Spring 4-26-2014

Chest Pain Center: The Efficiency and Efficacy on Chest Pain Treatment

Thomas A. Rhodes

Chest Pain Center: The Efficiency and Efficacy on Chest Pain Treatment

Submitted by

Thomas A. Rhodes

for

EMPA 396 Graduation Research Project in Public Management

Golden Gate University

San Francisco, California

Faculty Advisors:

Dr. Joaquin Gonzalez III and

Dr. Mick McGee

April 26, 2014

Abstract

Chest pain is one of the most common ailments seen in emergency departments across the nation adding to the overcrowding dilemma seen in emergency departments today. Patients presenting with this complaint create a medical dilemma due to the vagueness of signs and symptoms related to the complaint. This vagueness creates not only a risk to the patient if misdiagnosed, but also a legal risk to the physician and healthcare organization if conservative steps are not taken to delve deeper into the complaint. As a result, these patients are often admitted for multiple days with increased medical costs, reduced reimbursement to the hospital and outcomes that are not always ideal and in alignment with cost. In efforts to reduce healthcare costs and improve quality patient outcomes, chest pain centers have developed and evolved across the nation to focus solely on this patient population. Presently Sutter Medical Center, Sacramento (SMCS) does not have a chest pain center designed around specific care to the patient presenting with a complaint of chest pain. This paper will examine the relationship between those health care organizations that use a chest pain center model to care for the chest pain patient and Sutter Medical Center, Sacramento. Primary research (financial data and average length of stay data) and Secondary research (articles, previous research, reports, statistics) will provide the necessary information to determine efficacy of the chest pain center model and if SMCS should adopt the model or continue with business as usual.

Chapter 1 - Introduction

The leading cause of death and disability for both men and women in the United States with an annual death rate of 600,000 people, heart disease threatens someone in almost every household across America (http://www.cdc.gov/heartdisease/facts.htm). As a result of this threat to life, impassioned pleas to change lifestyle habits and seek preventive medical care by medical societies such as the American Heart Association, the Centers for Disease Control and the American College of Cardiology are evident in print media, television ads, mail campaigns and other sources of information fed to the masses. As the nation encourages its citizens to become more engaged in their health and lifestyle choices to reduce the risk of heart disease, it is also incumbent on medical practitioners and healthcare organizations to formulate better treatment plans and options for the treatment of heart diseases.

Background and History

Heart disease is estimated to cost the nation $313.6 billion annually with future costs sky rocketing to $444 billion (http://www.cdc.gov/heartdisease/faqs.htm#8). These numbers can be broken down easily by individual hospitals and the impact this disease has on the bottom line of healthcare organizations, not to mention the overall impact on healthcare spending nationally. It has long been known that rapid assessment and treatment for patients with low and intermediate chest pain symptoms results in better quality outcomes, which in turn reduces costs and length of stay in the hospital (https://www.icsi.org/_asset/ydv4b3/ACS-Interactive1112b.pdf). It is the patient presenting with low or intermediate chest pain symptoms that are at greatest risk for a less than optimal hospitalization and outcome because of the vagueness related to a definitive diagnosis. The patient with high-risk symptoms is much easier to treat because of the clarity in presentation and pathway to definitive care and treatment. Presently Sutter Medical Center,

Sacramento lacks a chest pain center design. As a result, the average length of stay for a chest pain patient is at 1.49 days; however, the goal is 1 day or less. The average cost to treat these patients based on 2013 data is $7602 when calculating direct and indirect cost to the total number of patients. Calculating direct cost shows a cost of $3979 per patient. The reasons for the prolonged hospitalization and increased costs are as follows:

- Prolonged waits in the emergency department (ED) because of ED impaction due to many patients competing for beds and care
- Variation in physician practice (emergency medicine physicians, cardiologists and internal medicine physicians)
- Lack of inpatient beds due to high patient census resulting in prolonged time in the ED slowing the process of care
- Vague patient symptoms at time of check-in resulting in misinterpretation of the patient condition by the nurse and physician
- Delayed testing (i.e. nuclear medicine stress test) to rule out high risk symptoms due to impacted nuclear medicine schedule, emergent add-on patients and physician indecision

As a result, SMCS has a tremendous opportunity to improve its delivery of care for the chest pain patient based on this aforementioned information.

Purpose of the Study

Based on areas of opportunity for treatment of the chest pain patient, SMCS seems ripe for process changes that can potentially have a positive impact for these patients. From this evolves the research question - can a chest pain center design reduce the average hospital length of stay, reduce overall treatment costs and improve patient outcomes for the chest pain patient

presenting to the emergency department? With the length of stay being what it is for patients at SMCS, this question must be addressed to improve those areas where quality and financial goals fall short of the organization's dashboard metrics for performance. More importantly - the service provided to the Sacramento community by SMCS mandates an obligation to provide the best care possible to its patients. Additionally, changes to Medicare reimbursement rates as well as the impact of the Affordable Care Act requires healthcare organizations, like SMCS, to become not only more affordable in their care delivery, but to also improve patient outcomes to survive the dramatic shift in U.S. healthcare funding This study will provide the foundation of determining if the research question has validity.

Research Problem

Presently a number of U.S. hospitals, such as Sutter Medical Center, Sacramento, lack a specialized area for rapid treatment of chest pain patients resulting in what is assumed to be 1) greater costs to treat these patients, 2) longer lengths of stay (LOS) in the hospital, and 3) an opportunity to improve quality outcomes**.** Theoretically it may seem to make sense, but the investment in a chest pain center can be costly. Without supporting evidence that the chest pain center will provide efficiencies and enhanced efficacy, hospital administrators are not likely to engage in such a costly endeavor. The creation of a chest pain center will require tremendous investment in capital equipment, staff, and process change. Additionally, internal physician conflicts may arise as this model may exclude physician groups presently involved in the care of these patients as the focus is whittled down to one specialty (usually cardiology). For this reason, many hospitals are without this specialized care area. Without an adequate study and analysis to determine the cost benefit of a chest pain center, hospitals will continue with business

as usual and see no reduction in the hefty costs, increased length of stays and questionable quality outcomes for the chest pain patient.

Research Hypothesis

The hypothesis for this research study evolves from 3 main points. The hypothesis states: Implementation of a chest pain center will reduce overall costs, achieve a shorter length of stay and improve patient outcomes. Because of the significance of heart disease on the lives of those living in this country, everyone should take notice and be aware of not only how to best care for themselves, but also where to seek the best medical care in their community. The belief is those cardiac centers will improve their care delivery with the implementation of a chest pain center because of rapid diagnosis, treatment and disposition.

Chapter 2 - Literature Review

Many scholarly articles and publications based on previous studies on the topic of rapid access to care for the chest pain patient exist providing for a foundation of helpful and informational material for this research project. The theories relevant to a chest pain center are the focus on many journals and studies relevant to rapid diagnosis, treatment of disposition of patients to improve outcomes. One such article - "Improved Outcome In Acute Coronary Syndrome By Establishing A Chest Pain Unit" (Keller, Post, Tzikas, Schneider, Arnolds, Scheiba, Blankenberg, Munzel & Genth-Zotz, 2009) illustrates this model. This article supports both the research question as well as the hypothesis. The research conducted was a retrospective analysis of 1796 patients over a course of 2 years. A comparison of patients treated by the emergency department (ED) and by a chest pain unit (CPU) was analyzed with data comparisons applied to determine the best service for this patient population. The combined 1-year endpoint from initial presentation used death, myocardial infarction (heart attack) and stroke to determine efficacy of treatment in the ED versus that of the CPU. The ideal measure was a 1-year event free survival.

- Of the patients presenting to the ED with a complaint of chest pain, only 483 were true ACS patients with 1,313 presenting as non-ACS.
- Cardiologists managed the CPU and trained cardiology nurses provided care in this unit as opposed to physicians trained in internal medicine, gastroenterology, nephrology, hematology and pulmonology managing the ED. If a diagnosis of ACS was made, the ED physician on duty would consult with cardiology.
- The CPU administered strict medical protocols to management of their patients for rapid diagnosis and disposition (cardiac catheterization lab, stress testing, etc.)

unlike the ED.

- Obtaining information on patient outcomes was conducted through telephone surveys or a standardized letter between May and November 2007 to ascertain individual patient outcomes at 1 year.
- Death of a patient was obtained by the local civil registry (this was a European study).

The analysis yielded that with a combined endpoint of death, myocardial infarction and stroke; the event-free survival after 1 year was significantly higher ($P_{logrank} = 0.02$) in patients treated in the chest pain unit as compared to the ED (Keller et al., 2009). Additionally the CPU shows a higher rate of patients with the discharge diagnosis ACS of 30 versus 17% in the ED (Keller et al., 2009) suggesting greater accuracy in CPU patient diagnosis compared to the ED.

The article "Non-Cardiac Chest Pain: Time to Extend the Rapid Access Chest Pain Clinic" (Chambers, Marks, Knisley & Hunter, 2012) highlights a study of patients presenting with chest pain unrelated to cardiac disease. This population is significant for increased costs, length of stay and questionable outcomes due to misdiagnosis, vague presentations and poor follow up care. The article estimates that three quarters of patients referred to a chest pain clinic present with non-cardiac chest pain. With the existence of the chest pain clinic, the patient is quickly ruled out for having cardiac dysfunction and can be managed in a multi-disciplinary approach through the use of other specialties such as gastroenterology, psychiatry, primary care and social services. Once cardiac disease is ruled out, the physician is much more comfortable discharging the patient for follow-up to another less invasive service where more specific care can be applied to remedy the non-cardiac ailment. This article emphasizes the need to develop these clinics not only for the cardiac patient, but also for the non-cardiac chest pain patient who

"clogs" the system awaiting expensive tests to rule out what is assumed. The article further suggests that costs related to prolonged hospitalizations and accurate diagnosis and care drop significantly with the chest pain clinic model (Chambers et al., 2012). The value found in this article is the ability of the chest pain center to improve patient throughput – the ability to move patients rapidly through the system to an end-point of discharge from the hospital. The other benefits found are decompression of the emergency department, accurate diagnosis for appropriate patient follow up, increased patient satisfaction and decreased cost as a result of accuracy in testing and treatment. The improvements are multi-faceted based on the purpose and design of the chest pain center, which supports the hypothesis.

"A Comparison Trial for Stratifying Intermediate-Risk Chest Pain: Benefits of Emergency Department Observation Centers" (Robinson, D. J., Woods, P.G., Snedecker, C. A., Lynch, J. H., & chambers, K., 2002) discusses the chest pain center design under the title of Emergency Department Observation Center. This research focused on a before- and-after trial of 2197 intermediate risk chest pain (IR-CP) patients transferred from the hospital's emergency department (ED) to one of three units -- ED-based observation center (ED-OC), inpatient observation center (IN-OC), and inpatient units -- compared mean cost, length of stay, and safety over a 2-year period. What was identified is as follows -the mean per patient cost for management of IR-CP was lower in the ED-OC ($1642) than the IN-OC ($1910) or the inpatient units ($2785). The mean length of stay was shorter in the ED-OC (0.75 days) than in the IN-OC (1.18 days) or the inpatient units (2.16 days). Return rates were lower in the ED-OC at 7 days (0%) and at 6 months (0.45%) than the IN-OC (0% and 1.22%) or the inpatient units (0.77% and 3.67%). Overall hospital costs for managing IR-CP dropped significantly (12.5%) after the ED-OC was opened. ED-OCs provide a safe and cost-effective alternative to admission of IR-CP

patients. Nearly 90% of all IR-CP patients seen by the ED-OC were discharged without jeopardizing their safety promoting effective and efficient care ultimately reducing length of stay as well as cost. The article further suggests that accuracy in diagnosis also promotes improved quality outcomes, reduced costs and shorter LOS (Robinson et al., 2002). This comparison trial illustrates a vitally important point because of the payment structure created by Medicare. Reimbursements are shrinking especially for longer hospitalizations. As well, cost containment through appropriate utilization of resources is a necessity for continued sustainment of successful operations in healthcare today. Hospitals must find better ways of managing and treating patients with cost effectiveness methods. This article provides support that management of chest pains, if done correctly through protocols in a proper environment such as a chest pain center, can provide that financial benefit without compromising patient safety or quality health outcomes.

Consistent with studies and articles within the United States is the idea that immediate patient risk identification be the responsibility of the ED physician during the early presentation of the patient to the emergency department. The benefit to early identification and risk stratification is immediate care for the patient preventing worsening of symptoms for those patients assessed as low to moderate risk. This is the population that typically consumes the most resources and time resulting in costly hospitalizations and less than ideal outcomes.

Additionally, this patient population congests the emergency department because of the vagueness of symptoms and significant risk for poor outcomes resulting in defensive medicine practices to avoid litigation and worsening of the patient condition. The ED screening is supported by several studies – "A Comparative Analysis Of Risk Stratification Tools For Emergency Department Patients With Chest Pain" (Burkett, Marwick, Thomas & Kelly, 2014),

"Development And Validation Of The Emergency Department Assessment Of Chest Pain Score And 2 H Accelerated Diagnostic Protocol" (than, Flaws, Sanders, Doust, Glasziou, Kline, Aldous, Troughton, Reid, Parsonage, Frampton, Greenslade, Deely, Hess, Sadiq, Singleton, Shopland, Woolhouse-Williams, Ardagh, Bannister & Cullen, 2014) and "Ninety-Minute Accelerated Critical pathway for Chest Pain Evaluation (Ng, Krishnaswamy, Morissey, Clopton, Fitzgerald & Maisel, 2001. These studies were primarily focused on the benefit of rapid assessment and treatment of these patients, but there are also added benefits of this such as cost.

Funding/Cost Related to Chest Pain Centers

Expediting care, minimizing delays and creating a specialized environment for this patient population positively impact hospital costs due to decreased days of hospitalization, preventing unnecessary testing and decreasing resources needed to care for this patient population. One such article "NICE Recommendations For The Assessment Of Stable Chest Pain: Assessing The Early Economic And Service Impact In The Rapid-Access Chest Pain Service" (Ashrafi, Rags, Abdool, Disney, Wong & Davis, 2013) suggests those patients seen in a chest pain center used fewer methods of testing to determine the diagnosis based on the National Institute for Clinical Excellence (NICE) chest pain center guidelines. The purpose of this study was not to determine if the cost of care was less but to determine if this model was more expensive. The conclusion based on 769 patients was the chest pain center with specific guidelines was not more expensive in the short term. This suggests a cost neutral benefit with quicker diagnosis, treatment and better outcomes.

Another article from the Journal of Public Health "Cost Implications Of Implementing NICE Guideline On Chest Pain In Rapid Access Chest Pain Clinics: An Audit And Cost Analysis" (Gosh, Qasim, Woollcombe & Mechery, 2012) discusses clinical practice guidelines

for the chest pain patient in a rapid access chest pain clinic. The focus is around first-line clinical investigations for the chest pain patient that involves advanced technology such as computed tomography (CT) scanners. This retrospective review shows that the clinical guidelines can result in a 42% to 43% increase in cost due to the cost of technology and the frequency of its use. What was lacking in the study is the individual unit costs associate with the chest pain clinic. Effective management of the unit costs (staffing, supplies, etc.) may lessen the cost impact based on technology used to diagnose this patient population. This study provides an alternative look at cost as it relates to a chest pain center.

In support of chest pain centers economically, the article "Rapid Access Chest Pain Clinics – Can They Be Justified?" (McGavigan, Begley, Moncrieff, Hogg & Dunn, 2003) discusses the entirety of the chest pan clinic operations including the economics. This was a prospective observational study of patients referred to the clinic over a 4-week period of time. The study involved the development of a Pro-Forma prior to initiation of a patient into the study. This was necessary because there was not an increase of resources – only a shifting of existing resources to provide care in this clinic. This study reviewed the referral process, patient inclusion criteria, clinical indicators, demographics, clinical outcomes and the economics. According to this study, same day clinics show economic benefit to the institution by avoiding expensive hospitalizations. Those patients at intermediate risk or lower in addition to those patients who rule out for cardiac related chest pain are treated in one day or less and either discharged for follow up outpatient medical management or rapidly moved to the next higher category of care. As a result, cost savings are achieved by avoiding unnecessary hospital admissions.

International Attention to Chest Pain

Interesting is the fact that Europe seems to be ahead of the United States in the development of chest pain centers. Information gathering on scholarly articles, journals and studies indicate the United Kingdom (UK) has been implementing these specialized areas since the early 1990s. Through Britain's National Institute for Health and Clinical Excellence (NICE), the UK's focus on rapid assessment of chest pain patients has been a high priority evidenced by the articles "A Nurse-Led Rapid Access Chest Pain Clinic Post NICE Guidance: Analysis Of Audit Results" (Robson, 2012), "Suspected Angina Pectoris: A Rapid‐Access Chest Pain Clinic" (Dougan, Mathew, Riddell, Spence, McGlinchey, Nesbitt, Smye, Menown & Adgey, 2001). These articles suggest that rapid access chest pain clinics provide better opportunities to improve care due to specialized medical and nursing staff with better risk stratification for this patient population as well as a more cost effective method of treating these patients resulting in reduced hospital admissions.

Another article "Rapid Access Cardiology—A Nine Year Review" (Debney & Fox, 2011) discusses a retrospective analysis of data collected by nurse specialists and physicians reviewing patient records from rapid access cardiology/chest-pain clinics between April 2002 and March 2011. A total of 12,000 patients were seen over this 9-year period of time in select clinics in the United Kingdom. The concluding information indicates that during this 9-year period of time, primary care referrals to the rapid access chest pain clinic increased dramatically. It has been proven that this clinic provides prompt diagnosis as well as prompt risk stratification and management that satisfy the needs of both the primary care physician and the patient. This further provides evidence that international attention to the chest pain center has been on the forefront of specialized medicine especially cardiology outside of the United States.

A third article "Troponin-I Positivity In Patients Referred To Rapid Access Chest Pain Clinic" (Motwani & Burrell, 2010) originated Ayub Medical College in Abbottabad, Pakistan. This article speaks to Point of Care testing as well as other methods to diagnose, risk stratify and treat chest pain patients in a rapid access chest pain clinic. Great detail was discussed on the types of test to be performed in this clinic, risk stratification based on test results and the demographics and characteristics of patients referred to the clinic. This was a cross-sectional study of 60 patients referred to the clinic with a history of recent onset chest pain. The patients were each referred to the clinic because of their cardiac type symptoms and discomfort. This article provides further evidence that a chest pain center is not a unique or novel idea, but has been in existence throughout the world for many years.

The value of the literature on this topic is immeasurable. The evidence presented provides insight to whether there is legitimacy with the research question and hypothesis - or not. It provides a foundation of information already investigated that aids in the advancement of medical care through a chest pain center. What is supported based on the literature review is that evidence exists on the benefits of a chest pain center. Specific to this project, the literature suggests that a chest pain center can improve patient outcomes, reduce the average length of stay for the chest pain patient and allow for decreased costs when providing care to this patient population. The literature also suggests that this model is not unique in the healthcare setting evidenced by international application of the chest pain center design for at least the past 10 years. There was very little research found in the literature review that countered the benefits to a chest pain center.

Chapter 3 – Research Methodology

This project is a qualitative case study research design to evaluate the added value or lack of value of a chest pain center for Sutter Medical Center, Sacramento. Primary and secondary data will provide appropriate information relevant to the research question and hypothesis. The following provides the hypothesis with associated variables:

- Hypothesis: Implementation of a Chest Pain Center will achieve a shorter length of stay, reduce overall costs and improve patient outcomes. The rationale in choosing this hypothesis is grounded upon financial and clinical improvement opportunities that exist based on present SMCS data as compared to national benchmarks. The understanding that chest pain centers exist in other healthcare facilities requires investigation to determine if a chest pain center can improve the financial and clinical performance of SMCS. This hypothesis establishes the foundation for further research.
- Dependent and Independent Variables
    - Independent Variable - Implementation of a Chest Pain Center
    - Dependent Variable 1 (DV1) - Shorter length of stay
    - Dependent Variable 2 (DV2) - Reduce overall costs
    - Dependent Variable 3 (DV3)– Improved patient outcomes

Implementation of a chest pain center, as the independent variable, will impact the dependent variables based on the relationships of the variables with one another. The chest pain center should create more rapid patient throughput due to a dedicated cardiac unit and expertise in medical and nursing care. This will create an environment where fewer resources will be needed because of more accurate diagnosis and treatment (DV 3). It will reduce expenditures by eliminating unnecessary tests, treatments and time in the hospital (DV 1 & 2). If the chest pain

center is properly operationalized, the dependent variables should respond as stated in the hypothesis.

Data Collection Process Overview

With a focus on Sutter Medical Center, Sacramento (SMCS), the research will establish baseline information by collecting data on this patient population. Both primary and secondary research tactics will be used. Using the Diagnostic-Related Group (DRG) 313 – Chest Pain, the data gathered will fall under the following:

- Cost accounting – will provide average cost per patient hospitalization
- Case management and utilization review – will provide the average hospital length of stay for the chest pain patient based on the diagnosis related group 313
- Patient quality outcomes (how well the patient responds to treatment) will be determined by the following agency:
    - The Joint Commission (http://www.jointcommission.org/core_measure_sets.aspx)
    - Centers for Medicaid and Medicare Services (http://www.medicare.gov/hospitalcompare/search.html)
    - The Advisory Board (http://www.advisory.com)
    - Specific organization quality metrics

Additionally, SMCS is benchmarked against multiple healthcare organizations and cardiac programs throughout the nation by Truven Health Analytics. The benchmarking program, ActionOI (https://actionoi.truvenhealth.com/security/default.aspx), enables the researcher to compare the independent and dependent variables with “like” facilities. Benchmarking to those organizations with a chest pain center will provide information to support

or reject the hypothesis through comparative analysis of organizational performance relative to the performance of SMCS.

Population sampling will be based on patients discharged from the hospital with the aforementioned hospital coded DRG. This will be the same population sample obtained from those organizations benchmarked to SMCS. This should be an adequate sample size for the research. Obtaining secondary data from the benchmarked facilities will include the following 3 structured survey questions:

1. Does your hospital have a chest pain center/clinic/rapid decision unit for the chest pain patient who presents to the emergency department?
2. What is the average length of stay for the Diagnosis Related Group (DRG) 313-chest pain?
3. What is the average hospital cost for DRG 313?

The information collected from the answers to these questions will help to provide the impetus for senior leaders to investigate further into the idea of implementing a chest pain center. The answers to the questions are designed to provide the researcher with evidence to support the implementation of a pilot study as a test-of-change next step for a chest pain center design. It is of the utmost importance that the researcher not assume or walk blindly into an endeavor of this magnitude due to the risk associated with cost, credibility, liability, and most importantly, the health, safety and lives of the chest pain patient.

Primary data was obtained through interviews. I conducted unstructured random face-to-face interviews with 5 cardiologists, 5 internal medicine hospitalists and 5 emergency medicine physicians from Sutter Medical Center, Sacramento (SMCS) with the following 2 questions and associated sub-questions based on the initial response:

1. Do you believe a chest pain center can benefit SMCS?
    a. If yes- how will it benefit SMCS?
    b. If no – why will it not benefit SMCS
2. Do you believe a chest pain center will be beneficial for the chest pain patient?
    a. If yes – how will it benefit the patient?
    b. If no – why will it not benefit the patient?

The significance of these interviews is to determine the level of engagement and "buy-in" from the local experts on the benefit of a chest pain center. The value of local experts is tremendous based on their knowledge, experience and opinions to determine best treatment options for the chest pain patient. Often these experts base their opinions on not only their personal experiences, but also the recommendations from multiple medical societies such as the American College of Cardiology (ACC), The American Heart Association (AHA), American College of Emergency Physicians (ACEP), Society of General Internal Medicine (SGIM) and the American College of Physicians (ACP). The value of these medical societies is they provide a rich source of medical information founded on years of medical research and patient quality data. Additionally, physician support is immeasurable if the implementation is to be successful because of the tremendous role they play in the execution of care and overall patient management. Experience has proven that physician disengagement results in disastrous outcomes and failed programs. Regardless of what the secondary data reveals, without physician support, the project will fail.

Operational Definitions

- ActionOI - The Truven Health ActionOI Operational Performance Improvement Solution delivers the tools to evaluate operational and financial data in a realistic context: head-to-

head with best-in-class organizations and facilities of similar size, payer mix, complexity, and patient population. With operational and financial data from more than 750 healthcare organizations across the country, ActionOI has the largest comparative database in the industry

- American College of Cardiology - The mission of the American College of Cardiology (ACC) is to transform cardiovascular care and improve heart health. The ACC strives to achieve its enduring purpose: to improve cardiovascular health through education, research, quality care and health policy (http://www.cardiosource.org).
- American College of Emergency Physicians (ACEP) - The American College of Emergency Physicians (ACEP) is the oldest and largest national medical specialty organization representing physicians who practice emergency medicine. With more than 32,000 members, ACEP is the leading continuing education source for emergency physicians and the primary information resource on developments in the specialty (http://www.acep.org)
- American College of Physicians (ACP) - a national organization of internists — physician specialists who apply scientific knowledge and clinical expertise to the diagnosis, treatment, and compassionate care of adults across the spectrum from health to complex illness (https://www.acponline.org)
- American Heart Association - The American Heart Association is the nation's oldest, largest voluntary organization devoted to fighting cardiovascular diseases and stroke (http://www.heart.org/HEARTORG/General/About-Us---American-Heart-Association_UCM_305422_SubHomePage.jsp)

- Centers for Medicare & Medicaid Services (CMS) - The Centers for Medicare & Medicaid Services (CMS) is an agency within the US Department of Health & Human Services responsible for administration of several key federal health care programs. In addition to Medicare (the federal health insurance program for seniors) and Medicaid (the federal needs-based program), CMS oversees the Children's Health Insurance Program (CHIP), the Health Insurance Portability and Accountability Act (HIPAA) and the Clinical Laboratory Improvement Amendments (CLIA), among other services.
- Diagnosis-Related Group (DRG) - This system is a per-case reimbursement mechanism under which inpatient admission cases are divided into relatively homogeneous categories called diagnosis-related groups (DRGs). In this DRG prospective payment system, Medicare pays hospitals a flat rate per case for inpatient hospital care so that efficient hospitals are rewarded for their efficiency and inefficient hospitals have an incentive to become more efficient. Each DRG associates hospital days with reimbursement (https://oig.hhs.gov/oei/reports/oei-09-00-00200.pdf)
- Implementation of a Chest Pain Center – development of a specific area within the hospital with treatment stations staffed by cardiologists, cardiovascular registered nurses, nursing assistants and a unit secretary who specialize in the care of patients who present to the emergency department with a complaint of chest pain
- Improve Patient Outcomes – the American Heart Association has defined guidelines for the treatment of the chest pain patient as well as the Joint Commission for Myocardial Infarction. The goal of the Chest pain Center is to meet and exceed the recommended guidelines for this patient presentation resulting in reduced adverse outcomes for the chest pain patient due to expert and efficient care

- Intermediate Risk Chest Pain – patients not in the midst of a true heart attack, but present with active chest pain that increases with exertion and subsides with rest, history of interventional cardiac treatment, known history of heart disease and a history of diabetes, elderly, hypertension and other maladies that contribute to heart disease (http://www.uptodate.com/contents/chest-pain-beyond-the-basics?view=print)
- Length of stay (LOS)– duration of the hospitalization based on the Diagnosis-Related Group (DRG) based on the chest pain diagnosis with a goal of meeting and/or exceeding the DRG length of stay for chest pain
- Observation Status - Observation care is a well-defined set of specific, clinically appropriate services, which include ongoing short term treatment, assessment, and reassessment before a decision can be made regarding whether patients will require further treatment as hospital inpatients or if they are able to be discharged from the hospital. Observation services are commonly ordered for patients who present to the emergency department and who then require a significant period of treatment or monitoring in order to make a decision concerning their admission or discharge. In the majority of cases, the decision whether to discharge a patient from the hospital following resolution of the reason for the observation care or to admit the patient as an inpatient can be made in less than 48 hours, usually in less than 24 hours. In only rare and exceptional cases do reasonable and necessary outpatient observation services span more than 48 hours. Hospitals may bill for patients who are directly referred to the hospital for outpatient observation services (https://www.cms.gov/Regulations-and-Guidance/Guidance/Manuals/downloads/bp102c06.pdf)

- Reduce overall costs – To decrease overall cost of care by providing more specific, specialized care to the patient thus reducing unnecessary testing and treatment, prolonged hospitalization and meeting or exceeding the DRG requirements for payment
- The Society of General Internal Medicine - a national medical society of 3,000 physicians who are the primary internal medicine faculty of every medical school and major teaching hospital in the United States. SGIM members teach medical students, residents, and fellows how to care for adult patients. They also conduct research that improves primary care, preventative measures, and treatment services for patients (http://www.sgim.org/about-us)
- Stress Echo Treadmill - Stress echocardiography is a test that uses ultrasound imaging to show how well your heart muscles are working to pump blood to your body. It is mainly used to detect a decrease in blood flow to the heart. This method of testing uses treadmill or bicycle exercise with electrocardiography (ECG) and blood pressure monitoring
- Stress Test-Dobutamine - A dobutamine stress echocardiogram is a diagnostic procedure that may be used when a doctor wants to assess the heart muscle under stress. If exercise on a treadmill is not an option (too much stress on the heart) due to a person's medical condition, a doctor may use an intravenous medication called dobutamine. Dobutamine causes the heart to beat faster and will mimic the effects of exercise on the heart.
- The Advisory Board - a performance improvement partner for 165,000+ leaders in 4,100+ organizations across health care and higher education. The advisory Board collaborates with executives and their teams to find and implement the best solutions to their toughest challenge. The Board creates performance technology products that tell members where their biggest improvement opportunities are, and how to get results.

Expert researchers analyze thousands of case studies every year to find and share proven best practices. The talent development team offers hands-on training to cultivate leaders and drive workforce engagement

- The Joint Commission - An independent, not-for-profit organization, The Joint Commission accredits and certifies more than 20,000 health care organizations and programs in the United States. Joint Commission accreditation and certification is recognized nationwide as a symbol of quality that reflects an organization's commitment to meeting certain performance standards (http://www.jointcommission.org/about_us/about_the_joint_commission_main.aspx)
- Treatment Stations – healthcare stations located within the CPC that are supplied with gurneys, cardiac monitors, blood pressure monitors, oxygen monitors, medical gasses, electrocardiogram (EKG) machines, medications and ultrasound machines for evaluation and treatment of these patients
- Truven Health Analytics - Truven Health Analytics delivers unbiased information, analytic tools, benchmarks, and services to the healthcare industry (http://truvenhealth.com/about-us/our-company)

Controlling for Internal and External Validity

The discussion of internal and external validity is essential to determine the merits of the research. Internal validity may be impacted by differences in practice patterns observed in the various benchmarked organizations. The researcher must ensure that evidence based medicine standards are practiced as defined by the American Heart Association and the American College of Cardiology. The researcher must also ensure that no other studies or process changes were in place that may impact the cost, LOS and quality outcomes for patients coded under DRG 313.

Instrumentation may also play a factor. If the diagnostic equipment used (cardiac ultrasound systems, nuclear medicine cameras, treadmills, etc.) for the chest pain patient changes (upgrades, manufacturer changes, measurement changes, etc.), the comparison results may be invalid. External validity may be impacted if the program features of benchmarked hospitals provide some uniqueness in design that is inconsistent with the standard chest pain center setting. Random variation may occur and the researcher must examine that variation to determine the reliability of the data.

Analysis methods as previously mentioned will primarily be secondary data analysis. Fortunately in today's healthcare environment, much of the data needed for this research project is available electronically and can be extracted from multiple databases. Collecting financial data, length of stay data and quality outcomes is readily available in the transparent world of healthcare. Much of this information is publicly reported in an effort to educate the healthcare consumer and provide that consumer the ability to select where they seek their healthcare. The researcher will need to define the most accurate and credible databases available for the required data. Primary analysis will be used to pull information from the benchmarked facilities through structured interviewing or surveys. When extracting data and sorting through the information, it is of the utmost importance to narrow down that information to ensure the data that is obtained for this project is accurate and reflects the purpose of the study relative to the research question and hypothesis.

Chapter 4 - Results and Findings

The first step in obtaining primary data was the unstructured face-to-face interview with SMCS medical staff. As previously mentioned, fifteen (15) physicians were randomly selected and interviewed. These key interview informants included: five cardiologists, five emergency medicine physicians and five internal medicine hospitalists. The selection of these physicians was determined by the specialty groups that presently provide care for the chest pain patient population. The emergency physicians are typically the first physician contact for these patients entering into the emergency department (ED). Once the ED physician examines and diagnosis the patient, that physician will alert an internal medicine physician for further analysis and possible hospital admission. If the patient presents with a level of complexity that is greater than the knowledge and expertise of the emergency medicine or internal medicine physician, the cardiologist is called to either consult or become the primary physician for the patient.

Interview Data Results and Findings

The unstructured interview questions were the first step in collecting data and probably the easiest because of access to the physicians. They were randomly selected based on the first physicians encountered during their daily rounds.

Question 1: Do you believe a chest pain center can benefit SMCS?

Responses included:

- "This is a program that we can market to the community and will add to the robust resume of the SMCS cardiac program (cardiologist)."
- "Absolutely! I do not understand why this was not in place years ago (cardiologist)!"
- "It's embarrassing! A program of this magnitude without a chest pain clinic. Get it done (cardiologist)!"

- "How could it not? This should be cheaper than the way we mange these patients now (internal medicine)."
- "Of course. We spend way too much time trying to treat these patients and we lose money the longer they wait in the ED (emergency medicine)."
- "I think so. I would support it as long as I can keep these patients and work the area (internal medicine)."
- "When you look at our profit margin, we certainly have opportunity to improve that margin. I believe the sophistication of a chest pain unit will improve our margins ten-fold. This is progressive thinking that all leaders should exhibit if we are to turn our financial dashboard green (internal medicine)."

It is obvious that the medical staff has a vested interest in the performance of SMCS based on responses. This was rather surprising considering the medical staff can appear somewhat laissez-faire with hospital politics and hospital performance separate from that of physician politics and physician performance. The two are not mutually inclusive of themselves. However, in this instance, it appears these physicians track not only clinical outcome performance, but also the economic performance of the healthcare organization as a whole. This appears to be a shift in physician thinking which is tremendously beneficial to the organization. The responses indicate physician engagement – an unexpected, but exciting outcome that will help propel this project forward. Every step taken to advance the practice of the chest pain patient must include a process to keep the physicians informed and allow them the opportunity to actively participate in the process.

Question 2: Do you believe a chest pain center will be beneficial for the chest pain patient?

- "It should considering the time they languish on the floor (inpatient unit), but only if we can expedite the stress testing and allow cardiology to control it (cardiologists)."
- "Yes. We will have multiple options for patient testing – stress echo with treadmill, stress echo with Dobutamine, Definity echo, as well as nurses who know what they are doing (cardiologist)."
- "Yes. We can get the patient out of the ED faster and not have to wait for the on-call physician to return our calls (emergency medicine)."
- "You mean patients will be out of the ER in under 60 minutes? Yeah! Put it in place so we can get these patients tested and treated (emergency medicine)."
- "If it is similar to what we had when I was a resident, it will definitely be better for the patient (internal medicine)."
- "Sure-give it a try. I think it's a good idea. If it doesn't work we can always go back to the way we do it now since our quality indicators are all good (internal medicine)."

The responses to question 2 are less surprising than those of question 1. Physicians are always vested in clinical performance measures that enhance their work environment by making their processes more streamlined and efficient. An added benefit is improved outcomes for the patients, which the physicians follow closely because of their individual performance measures that are often tied to financial incentives. As mentioned in the question 1 analysis, physicians have shifted their thought process from individualized thinking (what do my performance measures look like?) to more global thinking (how is the program and hospital performing?). This creates an environment that benefits the patient and allows for easier change efforts to improve the care delivery model. The support for the chest pain center from the medical staff

lessens the difficulty with implementation and typically provides a best practice model that other centers will attempt to emulate.

Unanimously all of the physicians queried are in favor of the idea of establishing a chest pain center. The general consensus is diagnosis, treatment and discharge will occur more rapidly benefitting both the patient and SMCS. The cardiologists stated they have always been in favor of this idea and staffing could consist of a nurse practitioner or physician's assistant with cardiac nurses providing first line oversight and care of the patient. They felt their role could be more as a consultant rather than the primary physician. This provides several layers of care and oversight that creates a care model of depth that can eliminate misdiagnoses, unnecessary testing and cost overruns due to fragmented or bad care. The emergency medicine physicians felt the chest pain center would help dis-impact the emergency department especially during the busiest hours of the day. They were in favor of this design because it moved the patient to the next level of care faster and reduced the burden of trying to manage these patients. One emergency medicine physician commented "it is preferred that it be separated by location and personnel." Enhancing throughput of patients in the emergency department plays a vital role in hospital performance because of how badly impacted emergency departments are today due to many patients using this environment for their primary care needs. A reduction of ED patients by 20% (the estimated percentage of chest pain patients presenting to the ED) will provide benefits not measured in this study, but hugely impactful. The internal medicine hospitalists were also in favor of the design, but wanted to staff the area with their own physicians to maintain their productivity. This group presently provides the primary care medicine for these patients when admitted and based on quality outcomes are doing an extraordinary job. Ultimately the chest pain center design will do well based on the commitment of these physicians and the present quality outcomes for the chest

pain patient.

It is of the utmost importance that SMCS have physician support to successfully implement a chest pain center. What the structured surveys provided, aside from the direct answers, was the notion that the planning must involve physicians from each of the three specialties. It is imperative their voices be heard and they have input in the design, staffing, equipment needs and operationalization of this area. They obviously have a vested interest in a chest pain center evidenced by their engagement as noted from the interviews. It is also obvious that a number of these physicians have prior experience with a chest pain center at other institutions. Their experiences must be part of the process.

Survey Data Results and Findings

The structured surveys were an area of concern for fear the data would not be shared or made available in a timely manner. The surveys were sent out to 10 hospitals benchmarked to SMCS. As part of the sharing agreement in place with SMCS through ActionOI, the surveyed hospitals will remain anonymous. Of the 10 hospitals surveyed, Only 5 responded to the following questions:

1. Does your hospital have a chest pain center/clinic/rapid decision unit for the chest pain patient who presents to the emergency department?
2. What is the average length of stay for the Diagnosis Related Group (DRG) 313-chest pain?
3. What is the average hospital cost for DRG 313?

Two of the responses indicated their facility did not have a chest pain center and did not provide a response to the remaining questions. Three of the facilities did have a chest pain center designed for the chest pain patient and provided information as requested.

The average length of stay is something looked at very seriously by not only SMCS, but by all healthcare facilities in the nation. With reduced reimbursements and changes in payment structure due to the ACA, the average length of stay has become a crucial indicator of healthcare economics. The four facilities (including SMCS) have the following responses (chart 1):

- SMCS has an average LOS of 1.49 days
- Hospital 1 has an average LOS of 0.95 days
- Hospital 2 had an average LOS of 1.2 days
- Hospital 3 had an average LOS of 0.8 days.

Though only 3 hospitals shared their data, it provides evidence that a chest pain center plays a significant role in reducing the average length of stay when compared to SMCS. To what extent the chest pain center reduces time in the hospital is unknown, but all facilities show better performance than SMCS.

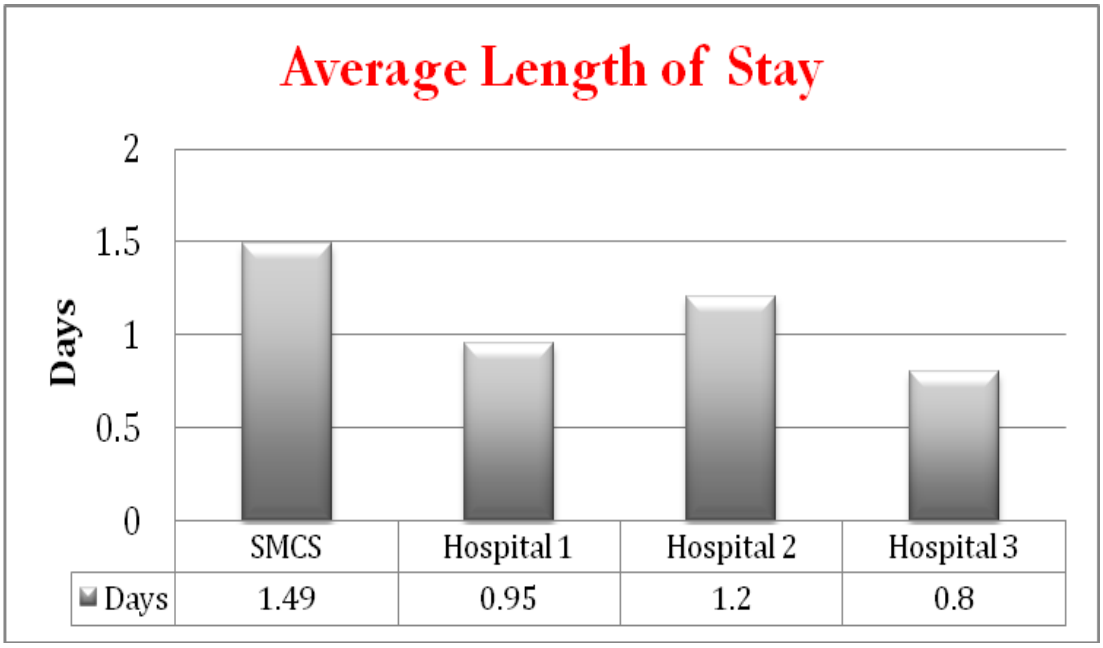

Chart 1

It is imperative for all healthcare facilities to reduce costs to sustain their business model in today's healthcare economic environment. If an organization can reduce LOS, it is assumed that costs will also decrease. In review of the costs related to the chest pain patient (DRG 313), SMCS has the greatest cost per patient. The following numbers reveal the cost for the chest pain patient at the four different facilities (Chart 2):

- SMCS - $3979 per chest pain patient
- Hospital 1 - $1826 per chest pain patient
- Hospital 2 - $2590 per chest pain patient
- Hospital 3 - $2065 per chest pain patient

The data suggests the chest pain center may help reduce the direct costs per patient presenting with chest pain to the emergency department. The idea behind the chest pain patient is reduction in utilization due to specialized care. Fewer tests are ordered, more accuracy in diagnosis occurs and shorter length of stays all contribute to a reduction in dollars spent to care for these patients.

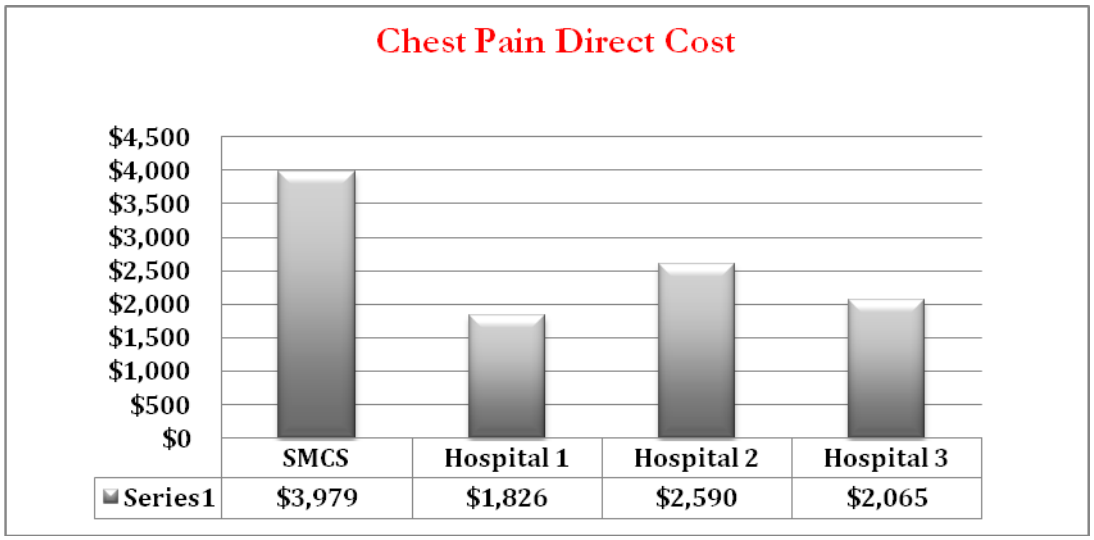

Chart 2

Quality care becomes a tremendous factor in maintaining and growing business in today's world of healthcare. A chest pain center theoretically should improve the quality of care for the chest pain patient because of the expertise of the physicians and nurses assigned to provide care in the center. Reviewing the Centers for Medicare and Medicaid services website, as well as, the Joint Commission site for performance revealed cardiac outcome measures. Each center has met the quality indicator goals by 100% including SMCS (Chart 3). Interesting is the quality outcomes for SMCS is equally good to those facilities with chest pain centers. Opportunity may not necessarily exist in the quality area; however, the cost of care and length of stay may suggest there is opportunity to improve the delivery of care from a quality perspective to make processes more streamlined and timely. Failure to work to improve all areas may eventually have a negative impact on the quality outcomes. The regulatory agencies annually make the outcome criteria more difficult achieve requiring healthcare organizations to improve the delivery of care. A chest pain center provides that opportunity to improve cardiac care for the hospital.

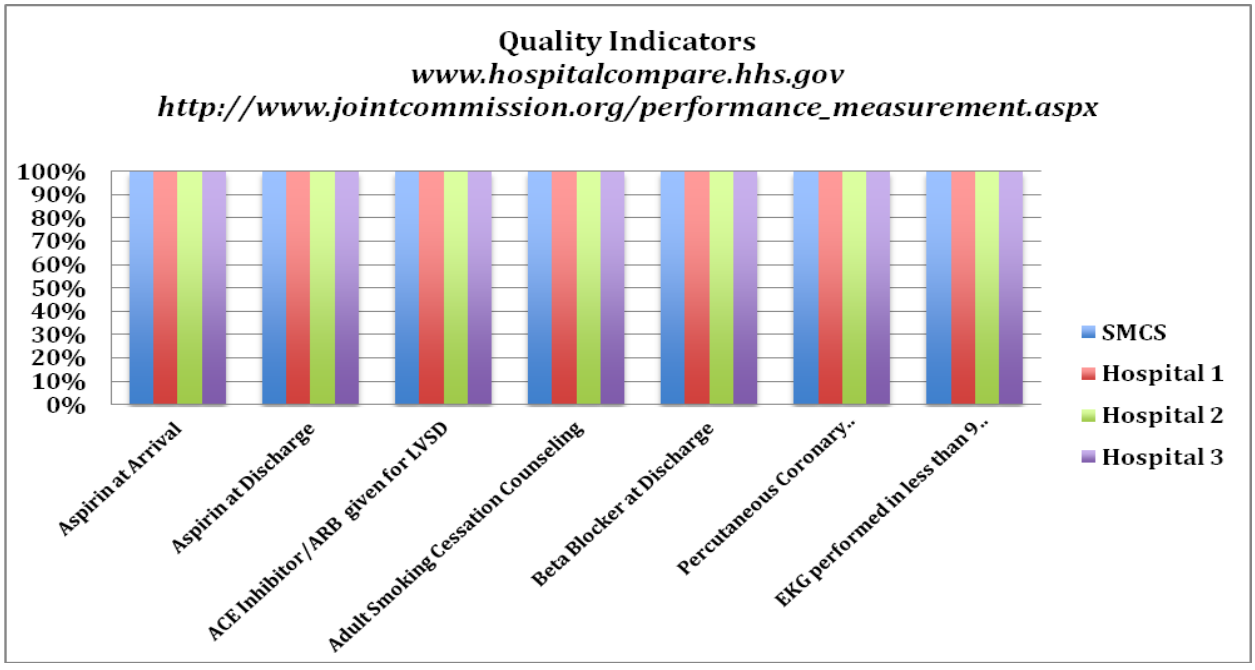

Chart 3

Significant Findings

The data in support of the hypothesis provides very telling information that requires attention and action around development of a chest pain center. The average length of stay has become a significant topic in healthcare today based on the reimbursement plans that Medicare is instituting. Chest pain patients are often billed under "observation" status, which reimburses at a significantly lower rate than patients admitted under "inpatient" status based on Medicare criteria (https://www.cms.gov/Regulations-and-Guidance/Guidance/Manuals/downloads/bp102c06.pdf). The longer the patient stays in the hospital (24 hours or longer), the lower the reimbursement will be for the hospital with greater cost to provide oversight and care. Decreasing the LOS will not only prevent the further loss of money from the hospital, but will also provide significant cost savings. Two of the 3 hospitals have achieved a LOS less-than-1-day which is the goal of SMCS for the chest pain patient. How that was accomplished requires further evaluation because SMCS has worked on this issue for several years without success. Obviously the chest pain center plays a large part in reducing the LOS, but the implementation is what requires evaluation.

The direct costs provide an even more striking difference compared to that of SMCS. The LOS data may not appear as striking as that of the difference in cost to provide that care. There are regional differences that are in play such as the wages paid to registered nurses in California versus other parts of the country. However, the LOS being shorter for the other hospitals provides a direct correlation to resources used such as hours of nursing care, testing, supplies and other utilities that cost more based on time in the hospital. With the smallest difference in cost of $1,389 (SMCS compared to hospital 3) and the largest difference in cost of $2,153 (SMCS compared to hospital 1), the research has provided ample evidence that justifies

the existence of a chest pain center. Many hospitals reduce costs through reductions in force, discontinuation of programs and other actions that have a negative impact on the hospital's clinical operations. The development of a chest pain center is a positive action that actually grows a business with greater efficiency in care, streamlining processes and ultimately reducing costs without cost containment at the expense of the workforce.

The quality data provides the most interesting information because SMCS is performing as a top decile medical center for the chest pain patient equal to that of those hospitals benchmarked to SMCS. What cannot be ignored is the fact that those other hospitals achieve the same quality standards in less time and at a much cheaper cost than SMCS. This type of performance from hospitals 1,2 and 3 will eventually set a new standard of expectations as desired by the ACA. It will not matter what the SMCS quality performance is if other hospitals achieve the same quality standards at a reduced rate. Consumers are now shopping for the best heathcare quality at a discounted rate.

The data provided through this research project overwhelmingly supports the hypothesis and was very rich in detail. The researcher did not expect the information to be as easy to interpret as it was. The differences of the benchmarked hospitals to that of SMCS are evident generating a level of excitement that will motivate others to embrace the data and move towards a plan to implement the chest pain center. Even though only 3 hospitals shared their data, the data was enough to support the notion that the chest pain center offers alternatives to financial stability and a system that makes Medicare an affordable government payer. The suggestion will be made to explore more hospitals with chest pain centers to obtain a more diverse and rich sampling for further evaluation and validation around care of the chest pain patient.

Chapter 5 - Conclusions and Recommendations

Conclusions

The data - length of stay, direct costs and quality outcomes, strongly suggests that a chest pain center provides efficiency and efficacy for the chest pain patient. As a result, the hypothesis as stated: implementation of a chest pain center will reduce overall costs, achieve a shorter length of stay and improve patient outcomes, is supported by this research. Based on the time and effort spent on this research project, the researcher believes more analysis and data may be required to support a business plan. The following recommendations are made:

- Analyze data from more facilities with chest pain centers to obtain a greater cross section of information to provide further validation of the value of a chest pain center
- Analyze more data from more facilities without chest pain centers for a greater comparative analysis to those facilities with chest pain centers
- Look for more quality indicators that are specific to chest pain centers (i.e. treadmill stress test completion time, time from ED to time transferred to the chest pain center, percent of patients ruled out for cardiac type chest pain, etc.)
- Wage adjust for direct costs because of the high wages paid to California registered nurses and ancillary staff compared to other states

Recommendations

With the conclusion of this project, next steps will be:

- Cardiovascular Service Line Executive, Cardiology Nursing Director, Chief Financial Officer and Cardiovascular Medical Director Develop a business plan by July 31, 2014
    - Evaluate operating costs (staffing, hours of operation, etc.)

  - Evaluate capital costs (equipment, construction, etc.)
  - What is the return on investment based on Medicare rates
  - Will be based on a 1 day LOS
  - Examine states licensing requirements and regulations for chest pain center in an acute care facility

- Implement a pilot chest pain center at SMCS by August 14, 2014 using a Plan, Do, Study, Act (PDSA) model
  - Complete the pilot 3 months from initiation
  - Pilot this area 3 days per week for no greater than 8 hours per day
  - Start small with a few patients and staff (2 to 3 treatment bays)
  - Document steps in the process on a weekly basis
  - Make recommendations to senior leadership
- Conduct further research on quality outcomes of a chest pain center
  - How best to sustain quality outcomes
  - Follow best practice models of care for the chest pain patient
  - Analysis should be added into the business plan
  - Incorporate best practice into standard clinical protocols/practice
- Consider an enterprise implementation for Sutter Health
  - Work with Sutter Health senior administrative leaders and cardiology leaders to standardize chest pain center care throughout the Sutter Health system
  - Focus on 2nd and 3rd quarter of 2015 for implementation to other facilities
  - Determine time commitment to implement
  - Determine what order to implement a chest pain center for other hospitals based

on readiness for change

The research of a chest pain center should not end with the implementation of this specialized area. Once the center is implemented, this researcher suggests expanding the study beyond the chest pain center itself. Further recommendations for additional research are as follows:

- Retrospective analyses at the one year anniversary of implementation to review the following:
    - End point of outcomes and quality
        - Death
        - Readmission
        - Stroke
        - Myocardial infarction
        - Progression of cardiac disease (i.e. congestive heart failure)
        - Comparison of quality data relative to this research project
    - Average LOS for the chest pain patient
    - Average direct cost per chest pain patient
    - Cost savings comparing dollars spent 2013, 2014 and 2015
- What are the impacts, positive and negative, on the emergency department once the chest pain center is implemented
    - Analyze at 6 months, 12 months and 18 months
    - Areas of Analysis
        - Financial impact (positive and negative variances to budget)
        - Throughput times (arrival to discharge or admit)
        - Physician and staff satisfaction

        - Patient satisfaction

- What are the impacts to the inpatient hospital populations and bed capacity based on a chest pain center
    - Analyze at 6 months, 12 months and 18 months
    - Inpatient bed capacity for the cardiac patient –still impacted or not
    - Inpatient staffing for the cardiac patient
    - Patient throughput for the inpatient environment
    - Staff and physician satisfaction

The idea of incorporating a chest pain center at SMCS for the rapid diagnosis, treatment and disposition of the chest pain patient breathes life into this research project. With the hypothesis being accepted, this research project will positively impact hundreds of patients in the Sacramento community. In turn, SMCS will reduce its overall cost structure, improve its standing in the cardiology community because of improved outcomes, and send patients home much sooner than before this project. Tremendous work lies ahead to gather the data, analyze the data and present the data. The use of the scientific method will bring credibility to the study – a necessity in persuading senior executives to invest money, time and people in the development of a new program. Knowing that heart disease is the leading cause of death for both men and women in the United States, professionals in the healthcare industry are acutely aware of the need to improve its delivery model for this patient population. Therefore, it is prudent to ask the question - can a chest pain center design reduce the average length of stay, reduce overall treatment costs and produce better quality outcomes for the chest pain patient presenting to the emergency department? The research says yes.

Bibliography

Ashrafi, R., Rags, S., Abdool, A., Disney, A., Wong, P. & Davis, G.K. (2013). NICE recommendations for the assessment of stable chest pain: assessing the early economic and service impact in the rapid-access chest pain service. *Postgraduate Medical Journal*, 2013, 251-257 doi: 10.1136/postgradmedj-2012-13109

Athaudau-Arachchi, P. M. & Hutcheon, S. D. (2013). Assessing the implications of implementing the NICE guideline 95 for evaluation of stable chest pain of recent onset: a single centre experience. *Scottish Medical Journal.* Retrieved from http://scm.sagepub.com/content/58/1/12

Boyle, R. M. (2007). Value of rapid-access chest pain clinics. *Heart 2007;93:415–416. doi: 10.1136/hrt.2006.100248*

Byrne, J., Murdoch, D., Morrison, C. & McMurray, J. (2002). An audit of activity and outcome from a daily and a weekly "one stop" rapid assessment chest pain clinic. Postgrad Med J 2002; 78:43–46

Centers for Disease Control and Prevention. *Heart Disease Facts* [Data file]. Retrieved from http://www.cdc.gov/heartdisease/facts.htm

Chambers, J.B., Marks, E., Knisley, L. & Hunter, M. (2012). Non-Cardiac Chest Pain: Time to Extend the Rapid Access Chest Pain Clinic. *The International Journal of Clinical Practice, DOI 10.1111/ijcp.12030*

Debney. M. T. & Fox, K. F. (2011). Rapid Access Cardiology—A Nine Year Review. *Oxford Journal of Medicine, 2012, 105:231–234 doi:10.1093/qjmed/hcr182*

Dougan, J. P., Mathew, T. P., Riddell, J. W., Spence, M. S., McGlinchey, P. G., Nesbitt, G. S., Smye, M., Menown, I. B. A. & Adgey, A. A. J. (2001). Suspected angina pectoris: a

rapid-access chest pain clinic. *Q J Med 2001; 94:679–686*

Francis, H.C., Colecliffe, W., Hazell, M. L., Singh, D., Niven, R., Hagen, D. S. & Frank, T. L. (2008). Prevalence of airflow obstruction in patients attending a rapid access chest pain clinic *Respiratory Medicine (2009) 103, 736e742*

George, J., Jack, D., Mackle, G., Callaghan, T.S., Wei, L., Dow, E. & Struthers, A. D. (2011). High sensitivity troponin T provides useful prognostic information in non-acute chest pain. *Q J Med 2012; 105:159–166 doi:10.1093/qjmed/hcr174*

Ghosh, A., Qasim, A., Woollcombe, K. & Mechery, A. (2012). Cost Implications Of Implementing NICE Guideline On Chest Pain In Rapid Access Chest Pain Clinics: An Audit And Cost Analysis. *Journal of Public Health, Vol. 34, No. 3, pp. 397–402 doi:10.1093/pubmed/fdr118*

Keller, T., Post, F., Tzikas, S., Schneider, A., Arnolds, S., Scheiba, O., Blankenberg, S., Munzel, T. & Genth-Zotz, S. (2009). Improved Outcome In Acute Coronary Syndrome By Establishing A Chest Pain Unit. *Clinical Research in Cardiology, DOI* 10.1007/s00392-009-0099-9

McGavigan, A. D., Begley, P. E., Moncrieff, J., Hogg, K. J. & Dunn, F. G. (2003). Rapid Access Chest Pain Clinics – Can They Be Justified. *Scottish Medical Journal, 2003;48: 013-016*

Marshall, K., Nelson, S. & Sykes, C. (2005). Analyzing and improving a rapid access chest pain clinic. *Nursing Times, vol. 101.* Retrieved from http://www.nursingtimes.net/nursing-practice/clinical-zones/pain-management/analysing-and-improving-a-rapid-access-chest-pain-clinic/203639.article

Motwani, U. H. & Burrell, C. J. (2010). Troponin-I Positivity In Patients Referred To Rapid

Access Chest Pain Clinic. *Retrieved from http://www.ayubmed.edu.pk/JAMC/PAST/22-4/Umar.pdf*

Newby, D. E., Fox, K. A. A., Flint, L.L. & Boon, N. A. (1998). A 'same day' direct-access chest pain clinic: improved management and reduced hospitalization. *Q J Med 1998; 91:333–337*

Patterson, C., Nicol, E., Bryan, L., Woodcock, T., Collinson, J., Padley, S. & Bell, D. (2011). The effect of applying NICE guidelines for the investigation of stable chest pain on out-patient cardiac services in the UK. *Q J Med 2011; 104:581–588 doi:10.1093/qjmed/hcr011*

Price, J. R., Mayou, R. A., Bass, C. M., Hames, R. J., Sprigings, D. & Birkhead, J. S. (2005). Developing a rapid access chest pain clinic: Qualitative studies of patients' needs and experiences. *Journal of Psychosomatic Research 59 (2005) 237–246*

Neha, S., Timmis, A., Hemingway, H., Walsh, N., Eldridge, S., Junghans, C. & Feder, G. (2012). Is access to specialist assessment of chest pain equitable by age, gender, ethnicity and socioeconomic status? An enhanced ecological analysis. *BMJ Open 2012;2:e001025. doi:10.1136/bmjopen-2012-001025*

Pottie, A. (2005). A Nurse-Led Rapid Access Chest Pain Clinic−−Experience from the First 3 Years. *European Journal of Cardiovascular Nursing 4: 227 DOI: 10.1016/j.ejcnurse.2005.03.003*

Rajpura, A. & Taylor, M. (2005). An evaluation of two Rapid Access Chest Pain Clinics in central Lancashire, UK. *Journal of Evaluation in Clinical Practice ISSN 1356-1294*

Robinson, D. J., Woods, P.G., Snedecker, C. A., Lynch, J. H. & Chambers, K. (2002). A Comparison Trial for Stratifying Intermediate-Risk Chest Pain: Benefits of Emergency

Department Observation Centers. *Medscape Cardiology.* Retrieved from http://www.medscape.com/viewarticle/433234_4

Sekhri, N., Feder, G. S., Junghans, C., Hemingway, H. & Timmis, A. D. (2007). How effective are rapid access chest pain clinics? Prognosis of incident angina and non-cardiac chest pain in 8762 consecutive patients. *Heart 2007;93:458–463. doi: 10.1136/hrt.2006.090894*

Tenkorang, J. N., Fox, K. F., Collier, T. J. & Wood, D. A. (2006). A rapid access cardiology service for chest pain, heart failure and arrhythmias accurately diagnoses cardiac disease and identifies patients at high risk: a prospective cohort study. *Heart 2006;92:1084–1090. doi: 10.1136/hrt.2005.079376*