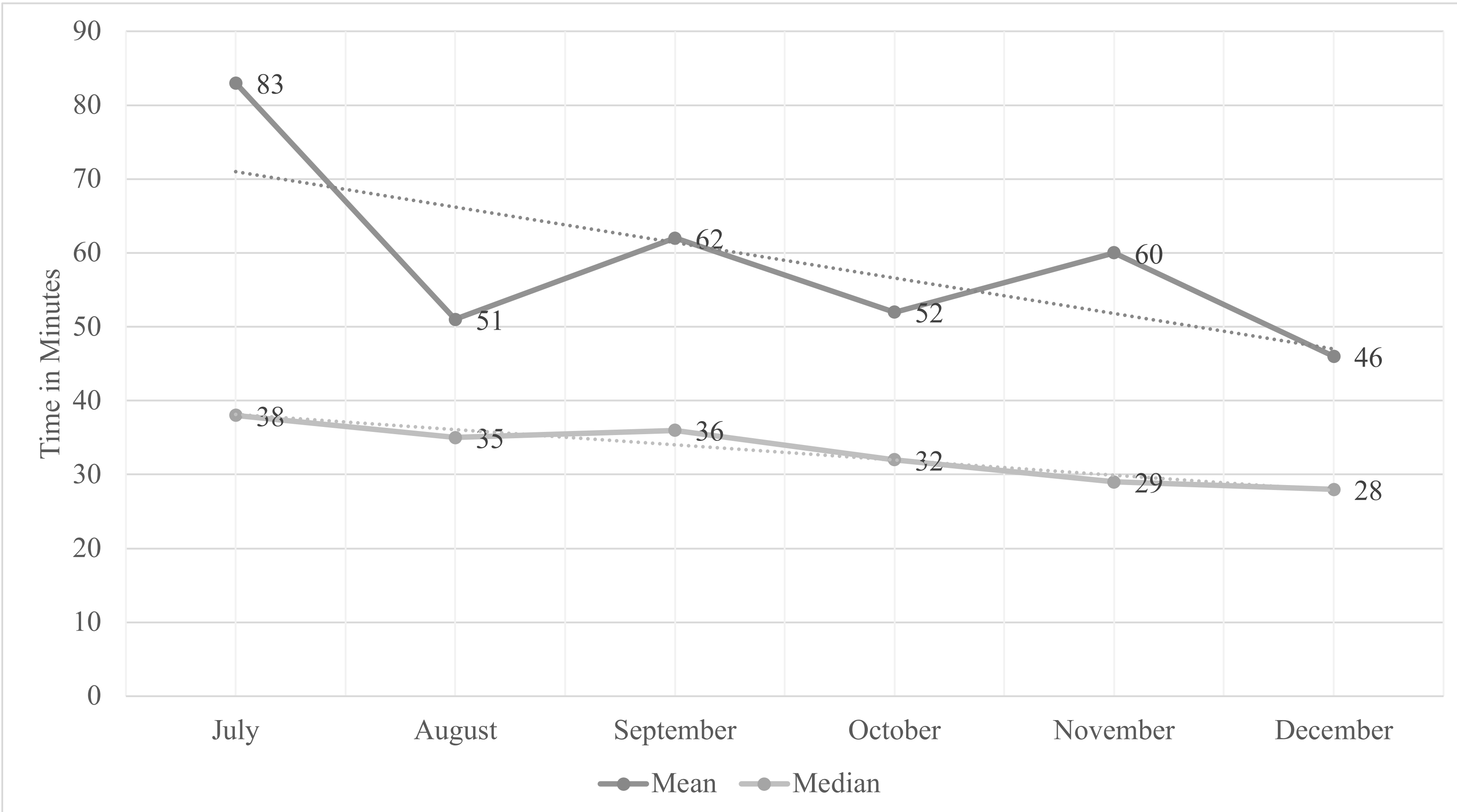
Table 4

Chi-Square statistics for interventions, July to December 2017[ab] (n = 525).

Characteristic	July to Aug		Aug to Sept		Sept to Oct		Oct to Nov		Nov to Dec		July to Dec	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Blood Culture # 1	0.183	.669	0.160	.690	0.344	.558	2.583	.108	3.295	.070	8.429	.004
Blood Culture # 2	0.147	.702	0.65	.798	0.337	.561	2.698	.100	1.437	.231	7.230	.007
Fluid Resuscitation	0.695	.404	1.261	.262	0.529	.467	0.616	.433	0.008	.928	0.56	.814
From Time of Alert												
Lactate resulted in 1 hour	0.126	.722	1.055	.304	0.709	.400	1.507	.220	0.533	.465	5.517	.019
Antibiotic # 1 started	3.713	.054	0.433	.510	2.446	.118	3.646	.056	0.638	.424	3.099	.078
Antibiotic # 2 started	0.040	.841	0.127	.722	2.339	.126	0.151	.697	0.99	.753	2.934	.087
From Time Zero												
Lactate resulted in 3 hours	3.318	.069	0.043	.836	0.240	.624	0.075	.784	0.639	.424	6.312	.012
Antibiotic #1 started	1.932	.165	0.003	.955	0.161	.688	0.349	.555	0.454	.500	3.741	.053
Antibiotic #2 started	0.004	.949	1.981	.159	0.016	.901	0.011	.918	0.634	.426	4.882	.027

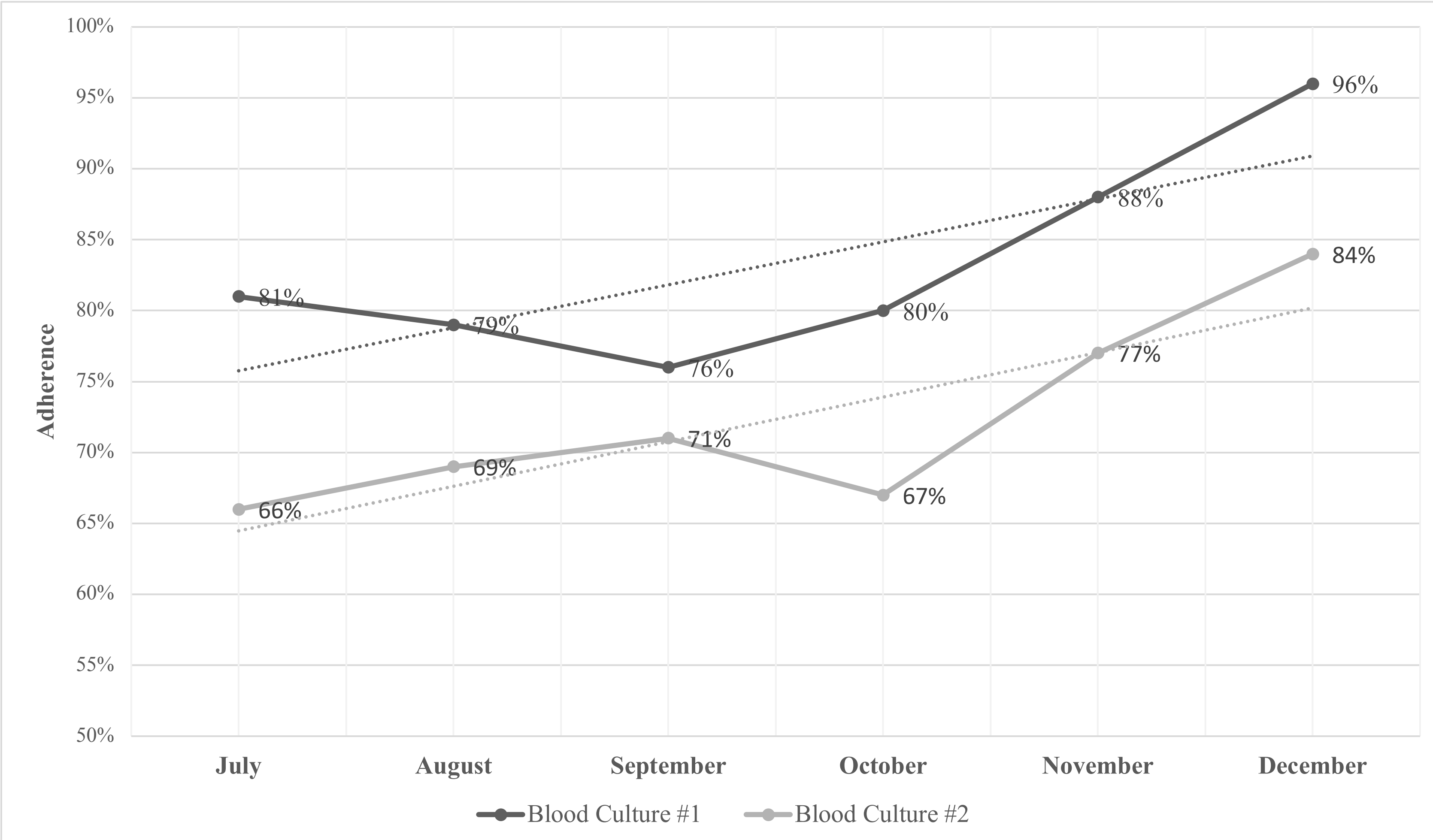
Note: [a]All degrees of freedom equal 1. [b]Statistical significance is $p < .05$.

Figure 1. Door to Sepsis Alert Measures of Central Tendency, 2017[a] (n = 525).



[a]All times rounded to the nearest minute.

Figure 2. Percentage of blood cultures collected prior to antibiotic administration, 2017[a]. (n = 525).



[a]All figures rounded to the nearest whole number. Statistically significant differences in adherence when July is compared to December for blood culture #1, $\chi 2$ (1, n = 168) = 8.43, p = .004, and blood culture #2, $\chi 2$ (1, n = 168) = 7.23, p = .007.

Figure 3. Fluid resuscitation of 30ml/kg for hypotension or lactate >2 received during entire ED length of stay.

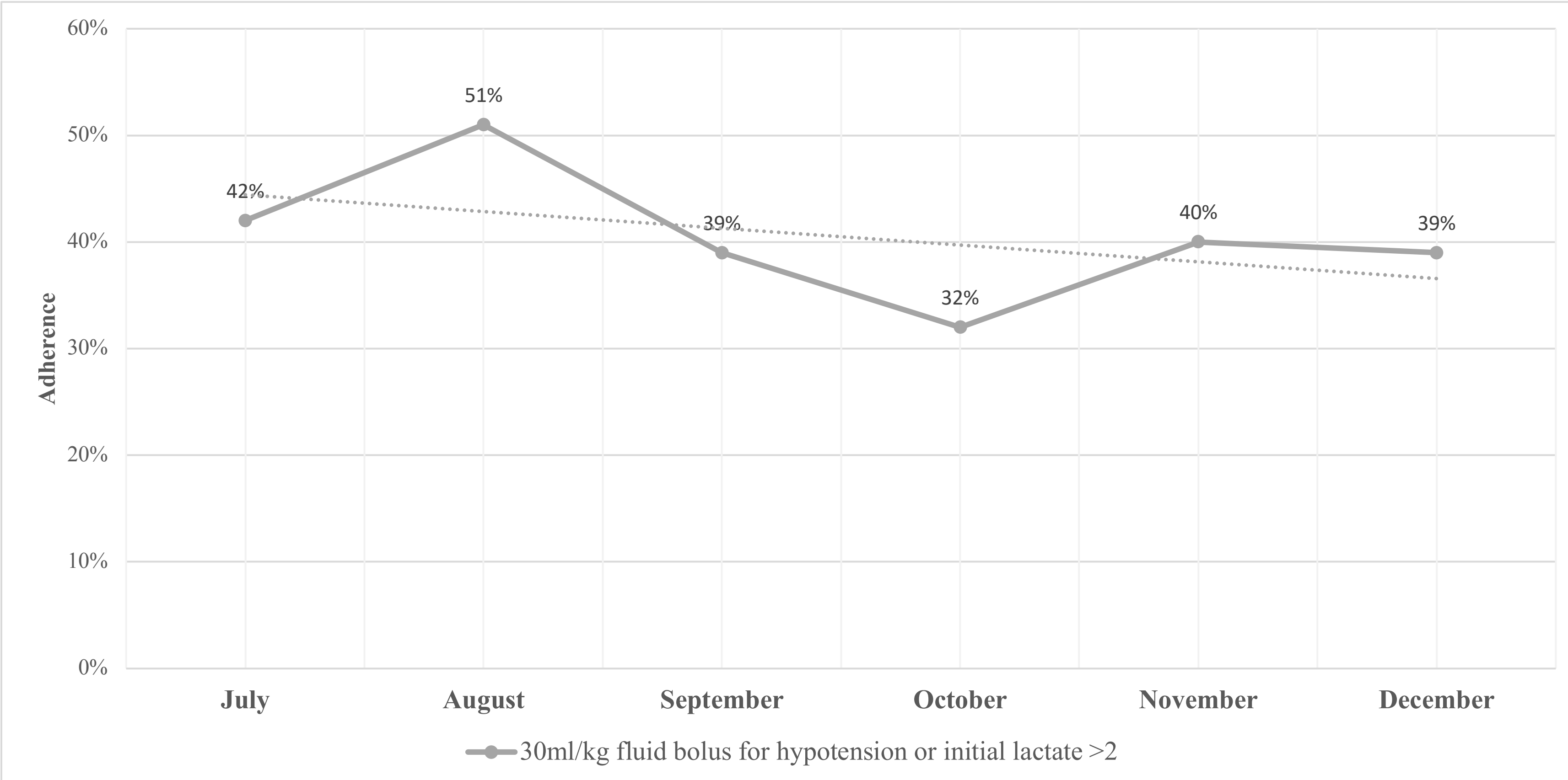
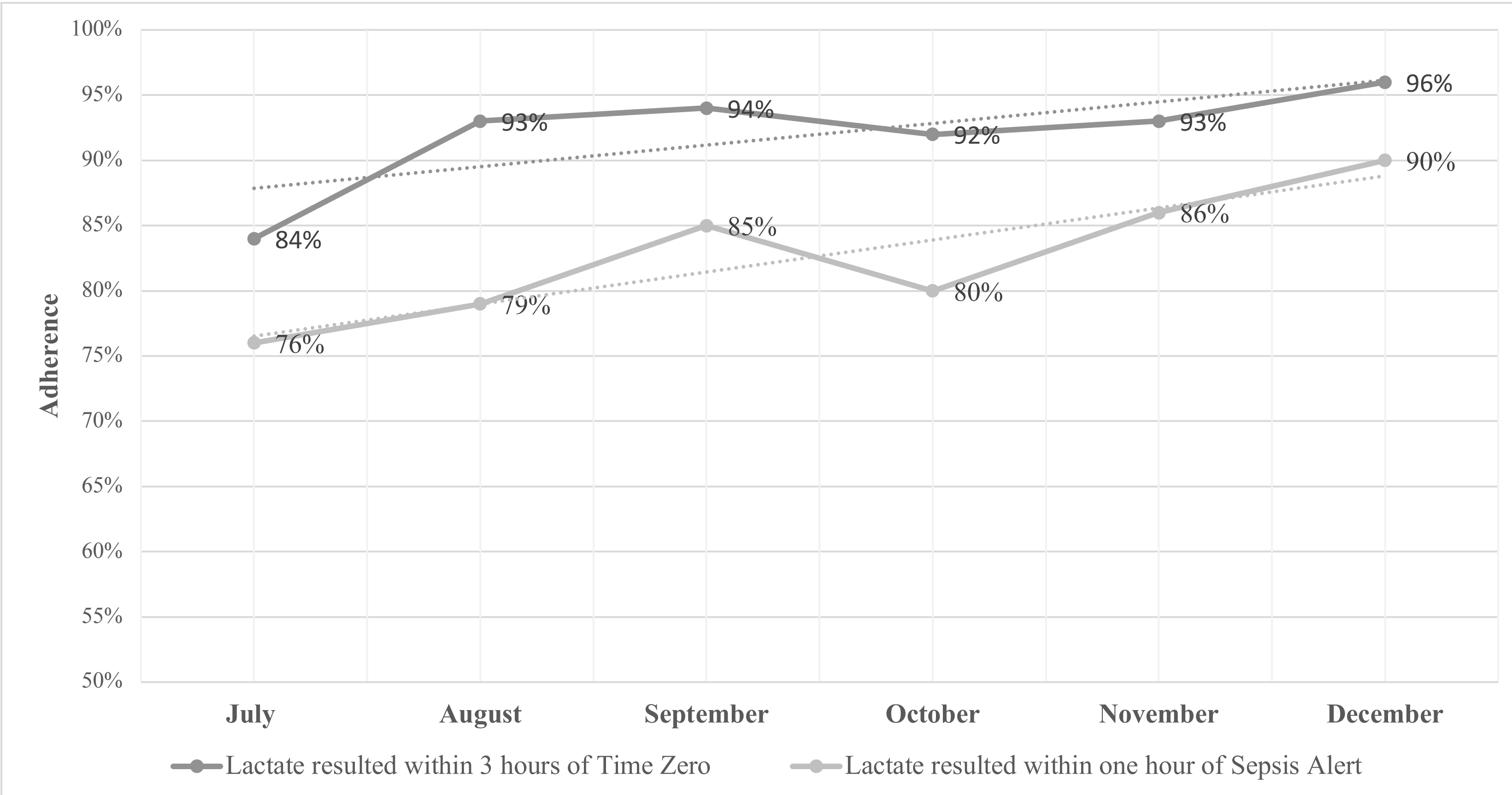
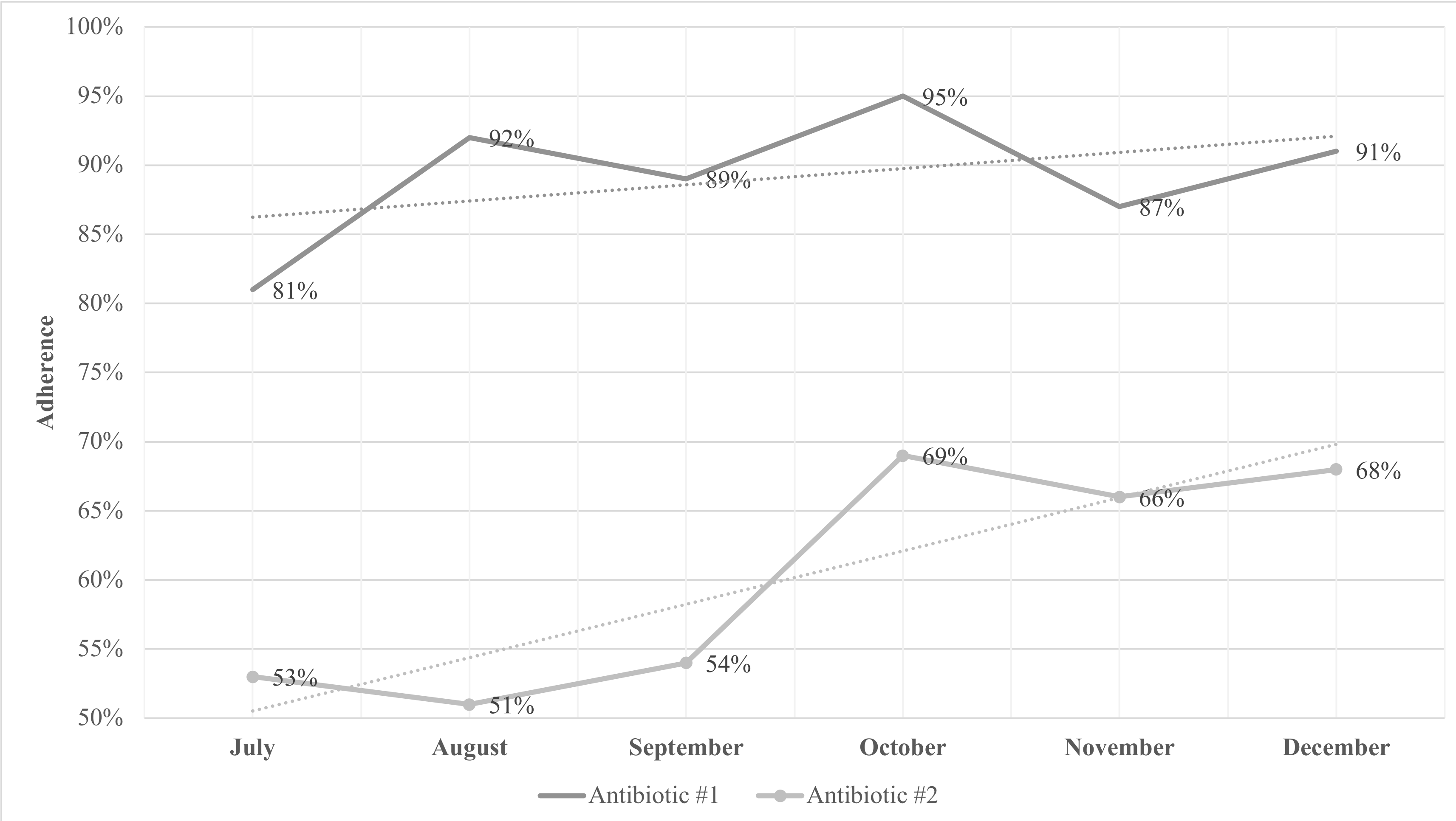


Figure 3. Percentage of lactates resulted by standard for Emergency Department sepsis alerts, 2017[a]. (n = 525).



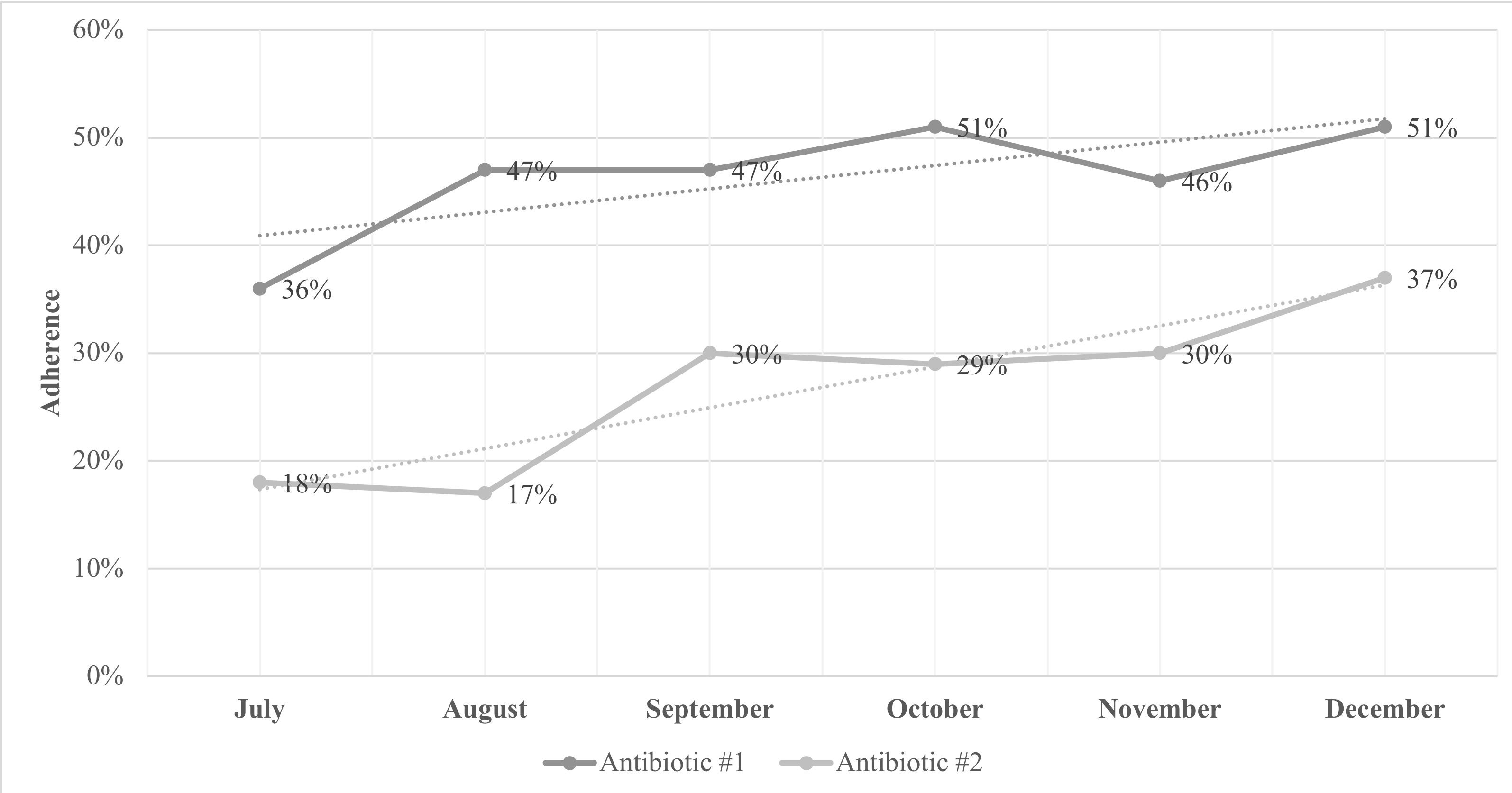
[a]All percentages rounded to the nearest whole number. The comparison of July to December established statistically significant differences in lactates resulted within one hour of sepsis alert, $\chi 2$ (1, n = 168) = 5.52, p = .019. The comparison of July to December established statistically significant differences in lactates resulted within 3 hours of sepsis alert, $\chi 2$ (1, n = 168) = 6.31, p = .012.

Figure 5. Percentage of antibiotics administered within one hour of Emergency Department Sepsis Alert, 2017[ab].



[a]Antibiotic #1 n = 518. [b]Antibiotic #2 n = 351.

Figure 6. Percentage of Emergency Department sepsis alerted patients given antibiotics within one hour of arrival, 2017[ab.]



[a]Antibiotic #1 n = 525. [b]Antibiotic #2 n = 351. The comparison of July to December was approaching statistically significant differences in antibiotic #1 administration within 1 hour of ED arrival, $\chi 2$ (1, n = 166) = 3.741, p = .053. The comparison of July to December established statistically significant differences in antibiotic #2 administration within 1 hour of ED arrival, $\chi 2$ (1, n = 115) = 4.88, p = .027.