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Using Shock Index as a Predictor of ICU Readmission: A Quality Iimprovement Project

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USING SHOCK INDEX AS A PREDICTOR OF ICU READMISSION:

A QUALITY IMPROVEMENT PROJECT

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This Capstone Project has been examined and approved.

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Date

DEDICATION

To my incredibly supportive and loving husband and children, I could not have done this without you. Thank you for everything.

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Abstract

Using Shock Index as a Predictor of ICU Readmission: A Quality Improvement Project

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Background: Adverse events will occur in one-third of patients discharged from the intensive care unit (ICU) and evidence shows that ICU readmissions increase a patient's length of stay, mortality, hospital costs, and nosocomial infections, as well as decrease long-term survival. Specific predictive factors that will accurately predict which patients are at risk of adverse events requiring readmission are needed.

Aim: The specific aim of this project was to identify if shock index (SI) values higher than 0.7 at the time of transfer from the ICU are a useful predictor of ICU readmission.

Methods: Using the Plan, Do, Study, Act (PDSA) framework, a retrospective chart review was performed using a matched cohort of 34 patients readmitted with 72 hours of discharge from the ICU and 34 controls to obtain SI values at admission, transfer from and readmission to the ICU. A second PDSA cycle looked for SI trends within 24 hours prior to discharge from the ICU.

Results: An odds ratio calculating the risk of readmission of patients with an elevated SI was 2.96 (Confidence Interval (CI) 1.1 to 7.94, p-value=0.03). The odds ratio for an 80% SI elevation over 24 hours prior to discharge was 1.56 (CI 0.36 to 6.76, p-value=0.55).

Conclusion and Implications for CNL Practice: Patients with elevated SIs at the time of transfer are three times more likely to be readmitted to the ICU. Patients with elevations in at least 80% of the 24 hour pre-discharge SIs showed no significant differences between the control and readmitted cohorts. Implications of these results for the clinical nurse leader will be discussed.

Key Words: *Intensive Care Unit, Readmission, Shock Index, PDSA, Quality Improvement*

Decreasing ICU Readmission: A Quality Improvement Project

Introduction

Readmission to the intensive care unit is costly both to the hospital and the patient. There is evidence that ICU readmissions increase a patient's length of stay at least two-fold, increase mortality 1.5 to 10 times, increase hospital costs by 15 billion dollars, increase the incidence of nosocomial infections by 30% (Tabanejad, Pazokian, & Ebadi, 2014) and decreases long-term survival (Timmers, Verhofstad, Moons, & Leenen, 2012). Additionally, it has been shown that adverse events will occur in one-third of discharged ICU patients. (Tabanejad et al., 2014)

Global Problem

There are many factors that contribute to a patient being readmitted to the ICU. Commonly found and statistically supported predictors include being male, having a history of multiple comorbidities, particularly a diagnosis of type II diabetes mellitus, the application of continuous renal replacement therapy (CRRT) during the ICU stay, an increased heart rate, or tachycardia, at the time of ICU discharge, and an increased white blood cell (WBC) count at the time of extubation. (Jo et al., 2015) Other factors that may contribute include transfer and transition issues, such as the patient being transferred out of the ICU at night when staffing and expertise of floor nurses is low, and/or to a unit that cannot provide a sufficient level of care (Hosein et al., 2014), patient age, length of stay in the ICU, the amount of time the patient spent on mechanical ventilation and low Glasgow coma scale scores (Johns, 2014). It has also been found that the most common reason for ICU readmission is respiratory distress and that if readmission occurs within 72 hours of ICU discharge, the reasons are most likely due to the initial unresolved ICU diagnosis. If the readmission is "late" (after 72 hours), it is usually due to complications from the patient's comorbid conditions. (Timmers et al., 2012)

However, knowing that there are certain predictive factors has not been found to accurately predict which patients will be readmitted to the ICU and which will not. With more and more acute patients being transferred out of the ICU because they are the least sick of the sick, or "most well" (Burns, 2006), it has been proposed that floor nurses are either ill-equipped to handle the complex care required or do not have the time to give the patient the attention he or she needs based on the care required. It is thought that due to this, many signs and symptoms may not be identified quickly enough for intervention to either prevent a readmission or quickly enough to readmit the patient before serious adverse events.

Local Problem

Although, one-third of patients will experience adverse events in the period following ICU discharge, it has been found that with better standards of care, one-half of those could be prevented. (Tabanejad et al., 2014) At a 330 bed New England Hospital, the ICU readmission rate is 6.6%, which is higher than the national average of 5.9% (Kramer, Higgins, & Zimmerman, 2013). In an effort to reduce the percentage of ICU readmissions, a quality improvement project to try to identify patients at risk for re-admittance, in the hope of being able to provide intervention either prior to initial ICU discharge or prior to the onset of adverse events that would require readmission to the ICU was initiated.

Through retrospective chart review for fiscal year 2014 of this hospital's patients readmitted to the ICU within 72 hours, the rate of return to the ICU is 6.6%, with 37.8% of those readmissions due to cardiac issues and 37.8% respiratory. 50% of the original admitting diagnoses were cardiac as compared to 28.1% respiratory, indicating an increase in respiratory readmitting diagnoses. (Appendix A) 56.7% of patients were readmitted to the ICU within 72 hours for the same admitting diagnosis. (Appendix B) and only 27% of readmitted patients ever

received a critical care medicine consult. (Appendix C) (E. Latina, personal communication, May, 2015)

For these readmitted patients, the average length of hospitalization was 2-3 times longer and their in-hospital mortality was 2-5 times higher. (Appendix D) Looking to see if there are differences between the time of day a patient was readmitted, it was found that weekends and holidays accounted for 40.5% of readmissions (Appendix E) and off hours for both weekend and weekday combined account for 51.4% (Appendix F). Not yet charted but reported by the nurse practitioner on the unit, on one particular unit with extremely high staff turnover, 48.6% of patients were readmitted to the ICU within 72 hours. Since the majority of readmissions are for the same diagnosis and the rate of respiratory distress is higher than it was originally, and since many readmissions are during off hours or holidays and weekends, as well as from units with high turnover, this data provides preliminary evidence that the readmissions could be due to a lack of skill or acuity expertise within the transfer units' staff to recognize clinical deterioration in time for intervention to prevent return to the ICU. This data provides evidence of a local problem of higher than average ICU readmissions at this ICU. The local problem is a lack of specific predictive factors to accurately predict which patients are at risk of adverse events requiring readmission. If an inexpensive, efficient indicator could calculate patients at risk for readmission, then early intervention could be initiated to either delay discharge or have the patient followed more closely by practitioners. It was proposed that Shock Index could be that index. (E. Latina, personal communication, May, 2015)

Shock Index (SI) is a ratio of heart rate to systolic blood pressure and is a noninvasive indicator of how well the left ventricle is functioning. It was created by Allgower and Burri who noticed that a healthy adult had a mean SI of .54 but that patients who suffered acute blood loss,

intra-abdominal bleeding, fat emboli and severe infections would have shock indices much

higher. They found that a shock index of 1.0 indicated "threatened shock" and if the index was

greater than 1.5, it indicated volume deficient shock. (Keller et al., 2010, p. 461) It has been used

to detect changes in cardiovascular performance before the onset of systemic hypotension and a

value greater than 0.8 has been found to have a 95% sensitivity for predicting shock. (Wira et al.,

2014)

SI has typically been used in trauma and hemorrhage situations in the identification of the

severity of shock and as a predictor of the need for transfusion. Additionally, increases in SI have

been shown to correlate well with severity of injury and undesirable outcomes. (Moffat, Vogt, &

Inaba, 2013) The shock index's usefulness comes from its simplicity in calculation and in its

non-costly, non-invasive ability to differentiate the risk of imminent cardiovascular collapse in

severe sepsis patients. Since originally devised, it has been studied for use in cardiogenic shock,

sepsis, ectopic pregnancy, gastro-intestinal hemorrhage and pulmonary embolism. (Wira et al.,

2014)

The normal SI range for a hemodynamically stable patient is 0.5 to 0.7 and abnormal

elevations have been determined to be 0.8 to 1.0, however, it has been found that there is no

established cut-off that has been routinely used in critical care literature for an SI above the

normal range. (Wira et al., 2014)

Literature Review

Evidence collected suggested that Shock Index may be an effective tool for predicting

ICU Readmission. Therefore a literature review was conducted to find evidence supporting the

effectiveness of the use of shock index. The search was conducted using the University of New

Hampshire's CINHAL database. It was searched using the term "shock index" and the search

results were limited to English only, full text, adult only, Academic Journals from 2005-2015.

104 results were produced but only 1 addressed the use of shock index and ICU readmissions.

However, after reading through synopses of the others, two were chosen for their research on

shock index and hemodynamic instability and another for its discussion of early warning systems

and ICU readmissions.

The article "Unplanned Transfers to the Intensive Care Unit: The Role of the Shock

Index" (Keller et al., 2010) has a level 3-B strength of evidence rating ("JHNEBP," 2015) and is

a retrospective randomized case-control study at an academic medical center. It looked at the SI

values of 50 patients with unplanned ICU transfers and 50 matched controls from 2003 to 2004.

They defined an unplanned transfer as "an episode of unexpected clinical deterioration in a

general medical patient that necessitated transfer to the ICU" (Keller et al., 2010, p. 461) and

only considered the first transfer to the ICU if the patient happened to have multiple transfers.

The control group was matched for age, diagnosis, unit and had to be admitted to the hospital for

at least 24 hours. The staff calculated SI from vital signs that were obtained at least every 8

hours.

The SI and corresponding odds ratio was found to be statistically significant if the SI was

.85 or greater, which indicated a strong association with ICU transfer. The transferred patients

were found to have significantly higher SI values than the controls and significantly longer

hospital stays and higher mortality rates. They found that SI values greater than 0.9 was used in

emergency departments in the identification of critical illness, even if the patients had stable vital

signs, and was used for immediate hospital admission and intensive therapy, but noted that it is

unclear whether it can be used to monitor ongoing treatment. They concluded that the findings of

their study may be useful as an indicator of illness without trauma and so could be used with patients who have various medical conditions.

Weaknesses within the study include not adjusting for comorbidities and not comparing SI to vital signs alone. Additional studies are also needed to compare SI with rapid response team activation criteria, to determine the role of comorbidities, and to determine cut-off values for certain diseases, including septic shock.

The article "Prevention of Unplanned Intensive Care Unit Admissions and Hospital Mortality by Early Warning Systems" (Mapp, Davis, & Krowchuk, 2013) discussed the physiological changes that patients exhibit prior to an adverse event. It is an integrative review that examines the effectiveness of early warning scoring systems in predicting patient deterioration and their efficacy for preventing unplanned ICU admissions or death. It has a level 1-A strength of evidence rating ("JHNEBP," 2015) and reviews nine studies from between 2007 to 2012 that examined early warning systems and associated clinical support.

The reviews looked at shock index, MEWS, CART and other adapted early warning systems in hospitals. The instruments all included variations of the vital signs HR, SBP, diastolic blood pressure (DBP), respiratory rate (RR) and temperature (T). One of the reviewed studies included Keller et al's 2010 study on shock index. Two of the studies included subjective parameters that included nurses' intuition. Four of the studies used other parameters such as body mass index (BMI), blood glucose, chest pain, increased supplemental oxygen use, increased white blood cell, new focal neurological weakness and nurses and family's subjective patient assessments. They concluded that the use of early warning systems results in improved patient outcomes, which was demonstrated by increased rapid response calls, decreased ICU

readmissions and decreased mortality. Additionally, they found that early warning systems did

not result in any negative outcomes.

They also found that early warning systems are more effective through the use of

algorithms because they provide nurses with direction, guidance and support in recognizing

changes in a patient's physiology. They recommended that early warning systems be

incorporated into an electronic medical record that uses algorithms and calculations that will then

provide instructions and guidance on appropriate interventions.

The article "The Shock Index as a Predictor of Vasopressor Use in Emergency

Department Patients with Severe Sepsis" (Wira et al., 2014) looks at the use of shock index as a

predictor of short-term cardiovascular collapse as defined by vasopressor dependence within the

72 hours prior. It is a level 3-B retrospective dual-centered cross-sectional study of 295 patients

with sustained SI elevations. ("JHNEBP," 2015) This study is the first to look at the impact of

sustained elevations in SI and its ability to risk stratify patients at risk for cardiovascular

collapse. Unique to these indices is the ability to identify vasopressor dependence as an

indication of the escalation of disease and hemodynamic decompensation.

The authors found that sustained elevation in SI was related to increased vasopressor use

and that the longer a patient had an elevated SI, the more likely they would need vasopressors

within 72 hours. They concluded that a sustained elevation in SI is a better predictor of

vasopressor use than one initial elevation. Additionally, sustained SI elevation was more related

to increased organ failure than in patients without sustained SI, even though other predictive

scoring systems such as APACHE and MEDS scores were the same.

In patients with sustained SI, it was also found that initial systolic blood pressure was

lower than in those patients who did not require vasopressor use, which although is an expected

finding, it was also found that the SBP of patients with sustained SI was greater than 100. From

this they concluded that patients with normal blood pressures but elevated SI are at risk for

hemodynamic decompensation. Many in the non-sustained SI group were hypertensive, which

would skew the SBP comparisons. Additionally, even in patients with early SBPs above 100,

there was a significant difference in vasopressor use between the non-elevated and elevated

groups.

Limitations included the small size of the data sample, the non-inclusiveness of the

patient registry, and the possibility of errors in the medical record.

The article "Application of the Shock Index to the Prediction of Need for Hemostasis

Intervention" (DeMuro, Simmons, Jax, & Gianelli, 2013), which has a level 3-A strength of

evidence rating ("JHNEBP," 2015), looks at the adequacy of using the traditional value of a

shock index of 0.9 in the minimization of false positives and negatives. 4292 trauma patients

from an 11 year period were divided into bleeding versus non-bleeding groups and their SIs were

calculated based on initial hospital vital signs.

The authors calculated sensitivity, specificity and positive and negative predictive values

for SIs from 0.1 to 2.0 in 0.1 increments for each case. They found that with a SI of greater than

or equal to 0.9 there is a sensitivity of 54.9% but higher specificity of 93.6% but by lowering the

cut-off to 0.8, the sensitivity increases to 76.1%, although the specificity decreases to 87.4%. By

lowering the cut-off to 0.8, the results more closely resemble what is found using the Assessment

of Blood Consumption (ABC) score, a highly accurate predictor of exsanguination. They

concluded that due to its simplicity, SI can be calculated by prehospital providers from vital sign

data, which will help identify bleeding trauma patients more quickly and more cost-effectively.

Limitations of the study included using the clinical endpoint of bleeding patients requiring therapeutic intervention rather than activation of the massive transfusion protocol or death.

Although the research on the use of shock index in predicting ICU readmissions is limited, the one study that specifically looked at using shock index in determining unplanned ICU admission found very promising results. There is also extensive evidence in support of the SI providing valuable information about the patient's hemodynamic stability and risk of deterioration that can be used by both critical care and floor staff to initiate more timely and effective interventions that may either reduce ICU readmission rates or facilitate transfer to provide more acute care earlier, possibly helping to minimize adverse events and thereby produce better outcomes.

Summary of the Evidence

The evidence shows that transferred patients had a significantly higher SI value than the controls, significantly longer hospital stays and higher mortality rates. SI elevations have been shown to be an indicator of illness without trauma and so could be used with patients who have various medical conditions and the use of early warning systems results in improved patient outcomes, which was demonstrated by increased rapid response calls, decreased ICU readmissions and decreased mortality, without negative outcomes. The evidence also suggests that sustained SI elevations were related to increased organ failure in patients, even though other predictive scoring systems such as APACHE and MEDS scores were the same.

Global Aim: To address the global problem of higher than average ICU readmissions within this clinical microsystem, the global AIM of this quality improvement project was to reduce the number of ICU readmissions.

Specific Aim: To address the local problem of a lack of specific predictive factors to accurately predict which patients are at risk of adverse events requiring readmission, the specific AIM of this project was to identify if shock index values higher than 0.7 at the time of transfer from the ICU are a useful predictor of ICU readmission within 72 hours of discharge.

Methods

Setting

This New England Hospital's ICU is a 20-bed ICU that cares for acutely ill patients suffering from sepsis, chronic obstructive pulmonary disease (COPD) exacerbations, other pulmonary infections and cardiac and gastrointestinal emergencies and surgeries. The majority of admitted patients are admitted for cardiac or respiratory issues or illnesses. The ICU professionals currently involved in the patients' care include critical care and pulmonary physicians, hospitalists, surgeons, critical care nurses, LNAs, and respiratory therapists. The ICU is staffed 24 hours a day, 7 days a week through mostly 12 hour nursing shifts, 8 or 12 hour respiratory therapy shifts, 24-7 hospitalist care and on call physicians

Theoretical Framework

By using the Plan-Do-Study-Act (PDSA) framework to guide the development and improvement process, current processes can be investigated (Plan), data can be gathered (Do) and analyzed (Study) and changes can be implemented (Act). (Institute for Healthcare Improvement, 2015)

Intended Improvement (Plan)

Discharge from this hospital's ICU is practitioner specific and there are no standardized discharge criteria that a patient has to meet prior to being discharged. Most ICU readmissions occur within 72 hours of ICU discharge, the purpose of this quality project was to identify

patients who are at risk for ICU readmission within 72 hours. The process included retrospective

data collection on those patients unexpectedly readmitted to the ICU within 72 hours of

discharge, excluding any patient whose return is expected, such as with surgery. The purpose

was to establish patterns of indicators that could be used to alert nurses and practitioners of

impending deterioration.

There are many factors that can contribute to a patient's return to the ICU and there have

been many predictive scoring systems created. However, these scoring systems incorporate

multiple factors, are lengthy and also costly. (Keller et al., 2010) Vital signs, such as heart rate

and blood pressure, are also monitored closely for any abnormal or alarming changes, however,

it has been found that heart rate and blood pressure as individual values are not useful in

predicting patient deterioration. (Keller et al., 2010) Due to these factors, this hospital is looking

to see if a less expensive but easily calculated predictor of a patient's likelihood of returning to

the ICU can be used, specifically the shock index.

Data Collection (Do)

A randomized retrospective matched cohort study was conducted to compare the shock

indices of patients who were readmitted within 72 hours of discharge from the ICU and to the

SIs of those who were not readmitted. For fiscal year 2014 (FY14), patients were chosen using

the ICU logbook. The selected readmitted cohort included only those patients unexpectedly

readmitted within 72 hours of ICU discharge. Patients whose return to the ICU was expected,

due to surgery or other procedure, were excluded, as were patients who were readmitted after the

72-hour window. There were 34 readmitted patients found to meet the criteria. SIs at time of

initial admission to the ICU, time of transfer from the ICU and at the time of readmission to the

ICU were calculated. The SIs were tabulated as the number of patients with an SI below 0.5,

within the normal range of 0.5 to 0.7, and greater than 0.7.

There were 1877 patients in the ICU logbook for FY14. When selecting the control

cohort, patients were initially grouped alphabetically to determine who had not been readmitted

to the ICU at any time during their hospital stay. Of those patients, every 4th patient whose MSN

number ended with a zero was chosen. This yielded 40 patients. ICU records were not found for

3 of those patients, and 3 other patients had died during the same hospital stay without being

readmitted to the ICU, so were excluded from study. This yielded a matched control cohort of 34

patients. The SIs of the control cohort were calculated for initial admission to the ICU and at the

time of transfer from the ICU. The SIs were tabulated as the number of patients with an SI below

0.5, within the normal range of 0.5 to 0.7, and greater than 0.7.

Results (Study)

Studying the results displayed in Tables 1 and 2, of the 34 readmitted patients, 3 (9%)

had an initial SI of less than 0.5, 6 (18%) had an SI within 0.5 and 0.7, and 25 (73%) had an SI

greater than 0.7. Of the control cohort, 5 (15%) had an SI less than 0.5, 8 (23%) fell within 0.5

and 0.7, and 21 (62%) had an SI greater than 0.7.

At the time of transfer from the ICU, 1 (3%) of the readmitted patients had an SI of less

than 0.5, 11 (32%) had an SI within 0.5 and 0.7, and 22 (65%) had an SI greater than 0.7. Of the

control cohort, 3 (9%) were found to have an SI less than 0.5, 18 (53%) fell within 0.5 and 0.7,

and 13 (38%) had an SI greater than 0.7.

When readmitted to the ICU, 1 (3%) of readmission cohort had an SI of less than 0.5, 8

(24%) had an SI within 0.5 and 0.7, and 25 (73%) had an SI greater than 0.7.
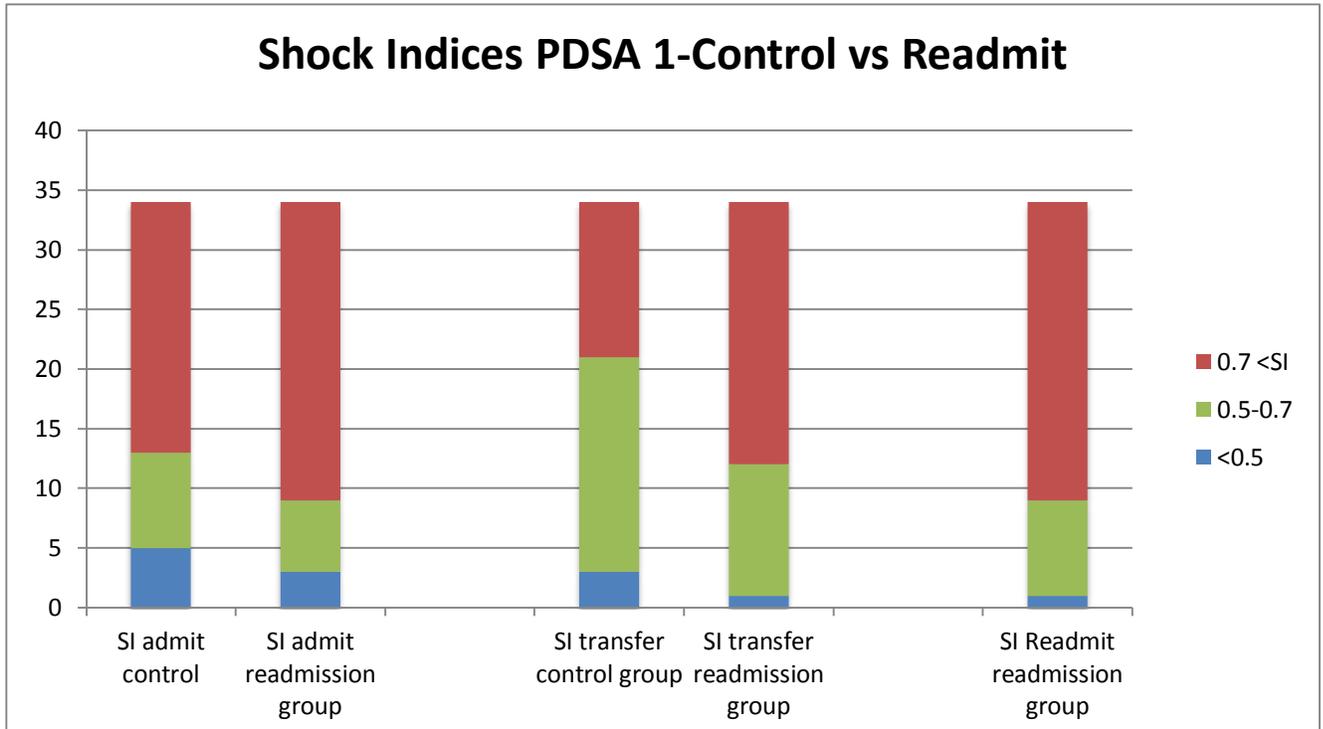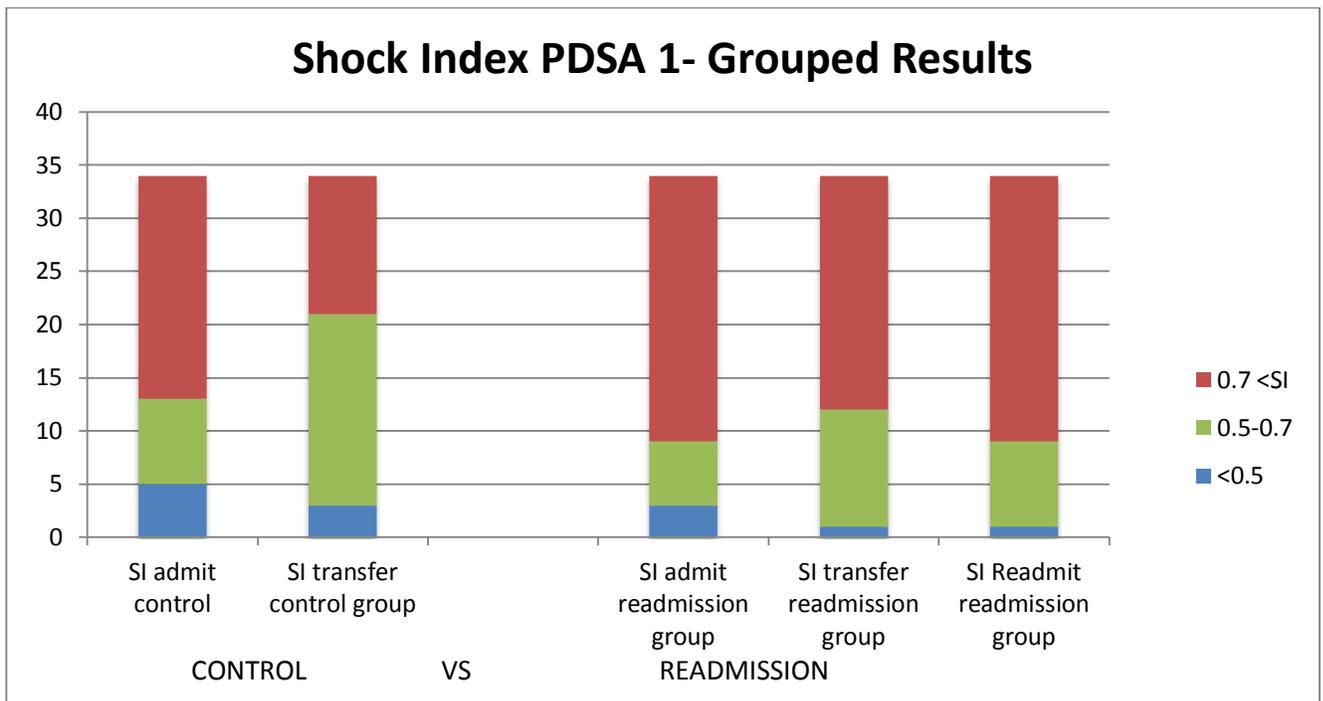
Table 1

Table 2

The odds ratio for this sample was calculated for the likelihood of being readmitted with

an SI greater than 0.7 (Table 3). (MedCalc, 1993)

Table 3

	Readmitted	Not Readmitted
SI > 0.7	22	13
SI </= 0.7	12	21

Odds Ratio: 2.96
95% Confidence Interval = 1.1 to 7.94
Significance level: p=0.0310

A second PDSA cycle was then undertaken to see if patients with SI elevations above 0.7

had the elevations for at least 80% of their vital sign assessments, which could indicate

impending deterioration within the 24 hours prior to discharge. The shock indices trends for each

patient in both the readmitted and control cohort for up to 24 hours prior to discharge were

assessed.   An odds ratio was calculated for the risk of readmission if there were elevations at

least 80% of the previous 24 hours.

Table 4

	Readmitted	Not readmitted (Control)
80% elevations within 24 hour	15	8
< 80% elevations within 24 hours	6	13

Odds Ratio: 1.56
95% Confidence Interval: 0.36 to 6.76
Significance level: p= 0.55

Discussion (Act)

Using shock index values higher than 0.7 at the time of transfer from the ICU may be a useful predictor of ICU readmission within 72 hours of discharge. From Tables 1 and 2, the control and readmitted cohorts had 62% and 73% of the patients with elevated SIs. At the time of discharge from the ICU the control 38% of the control cohort had elevated SIs compared to 65% of the readmitted cohort. At the time of re-admittance, the percentage of elevated SIs in the readmitted cohort was the same as at initial ICU admittance. Based on the calculated odds ratio in table 3, patients discharged with an SI above 0.7 are almost 3 times more likely to be readmitted to the ICU compared to those whose SIs are either at or below 0.7, with the results being significant (95% CI: 1.1 to 7.94, p=0.0310). Although the results are significant, since the confidence interval ranges from 1.1 to 7.94, there is the chance that there is only a very slight increased chance of readmission with elevated shock indices, so further research is needed for more conclusive and reliable results.

During the second PDSA cycle, the odds ratio indicated a 1.56 times increased risk of readmission if 80% of the SIs were above 0.7 (Table 4), however these results not significant. (95% CI=0.36 to 6.76, p=0.55). Factors affecting the 24-hour elevations in SI could be the use of vasoactive medications and external heart rate pacing. Many patients in this ICU have had surgery, particularly cardiac, and have unstable vital signs post-operatively, requiring vasoactive intravenous medications to maintain blood pressure and heart rate. Post-operatively, patients can be very hemodynamically unstable (Bishop, Yarham, Navapukar, Menon, & Ercole, 2012) but after the patient is stabilized, transfer to a less acute floor within this hospital is possible within the following 24-hour period. So, although the patient had SI elevations, as hemodynamic stability is achieved, even if the SI is still elevated at transfer, the patient could be at less risk of

readmission, provided hemodynamic stability is maintained and the patient continues recovering. Additionally, artificially maintaining a specific heart rate through pacing could also affect the SI. The pacing will maintain a specific heart rate; therefore the relationship between the heart rate and blood pressure could be altered.

SI indicates hemodynamic instability and left ventricular dysfunction. (Keller et al, 2010) Patients with greater than normal SI values appear to be more hemodynamically unstable and therefore more susceptible to adverse events that ultimately lead to re-admittance to the ICU. An above normal SI could be indicative of a hemodynamic problem that would otherwise not be detected by heart rate and blood pressure alone. It appears that the relationship of the two to each other is the more predictable indicator of risk for adverse event.

Due to the variety of factors that are associated with ICU readmission, this information could be used to identify at risk patients. More accurate identification of patients at increased risk of re-admittance can alert healthcare practitioners to the patient's instability and possible deterioration so preventative action can be implemented.

Limitations

Limitations include the small size of the study since only one fiscal year of 34 matched patients was assessed. Sample size is an important factor because small studies tend to be not as reliable as larger studies. With a small sample size there is the risk of type I error and the erroneous conclusion that shock index elevations can predict readmission, when they may not. Additionally, type II errors are also possible. This type of error concludes that shock indices do not correlate with ICU readmission when in fact they do. To minimize both type I and type II errors, a larger cohort of patients is needed. (Fletcher, Fletcher, Fletcher, 2014, p. 181)

Additionally, the use of vasoactive medications and pacing would have to be taken into consideration, as would the different reasons for readmission. Also, since this study did not exclude patients who were admitted post-operatively from the control group, is it possible the results were affected due to the nature of their expected hemodynamic instability.

Discussion and Implications for CNL Practice

This quality improvement project utilizes the CNL competencies within critical thinking, assessment, risk reduction and healthcare systems policy outlined in the CNL White Paper. The CNL needs to use quality improvement methods to evaluate client care and then use risk analysis tools to anticipate the risks to the patient's safety. An analysis of the outcomes associated with the use of SI data could then allow the CNL to use creative problem solving and evidence-based practice to design client care to improve patient readmission rates. (CNL White Paper, 2007)

Recommendations

Although SI values appear to be a useful predictor of ICU re-admission, further study needs to be done on specific events surrounding a patient's deterioration. Along with these SI values, vasoactive medication use, other medication administration, respiratory rate, level of support and oxygen saturation should be compared to determine whether the readmissions are due to common or special causes. Additionally, further SI values should be collected from previous years' readmissions to increase the sample size and strengthen and support justification for quality improvement interventions.

Possible applications of these results by the Clinical Nurse Leader to improve patient outcomes include scheduling reevaluation by a critical care practitioner prior to discharge or implementing follow-up care by a critical care practitioner for the 72 hours post discharge to monitor for deterioration that would lead to re-admittance. (Latina, 2015) Another option could

be to send at risk patients to a step-down unit with higher skilled nursing staff and lower nurse to patient ratios or to assign experienced floor nurses with critical care experience to these patients.

An evidence-based option shown to improve patient outcomes is the use of a nurse liaison who could help bridge the gap between the critical care and floor staff by acting as a resource and providing clinical support. It has been found that liaison nurses decrease unplanned ICU admissions and readmissions, hospital mortality, discharge delay and adverse events. (Endacott, Eliott, & Chaboyer, 2009) and it has been found that liaison nurses play an important role in improving the continuity of care. Evidence shows that liaison nurses increase the patient's and families satisfaction with both the ICU and floor nursing staff, improve nursing quality of care, increase confidence of both types of nurses in the ability to provide appropriate care, improve discharge planning, reduce ICU readmission rates, reduce hospital inpatient days, increase patient self care activities, provide accurate assessment of the patient's clinical condition, prevent the development of acute and critical conditions and provide a knowledgeable resource for the floor staff. (Tabanejad et al., 2014)

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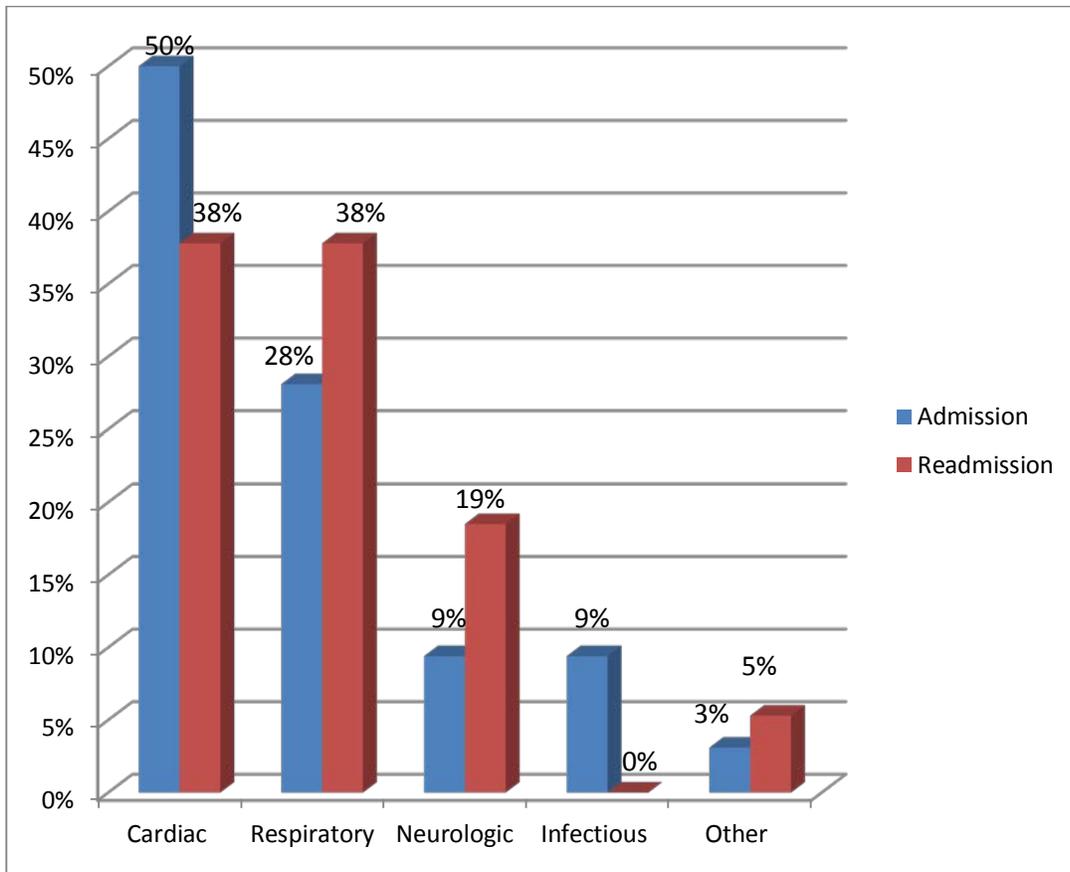with Severe Sepsis. *Western Journal of Emergency Medicine*, *XV*(1), 60-66.

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APPENDICES

Appendix A

Patient Diagnoses on Admission and Readmission

Diagnosis	Admission	Readmission
Cardiac	50%	37.80%
Respiratory	28.10%	37.80%
Neurologic	9.40%	18.50%
Infectious	9.40%	0%
Other	3.10%	5.30%

Appendix B

Admission vs. Readmission Diagnoses in ICU Patients

Diagnosis	Present on Admission	Present On Readmission	Same as Admission	New on Readmission
Cardiac	50%	37.80%	27%	10.80%
Respiratory	28.10%	37.80%	18.90%	18.90%
Infectious	9.40%	0%	0%	0%
Neurologic	9.40%	18.50%	10.80%	8.10%
Other	3.10%	5.30%	0%	5.40%
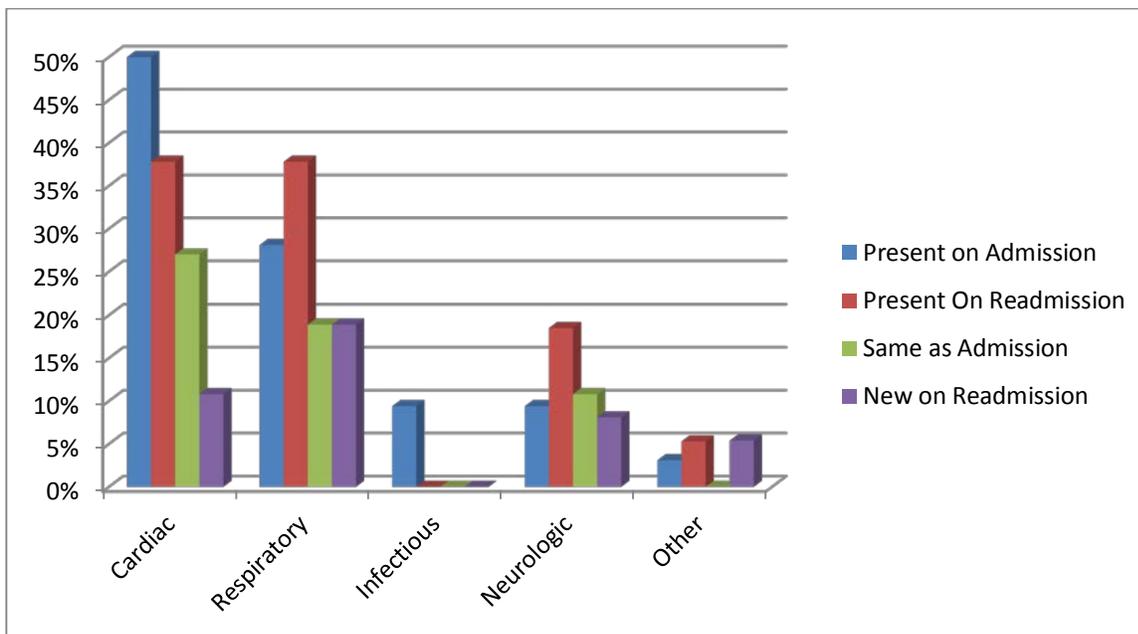
Appendix C

ICU Providers and Consults in Discharged Patients

Service	% Of Readmitted Patients	CCM consult
CTS	37.80%	2.65%
Hospitalist	51%	23.97%
NEHI	8.10%	0%
General Surgery	2.70%	0%
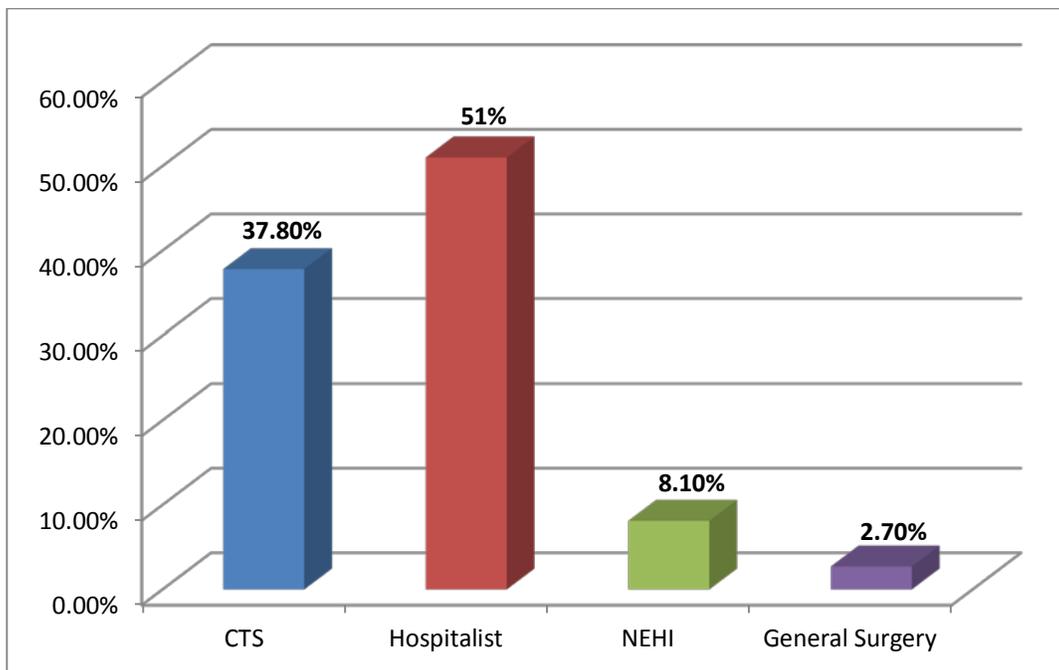
Appendix D

Length of Stay and In-Hospital Mortality

	Average Patient	1 Readmission	2+ Readmissions
Average Length of Hospitalization (days)	8.6	19.8	28.5
In-hospital mortality %	9.79	25	50

	Average ICU Mortality Rate	1 Readmission	2+ Readmissions
Number of Deaths	156	8	2
Total Admissions	1593	32	4
Mortality Rate	9.79%		
Case Fatality Rate		25%	50%
Proportionate Mortality		5%	
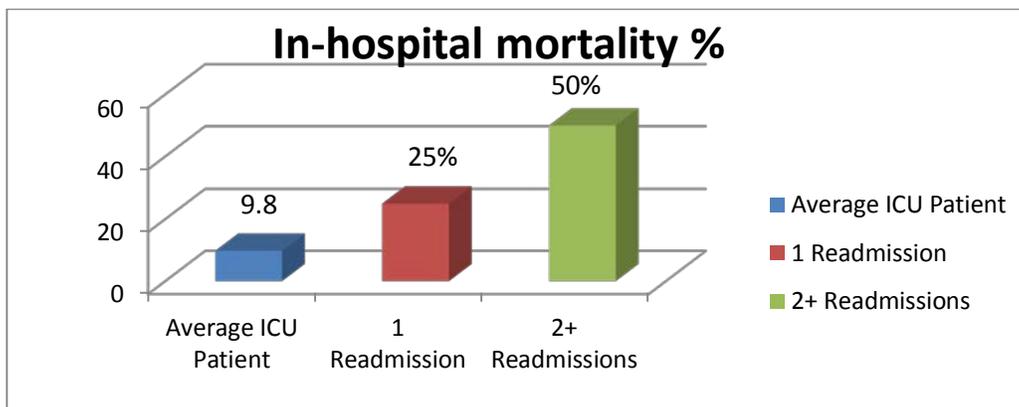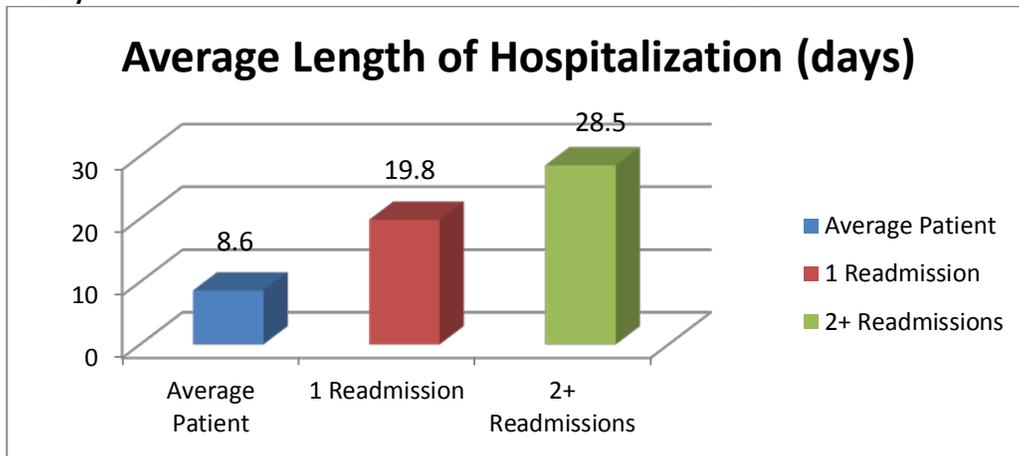
Appendix E

Timing of Admissions/Transfers/Readmissions

Timing of Admission/Transfer	Percent
Weekday admissions	76%
Weekday transfers	78%
Weekday readmissions	59.40%
Weekend/holiday admissions	24%
Weekend/holiday transfers	21%
Weekend/holiday readmissions	40.50%

Timing of Admission/Transfer	Percent
Weekend/holiday admissions	24%
Weekend/holiday transfers	21%
Weekend/holiday readmissions	40.50%
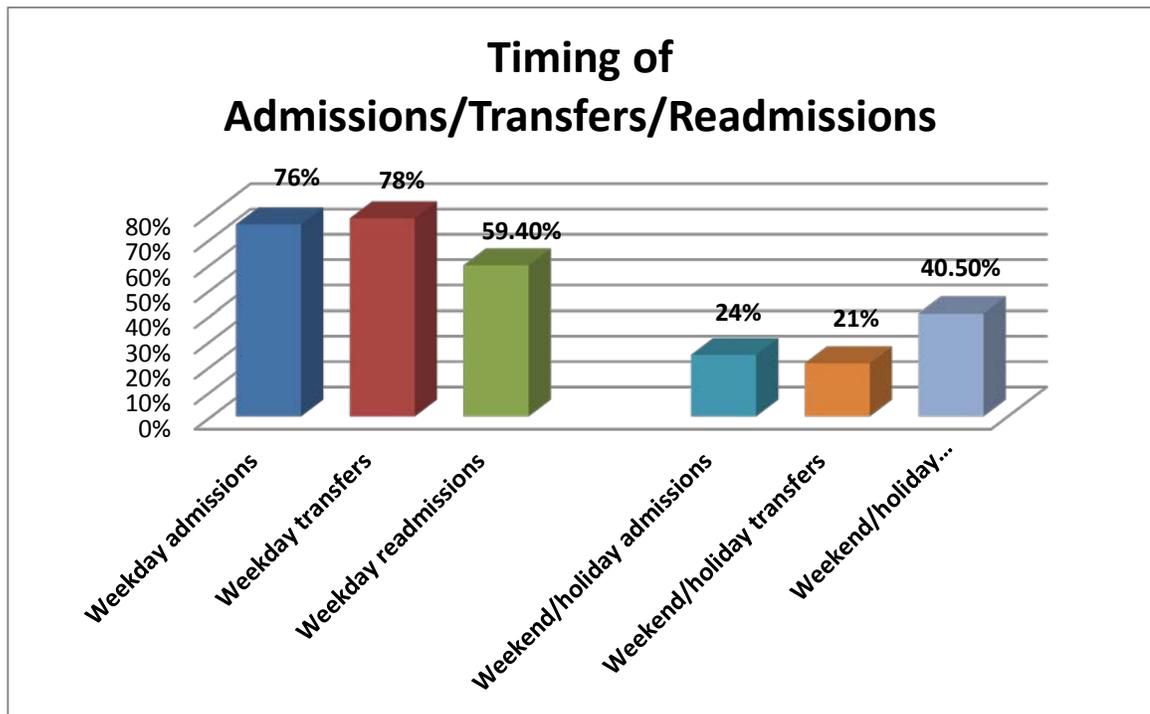
Appendix E Continued

Weekend/Holiday
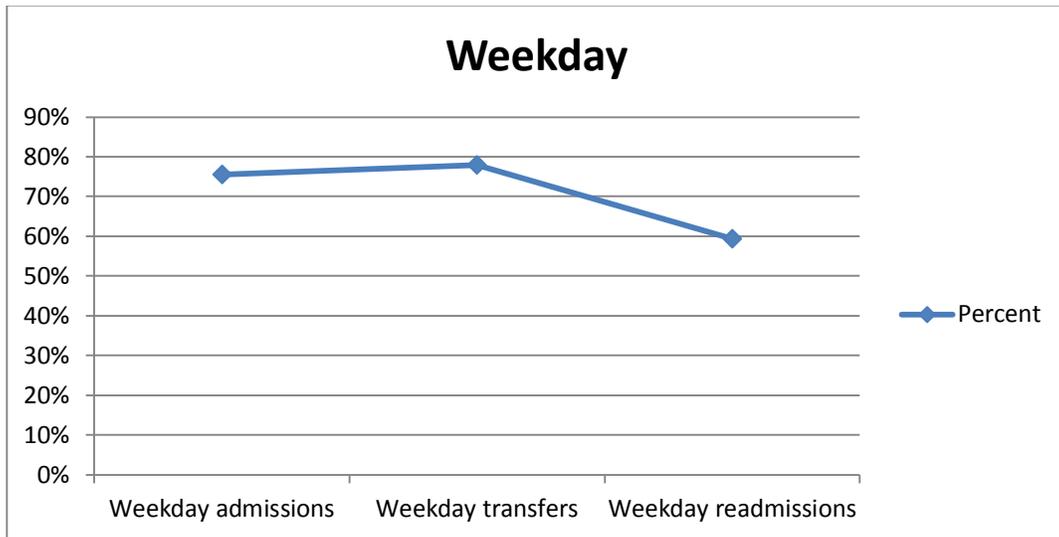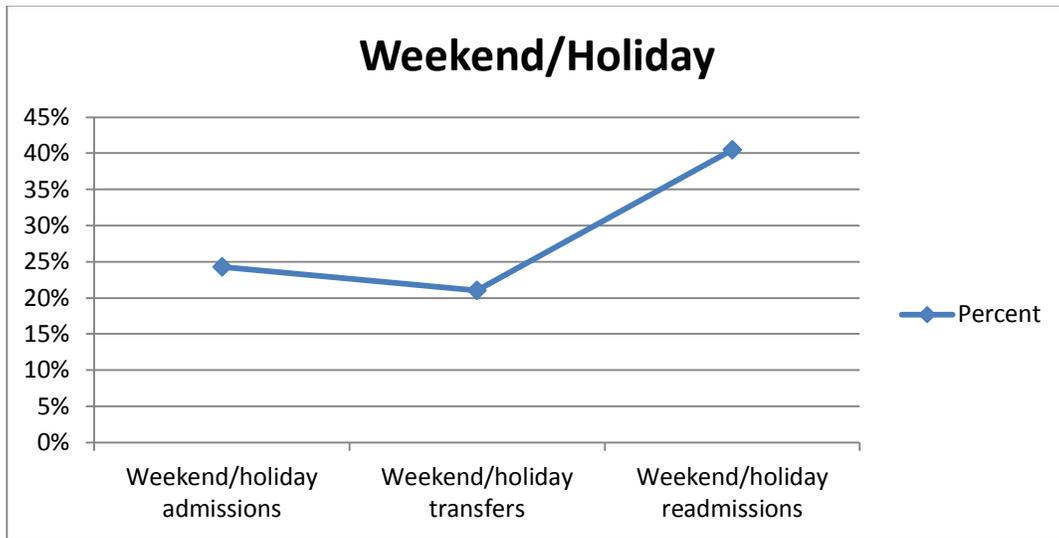
Appendix F

Admission/Transfer Timing

	Admission	Transfer	Readmission
Off Hours	37.50%	13.50%	35.20%
Weekend Off Hours	15.60%	5.40%	16.20%