Southern California CSU DNP Consortium
California State University, Fullerton
California State University, Long Beach
California State University, Los Angeles

DEVELOPMENT AND IMPLEMENTATION OF A PERIOPERATIVE WEB-BASED INTERFACE

A DOCTORAL PROJECT
Submitted in Partial Fulfillment of the Requirements
For the degree of
DOCTOR OF NURSING PRACTICE

By
Maria H. Letts

Doctoral Project Committee Approval:

Joy R. Goebel, PhD, RN, Project Chair
Jarline Ketola, PsyD, RN, Committee Member

May 2016
Copyright Maria H. Letts 2016 ©
ABSTRACT

Clinicians in preoperative settings employ a variety of clinical tools to stratify risk, classify disease severity, and individualize care. The process of accessing multiple tools for a single patient encounter was time consuming, affected productivity, and potentially decreased compliance of provider’s use of evidence-based recommendations. The purpose of this project was to develop and evaluate a web-based interface for perioperative tools in a pre-anesthesia setting. This interface improved access to evidence-based clinical assessment tools, practice efficiency, and supports decrease variability in documentation.

A literature review identified research-based preoperative assessment tools. The user-centered design theory guided the development and implementation of the web-based interface. The Pre-Anesthesia Consultation and Education (PACE) launched using the web-based interface in September 2015. The National Surgical Quality Improvement Program calculator, STOP-Bang questionnaire, CHA2DS2-VASc calculator, Glomerular filtration rate calculator, and Model For End-Stage Liver Disease score calculator were included with the first iteration of the PACE interface.

When compared to the alternative process for accessing clinical tools though search engines on the Internet and paper-based clinical tools, accessibility from the PACE interface is more efficient in terms of number of steps and number of access points via the intra- or internet. The PACE web interface was accessed 515 times in September,
with 216 views in week one. The clinical tool web page (where the surgical risk tool and the STOP-Bang are located) had 85 views for the month. These reports may underestimate actual interface use as providers may leave the interface open during the day for multiple patient encounters. Designated as the population most appropriate for clinical tool application, 452 patients (49.8%) who were classified as ASA III or greater were seen in September. The frequency of interface views started to reflect the volume of higher acuity patients, ASA class III-V by the last two weeks of the month. Nevertheless, no evidence was found for surgical risk tool access from the website during the implementation period.

A centralized platform provides point of care access to clinical tools, supports compliance, and encourages less variability in documentation. This quality improvement project provided a formal framework for integrating evidence-based research and tools into an interactive practice experience that supports the daily demands of clinical practice and helps providers in achieving better clinical decisions.
# TABLE OF CONTENTS

ABSTRACT .......................................................................................................................... iii

LIST OF TABLES .................................................................................................................. vii

LIST OF FIGURES ............................................................................................................... viii

DEDICATION ...................................................................................................................... ix

ACKNOWLEDGMENTS ....................................................................................................... x

BACKGROUND ................................................................................................................. 1

  Purpose Statement ........................................................................................................ 2
  Conceptual Framework ............................................................................................... 2

REVIEW OF LITERATURE ............................................................................................... 7

  Overview ...................................................................................................................... 8
  Web-based Interface Development and Implication .................................................... 8
  Evidence for Clinical Tools ....................................................................................... 11
  STOP-Bang Questionnaire ......................................................................................... 11
  National Surgical Quality Improvement Program (NSQIP) Calculator ..................... 14

METHODS ......................................................................................................................... 18

  Description of Setting ............................................................................................... 18
  Provider Demographics ............................................................................................ 18
  Procedures ................................................................................................................. 19
  Measures of Outcomes ............................................................................................. 22
  Data Collection and Analysis .................................................................................. 22
  Protection of Human Subjects .................................................................................. 23

RESULTS ............................................................................................................................ 24

  Effectiveness ............................................................................................................ 25
  Efficiency .................................................................................................................. 26
  Satisfaction ............................................................................................................... 28
DISCUSSION .......................................................................................................................... 29
SUMMARY .............................................................................................................................. 31
REFERENCES .......................................................................................................................... 32
APPENDICES .......................................................................................................................... 32

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>DEVELOPMENT AND IMPLEMENTATION OF A PERIOPERATIVE WEB-BASED INTERFACE TIMELINE</td>
<td>37</td>
</tr>
<tr>
<td>B</td>
<td>PACE WEB-BASED INTERFACE TIPS SHEET</td>
<td>38</td>
</tr>
<tr>
<td>C</td>
<td>PACE WEB-BASED INTERFACE WELCOME PAGE</td>
<td>40</td>
</tr>
<tr>
<td>D</td>
<td>PACE WEB-BASED INTERFACE CLINICAL TOOLS PAGE</td>
<td>41</td>
</tr>
<tr>
<td>E</td>
<td>ASA PHYSICAL STATUS CLASSIFICATION SYSTEM</td>
<td>42</td>
</tr>
<tr>
<td>F</td>
<td>STOP-BANG QUESTIONNAIRE</td>
<td>43</td>
</tr>
<tr>
<td>G</td>
<td>SAMPLE OUTPUT OF NSQIP TOOL</td>
<td>44</td>
</tr>
<tr>
<td>H</td>
<td>TABLES OF EVIDENCE</td>
<td>45</td>
</tr>
</tbody>
</table>
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Demographic for Patient Population with ASA Classification</td>
<td>24</td>
</tr>
<tr>
<td>2. Page Views and ASA Class III-V Adult Patient Volume</td>
<td>25</td>
</tr>
<tr>
<td>3. Table of Evidence</td>
<td>43</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Logic Model for Development and Implementation of a PACE Interface</td>
<td>6</td>
</tr>
<tr>
<td>2. Control chart displaying web page view and ASA class III-V adult patients</td>
<td>27</td>
</tr>
</tbody>
</table>
DEDICATION

This DNP project is dedicated to my daughters, Simone and Krysten DeShields. May God give you the inspiration, courage, and strength to accomplish your full potential. To my amazing sister, Sandra Letts, thank you for your ongoing support, inspiration, and encouragement.
ACKNOWLEDGMENTS

I acknowledge and express sincere appreciation to my committee chair, Dr. Joy Goebel, for her wisdom, patience, and graceful feedback throughout this project and on the road to obtaining a DNP degree. Sincere gratitude to my committee member, Dr. Jarlene Ketola, for her support and encouragement throughout this project. To the amazing Sarah Douville and the CSU DNP consortium professors, thank you so much for creating an exceptional professional environment for advancement. Thanks to my colleagues and co-workers for your ongoing encouragement and support especially Jan Belden (my editor), Dr. Patti Radovich, Dr. Karen Bradley, Pat Crudup, Marc Dailey, and my PACE family.

Thank you friends and family for your ongoing support and encouragement. Thank you all who took the time to read my paper. Bien and Sandra thanks for walking with me. To my sister and best friend, Sandra Letts, thank you for setting a great example of professional excellence. To an amazing God, thank you for carrying me all the way.
BACKGROUND

Information technology (IT) is at the center of modern life. On the 25th anniversary of the World Wide Web in the United States of America, a national survey revealed that 87% of adults in America use the Internet. Internet use has not only become a part of daily life but has also become a major component for commerce, communication, socialization, education, research, and so much more (Pew Reasearch Center, 2014). Within the health care setting, integration of informatics has improved quality care. Informatics is defined as “the collection, classification, storage, retrieval, and dissemination of recorded knowledge” (Merriam-Webster Dictionary, 2015).

Health care providers use informatics on a daily basis for information to guide patient care and make critical decisions. Informatics can contribute to the enhancement of patient care processes and outcomes through improved data management and increase communication among providers (Kibbe & Bard, 1997). Loma Linda University Medical Center (LLUMC) must find innovative ways to apply clinical informatics to improve and provide quality care like all other health care institutions.

LLUMC is a large tertiary facility providing care to patients within the Southern California Inland Empire. Staffed primarily by Nurse Practitioners (NPs), the Pre-Anesthesia Consultation and Education (PACE) department is one of the health care settings within LLUMC seeking to improve care processes and patient outcomes. NPs within the PACE department determine patient stability for anesthesia by obtaining a patient history, preforming a focused physical examination, ordering appropriate testing and evaluating test results before an anesthesia event or procedure. PACE clinicians analyze patient level data to identify medical issues and determine the severity of co-

To ensure patient centered quality care, clinicians utilize a variety of tools such as medical calculators, charts, guidelines, and algorithms. These clinical tools provide information for risk stratification and classification of disease severity to individualize patient care. Before the initiation of the project, PACE clinicians accessed clinical tools through search engines on the Internet and paper-based format for institution specific guidelines. Accessing tools for a single patient encounter was time consuming, affected productivity, and potentially decreased the compliance of provider in using evidence-based recommendation.

**Purpose Statement**

The purpose of this Doctor of Nursing Practice (DNP) project was to develop a web-based interface for perioperative information and tools in a pre-anesthesia setting for an academic tertiary hospital. This interface would serves to improve access to evidence-based care and facilitate efficiency.

**Conceptual Framework**

Conceptual and theoretical frameworks provide structure and serve as guides for clinical projects (Bonnel & Smith, 2014). The logic model and user-centered design theory guided the infrastructure for the successful development and implementation of the PACE interface. In addition to identifying key concepts for this project, boundaries defining its scope or extent are defined within the framework (Bonnel & Smith, 2014).

The logic model is a systematic way to visually organize, plan, and analyze an outcome-based program or project. The development of the plan allows for reviews,
corrections, and adjustments. This flexibility produces a better program design with systematic monitoring, management, and report of program outcomes. The first publication citing use of the logic model was by Joseph Wholey (1979). Since then, there have been many variations and types of logic models implemented. Institutions, such as The U.S. Agency for International Development (USAID), have used the logic model for program planning and development (Taylor-Powell & Hernet, 2008). Educational organizations, such as the Institute of Educational Sciences and the U.S. Department of Education, utilize and endorse this framework to plan, monitor and evaluate educational programs (Lawton et al., 2014).

Selection of the logic model approach provided a visual display of the links between input or resources, activities, and the output or outcomes for project development and evaluation. The model served as a tool to communicate with stakeholders the process for achieving project goals. It provided a clear sequence of the processes that guided this project towards the desired outcomes. Stakeholders, such as anesthesiologists, administrators, perioperative staff and health care providers within the institution are more likely to be more engaged and supportive of a plan that is clear and easy to understand.

Three key concepts for this project—Input, Activities, and Output—are italicized and defined as follows:

*Input* includes material and non material resources, such as personnel, instruction materials, equipment, time, and the specialized knowledge and information needed to create and implement the processes to achieve the final outcome (Lawton et al., 2014). PACE clinical practice needs provided input to identify clinical tools and defined the
scope of the web-based interface. The IT department within the institution provided specialized service and knowledge for the PACE web interface development.

Activities are the actions, steps, and processes that must occur to produce the final results (Lawton et al., 2014). A literature review identified evidence based clinical tools. Direct provider observation occurred during pilot testing and implementation. The PACE interface development was guided by and accomplished through the IT department.

Outputs or outcomes are products of the activities. They are the measurable and specific effects or changes within a time period. Outcomes were qualified as short, mid or long-term observable results (Lawton et al., 2014). Short-term outputs measured data, which consisted of the frequency of interface and clinical tool page access during implementation and within the first month of go-live. Mid-term output will occur within a year of initiation of the project. Long-term outcomes, also referred to as impact, are the intended or unintended change occurring at an organizational level or within a system (Lawton et al., 2014). The impact of long-term outputs from this DNP project, such as improved quality perioperative care, will be observable at the institutional level one-year or more post implementation.

The user-centered design concept provided an appropriate support with the logic model to achieve the purpose of this project. The term, user-centered design, was popularized by Donald A. Norman, who observed the frustration individuals often experience when using new technology (Zachry, 2005). User-centered design is a common design philosophy that focuses on the needs and limitations of the end users throughout the process from conceptualization to implementation. Rather than creating a product that forces the end user to change his behavior, this approach takes into
consideration how the end user will use the product. With this approach, there is an increased likelihood that the end user will adopt and use the product in practice. This approach involves a variety of methods or activities that requires the involvement of the end users throughout the process. These methods and activity include “assessing the intended users, observing and analyzing tasks and requirements, developing and testing prototypes, evaluating design alternatives, analyzing and resolving usability problems, and testing the features and interfaces with users in an interactive manner” (Dabbs et al., 2009, p. 176).

Activities conducted specifically for this project included analyzing provider requirements, resolving usability problems during the development, and testing phase. This framework supported the three definitions included in the project outcomes: effectiveness, efficiency, and provider satisfaction (see Figure 1 for Logic Model with detailed input, activities, and output).
Figure 1: Development and Implementation of a Web-based Perioperative Interface Logic Model.
REVIEW OF LITERATURE

Overview

DNP graduates must analyze critical elements of health information technology (HIT) needed to implement quality improvement initiatives that support clinical practice and decision-making (American Association of Colleges of Nursing, 2006). The literature review identified research based perioperative assessment tools. The first section of this literature review will provide examples of successful web-based interface projects. The second section will provide the evidence for the selection of clinical tools the NSQIP surgical risk calculator and the STOP-Bang questionnaire which were among the first tools included in the first iteration of the PACE interface.

Articles containing examples of successful web-based projects and evidence-based data supporting the use of the specified clinical tools were selected from an Internet search of the CINAHL (Cumulative Index to Nursing and Allied Health Literature) and Pub Med through the CUSF (California State University Fullerton) library and the LLU (Loma Linda University) library databases. The initial search had no limitations on the dates and included all publications. Article titles and abstracts were briefly reviewed for applicable literature. Articles that demonstrated evidence-based outcomes were selected based on applicability to the project and study design. Selected articles were searched for additional applicable references. An additional search for authors with multiple publications was conducted through Academic Search Premier. A search of the World Wide Web was conducted for articles not available from the databases listed.

Various search combination of key words and terms were used which included: health information technology, perioperative website medical informatics, preoperative
assessment, clinical tools, STOP-Bang, sleep apnea, obstructive sleep apnea, NSQIP, surgical risk, and user-centered design.

**Web-based Interface Development and Implementation**

Health information technology (HIT) has the potential to transform the health care industry by using innovative processes to increase efficiency, improve patient safety and improve quality care (Shekelle, Morton, & Keeler, 2006). In the report, ‘To Err Is Human: Building a Safer Health System’, the Institute of Medicine (IOM) challenges the health care industry to use HIT innovatively to improve quality care (Damberg et al., 2009). HIT systems have proven to be clinically valuable, with embedded tools that are reliable in accommodating the needs of a variety of clinical settings and users (Abernethy, Wheeler, & Bull, 2011; Goebel et al., 2014).

‘Do not reinvent the wheel’ is a common adage that encourages leaders to capitalize on yesterday’s successful innovations to provide solutions for today’s challenges. Developing an effective software program or web-based interface requires time and resource. As such, it is imperative to evaluate and utilize evidence-based IT processes and information. The process for developing the PACE interface was more effective and efficient by applying the lessons learned from the literature as well as the expertise and support of the IT department at LLUMC.

A recent project for federally qualified health centers employed user-center design to develop a HIT tool to maintain insurance coverage for low-income families and children. With information gathered from observations of family and staff, an informatician designed and customized a health insurance tool to identify and track the insurance status of these patients. The HIT team created an intuitive “pop-up” message at
the point of service that served as a reminder for staff to discuss insurance deadlines and status with patients and families. The implemented technology resulted in successful communication of the patient’s health care needs and issues related to insurance status. The efficiency and the quality of care provided contributed to improvement in the health of this population. Based on the outcome multiple primary care clinics adopted the health insurance tool (DeVoe et al., 2014).

The development of a HIT-based data infrastructure for the collection of data from multiple hospice and palliative care sites also used a user-centered approach. Users included patients, physicians, nurses, and clinical staff. Abernathy et al. (2011) emphasized the importance of the “human factor” by engaging project participants, when implementing the HIT system within participating facilities. The authors recommend that technical support to troubleshoot problems from a supportive and well-developed IT department is essential. Other lessons learned through the HIT incorporation process included: engaging leadership support, involving a full range of stakeholders, including personnel in the decision making process, responding to the needs of the sites and daily promotion of teamwork. Once implemented, the database served as a data resource to support quality initiatives and research demonstrating that HIT systems and tools can be clinically valuable and applicable in a variety of clinical settings and users (Abernethy et al., 2011).

Another report, describing the use of HIT to develop a documentation template for Veterans Health Care Administration palliative consults, documents the importance of a user-centered design to guide the developmental process. The template captures data to support quality improvement initiatives at multiple facilities across the country. The
author determined that successful implementation of informatics technology is influenced by the “technical aspects of the tool design . . . contextual and process related factors and the people factor” (Goebel et al., 2014). A multidisciplinary approach was helpful in identifying and addressing concerns and resolving conflicting recommendations during the development of the tool. The author recognized the importance and potential contribution of HIT tools to quality care (Goebel et al., 2014).

In addition to data collection, HIT can provide a means for improving patient safety. Damberg et al. (2009) documented lessons learned from the planning and implementation of a HIT system implemented to improve patient safety for 104 Agency for Health Care Research and Quality (AHRQ)-funded grantees. Data collection occurred through interviews with principal investigators involved in the HIT development process. To evaluate successful implementation a conceptual framework, using the three key phases of development, adoption, and implementation/sustainability was created. As a result, identification of internal and external factors that affected implementation included organizational structure, organizational culture and leadership support occurred. The author emphasized the critical importance of involving end users in all phases of implementation and provided other details that can serve as a guide to health care clinicians in the development of future HIT projects (Damberg et al., 2009). This knowledge shared would be used throughout the development of the PACE interface.

The targeted end users for the PACE interface are clinicians who will utilize embedded web-based clinical tools during the PACE encounter. The average preoperative encounter time with the provider is approximately 20 minutes (Zollo, Lurie, Epstein, & Ward, 2009). The preoperative evaluation consists of the following: greeting
the patient, obtaining a health history, reviewing anesthesia options, completing a focused exam, describing the anesthetic risk, discussing post-operative pain management options and closing the encounter (Klafta & Roizen, 1996). HIT tools, such as the electronic medical record and web-based clinical tools at the point of care, support maximization of limited organizational resources for completing the pre-anesthesia evaluation process efficiently while effectively meeting the needs of the patient.

**Evidence for Clinical Tools**

Clinical tools such as the NSQIP and the STOP-Bang provide consistency in documentation of severity of illness, uniformity in risk assessment, and enhanced clarity in communication to patients. Several studies indicate that patients desire information regarding perianesthesia risk. According to Bolimoria (2013), “The Centers for Medicare and Medicaid Services are considering requiring clinicians to discuss empirically derived, customized risk assessments with patients before any elective operation” (Bilimoria et al., 2013, p. 841). The NSQIP surgical risk calculator and the STOP-Bang questionnaire are evidence-based tools routinely used preoperatively to identify patients that are at increased perioperative risk for postoperative complications. These tools were integrated in the PACE interface for provider use to increase efficiency and generate point of care information to facilitate discussions to better inform and educate patients about perioperative risk and postoperative expectations (Bilimoria et al., 2013).

**STOP Bang Questionnaire**

Perioperative risk discussion should include information regarding comorbidities that have the potential to increase the potential for negative outcomes. One of these comorbidities is undiagnosed sleep apnea, which can result in serious and significant
perioperative complications (Vasu et al., 2010). Obstructive sleep apnea (OSA) is the recurrent obstruction of breathing during sleep with episodes that last 10 seconds or more. It is more prevalent in men, affecting one in every nine in the general population, while the incidence among women is only about one in 20 (Chia, Seet, Macachor, Iyer, & Wu, 2013). The incidence of moderate to severe sleep apnea among adults age 50-70 years is even higher at a rate of 17% among men and 9% among women. The prevalence of undiagnosed moderate to severe sleep apnea in the adult population is up to 80% of men and 93% of women. The estimated prevalence of OSA in elective surgical cases is as high as 41.5% (Vasu et al., 2010).

OSA has been associated with obesity, cardiovascular disease, cerebrovascular disease, and other comorbidities that interact with anesthetics, analgesia, and sedatives. Central nervous system suppression from these drugs in combination with OSA and associated comorbidities result in airway obstruction, hypoxia, hypercapnia and asphyxia related complications (Chia et al., 2013; Vasu et al., 2010). Higher rates of postoperative cardiac events and respiratory failure, increase length of stay and critical care admission are associated with OSA. These outcomes emphasize the importance of preoperative identification of patients who are at increased risk for OSA (Vasu et al., 2010). In an effort to reduce postoperative complications, multiple tools have been developed to assist providers in the preoperative identification of OSA (Chung et al., 2012).

The STOP-Bang (snoring, tiredness during daytime, observed apnea, high blood pressure, body mass index, age, neck circumference, gender) questionnaire is a validated and concise preoperative tool that identifies patients with occult or undiagnosed obstructive sleep apnea (see Appendix G for an example of the STOP-bang
Several studies have demonstrated the validity and high sensitivity of the STOP-Bang screening tool in predicting OSA. Patients receive one point for each item given a ‘yes’. A STOP-Bang cutoff score of $\geq 3$ detects OSA and identifies patients at high-risk for developing postoperative complications with a sensitivity of 91.7% and a specificity of 63.4%. A high negative predictive value was also found (Chung et al., 2012). When compared with the other tools used for predicting moderate-to-severe OSA such as the STOP, 4-Variable screening, and the Epworth Sleepiness Scale (ESS), the STOP-Bang questionnaire had higher sensitivity in predicting moderate-to-severe (87.0%) and severe (70.4%) OSA (Silva, Vana, Goodwin, Sherrill, & Quan, 2011). Preoperative STOP-Bang scores of six or higher have been associated with up to “a five fold increase in postoperative critical care admission” (Chia et al., 2013, p. 952).

Although the entire tool is highly sensitive, there may be a difference in the predictive value to each item in the STOP-Bang questionnaire. However, to facilitate ease of use, the authors recommended equal weight for all items. Specificity and clinical utility improves by considering BMI, neck circumference and gender (Chung et al., 2014; Vasu et al., 2010).

Undiagnosed sleep apnea is an important perioperative issue. Patients in the outpatient setting with sleep apnea require extended recovery before discharge and have an increased possibility for hospital admission. The need for postoperative opioids for pain management can further extend recovery and may result in hospital admission (Chia et al., 2013). On several occasions, the PACE clinic staff, in collaboration with an anesthesiologist and the surgeon, have relocated assigned surgery from an outpatient operating room (OR) setting to a facility that had resources for inpatient stay and closer
monitoring due to pre-operative recognition of undiagnosed OSA. As a result, the PACE medical director has recommended increased utilization of the STOP-Bang tool and concise documentation for patients at risk. Predicting OSA can be useful in planning to increase efficiency in utilization of allocated perioperative resources. Including the STOP-Bang tool as a part of the web-based interface at the point of care facilitated immediate access for providers to screen patients and provide information to high-risk patients prepare for possible extended postoperative care or admission.

**National Surgical Quality Improvement Program (NSQIP) Risk Calculator**

Additional tool embedded into the PACE interface is the NSQIP risk calculator. A component of the preoperative process is to provide patients with complete and accurate information regarding potential risk for an informed decision regarding surgery and anesthesia. The NSQIP (National Surgical Quality Improvement Program) risk calculator is a validated risk calculator that allows providers to enter preoperative information to estimate the risk of postoperative complications. It was developed as an aid to support surgical decision making and provides information for a patient centered informed consent process (Gupta et al., 2011). Clinicians may use information from the NSQIP calculator when considering potential risk, and to determine whether proceeding with surgery is in the best interest of the patient. In the near future, physicians who discuss patient specific risk with patients prior to every elective procedure may receive incentives by Centers for Medicare and Medicaid Services (CMS) (Bilimoria et al., 2013; Cologne, Keller, Liwanag, Devaraj, & Senagore, 2015).
The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) data related to preoperative risk factors and postoperative complications from more than 500 hospitals in the United States contributed to the development of the NSQIP calculator (Bilimoria et al., 2013). NSQIP data can be used for quality assessment at the institutional level to facilitate improved outcomes (Gupta et al., 2011). The NSQIP risk calculator uses 21 patient predictors and the planned surgery or procedure based on Current Procedural Terminology (CPT) codes, to predict the risk of nine different potential outcomes within 30-days following a procedure. According to Bilimoria (2013), there are more that 1500 surgical subspecialty CPT codes available within this risk calculator.

The list of potential outcomes or complications include:

- Death
- Pneumonia
- Unplanned and prolonged intubation for greater than 48 hours
- Cardiac event such as cardiac arrest, myocardial infarction, stroke
- Venous thromboembolism, pulmonary embolism
- Progressive renal insufficiency, acute renal failure
- Urinary tract infection, sepsis
- Wound disruption, surgical site infection (SSI), return to the Operating Room (American College of Surgeons, 2014).

Until the NSQIP calculator became available, there was no risk estimation tool, which covered nearly all surgeries across multiple subspecialties (Bilimoria et al., 2013).
The NSQIP calculator provides a customized, patient specific empiric estimate of risk in a user-friendly format (see Appendix H for a sample of the NSQIP calculator output).

Postoperative respiratory failure (PRF) is a serious pulmonary complication associated with morbidity, mortality, and increase length of stay. PRF is defined as respiratory failure “requiring mechanical ventilation 48 hours after surgery or unplanned intubation within 30 days of surgery” (Gupta et al., 2011, p. 1). Respiratory complications are associated with high cost and “the largest increase in hospital length of stay (by 5.5 days). Death within 30 days was seen in 25% of patients with PRF” (Gupta et al., 2011, p. 5). The NSQIP calculator can provide actuarial estimate of risk to determine the probability of PRF as a postoperative complication (Gupta et al., 2011). Accurate prediction and documentation of postoperative risk in the preoperative phase of care can support physicians and patients in making appropriate plan for preoperative care (Bilimoria et al., 2013; Cologne et al., 2015).

Concise documentation using a universal tool can concretely present the complexity and acuity of a patient’s condition pre-procedure and support planning for an appropriate level of care. Using the NSQIP calculator, institutions can improve preoperative documentation of patient acuity and risk to provide coders, patients and providers with specific predictable data (Gupta et al., 2011). Having the NSQIP calculator accessible at the point of care will allow PACE clinicians to provide individualized patient centered information to families and patients for discussions regarding risk versus benefit in relation to the timing of surgery and other important topics. Both institutions and patients are likely to benefit from the consistent use of the NSQIP screening tool (Cologne et al., 2015; Gupta et al., 2011).
The NSQIP data guided a Veterans Administration Healthcare Administration System process improvement program to decrease postoperative pneumonia and prolonged ventilation. Use of the NSQIP achieved up to 45%, reduction in complications and 27% reduction in postoperative mortality. The financial benefits from this quality improvement process were estimated at over five million dollars (McNelis & Castaldi, 2014). This example supports the validity and value of the NSQIP data in predicting and improving patient outcomes and institutional benefits.

Although extensive literature supports the validity of the NSQIP to improve patient outcomes, the NSQIP does have some limitations. The comorbidities reported in the NSQIP data do not include sleep apnea. Additionally, the calculator is based on 21 perioperative risk factors but does not include other risks that could influence postoperative outcomes (Bilimoria et al., 2013). Despite these limitations, the NSQIP is an easily accessible and quick to use tools that supports decision-making in the perioperative period. Providing this tool at the point of care with easy access through a web-based interface increases efficiency and documentation accuracy to improve patient outcomes.
METHODS

The purpose of this project was to develop an interface that provides PACE clinicians easy access to evidence-based tools used in clinical practice and for patient education. This section defines the methods and describes the evaluation of this project. Appropriate Institutional Review Board (IRB) approvals were obtained from California State University Long Beach (CSULB) and LLUMC. Due to the time limitation in the DNP program, the development of the web-based interface focused on the PACE provider experience and clinical practice needs.

Description of Setting

The setting for implementation of the web-based interface was the PACE department within LLUMC. The PACE department at LLUMC is responsible for the pre-anesthesia assessment and education for patients scheduled for elective surgery or procedures under anesthesia at any of the five operating suites within LLUMC. The patient population includes pediatric and adult patients scheduled for minor surgeries, such as cataract surgery under local anesthesia or major surgery such as liver transplant. Patient acuity as described by the American Society of Anesthesiologist (ASA), varies from patients who are healthy with no underlying disease to patients with multiple comorbidities and severe systemic diseases (American Society of Anesthesiologist, 2014) (see Appendix F for a description of ASA Physical Classification system). Patients with complex or multiple co-morbidities benefit from the use of standardized clinical tools to classify the status of their clinical condition.

Provider Demographics

The staff for the PACE department include the director, ten nurse practitioners, a nurse supervisor, ten registered nurses, six medical assistants and one administrative
secretary. Staff demographics include males and female with females being the majority. The clinical experience of NPs in the PACE department includes: critical care, emergency room, neonatal intensive care, cardiology, pain service, out patient clinics and medical-surgical units. There is a wide range in the level of digital experience among NP clinicians within the PACE department. However, all NPs within the department demonstrate adequate IT skills required to access and utilize the PACE interface.

The PACE interface was made accessible to all users within the institution who have been provided access to the institutions intranet. Employees most likely to use the interface are those within the PACE department and within the institution that utilize the PACE department for pre-anesthesia evaluations. This included employees that provide pre-operative and pre-anesthesia services to the institutions five OR sites such as anesthesiologist, residents, nurse practitioners, nurses, medical assistant, schedulers and clerical staff.

**Procedures**

The author compiled a list of clinical tools through an evaluation of clinical practice needs. This evaluation included feedback from the PACE medical director regarding components of the pre-anesthesia evaluation that needed clinical documentation enhancement. PACE clinicians supplied a list of clinical tools that would support quality care. The author identified a list of clinical tools that were not in current use through a review of literature for evidence of validity and application to practice. This project focused on two tools embedded in the PACE interface: the NSQIP calculator and STOP-Bang questionnaire.
The design and development of the PACE interface was conducted in collaboration with the IT department within the institution. Selection of the platform used to create the interface was by the IT department to maintain consistency throughout the institution. HP (Hewlett-Packard) TeamSite is a content management system created by Hewlett Packard, and designed for creating complex web applications for both Internet and intranet use (Interwoven, 2015). The TeamSite platform allows for integration of advance analytic directly into the system. In addition to TeamSite, the institution uses additional tools and systems for web development. These include Adobe Dreamweaver, used to design the graphic for user interface and SharePoint platform to enhance TeamSite functionality.

Web development platforms used for the PACE interface development and implementation; require specialized technical expertise and partnership with IT throughout the process and post implementation. Updates and changes were submitted through an IT regulated process and implemented upon approval of the PACE director. Currently, the institution is in the process of gradually migrating to Drupal Version 7 for content management. Drupal will require limited training for interface content management, and therefore future web-based interface changes will be handled at the departmental level. This will decrease the time it takes to process web updates.

Through the integration of TeamSite and SharePoint, the PACE interface can generate daily, weekly or monthly reports with graphics that displays usage and the number of users over time for selected web pages. These reports provide data that compare departmental usage to all web-based interface utilization for the institution. The metrics for the institution web usage may be of significance when assessing the
organizational culture and attitudes toward adoption of informatics for the PACE interface. Data retrieved from web utilization helps to support and direct future planning and improvements.

During the design phase, the process for measuring effectiveness through utilization was determined and refined. Specifications and requirements were determined using a user-centered approach to ensure ease of usability to the maximum extent possible. The PACE interface content and layout was intentionally selected to make information easy to access and use. During the development phase, mapping the PACE interface and selection of content was accomplished through back and forth communication using designated worksheets via emails.

The final content for the PACE interface was approved after careful review with end users and the design staff. End user observation during testing and implementation provided information for modification and resolution of issues. In addition to clinical tools, the PACE interface provides easy access to non-clinical information frequently utilized by PACE clinicians such as: the facilities practice guidelines, frequently used algorithms, education material for the staff, contact numbers for affiliated departments, frequently used forms, and patient education material.

Marketing for the PACE interface occurred through emails, presentation demonstrating content, and a tip sheet. Emails with tip sheet and a link to the web-based interface were disseminated to PACE staff, other affiliated department (see Appendix C for tip sheet content). On the first day of September 2015, the PACE interface was launched as scheduled. At the end of the first month, utilization data were reviewed to evaluate effectiveness. Ongoing end user observation of workflow provided information
to assess efficiency. Informal interviews provided end user feedback to appraise provider satisfaction. Feedback generated suggestions and ideas for continual enhancement of the interface.

Post implementation, long-term sustainability of this project will require ongoing evaluation, monitoring, and updates. Evaluation of clinician efficiency, workflow impact, consistency in utilization and user satisfaction will occur after the completion of the DNP program (see Appendix B for key task and implementation phases and Appendix B for project timeline). Providing quality improvement reports with utilization metrics, documentation reviews, and end user feedback will provide validation for ongoing administrative support.

**Measures of Outcomes**

The user-centered design framework defines usability in terms of effectiveness, efficiency, and satisfaction (Kubler et al., 2014). The frequency of web page view assessed *effectiveness*. Observation of the number of clicks required to access the interface and clinical tools measured *efficiency*. Informal interviews evaluated end user *satisfaction* concerning the ease of use and the positive or negative impact on workflow. Measurement of some concepts will occur after the conclusion of this DNP program.

**Data Collection and Analysis**

For the purpose of this study, data collection included the adult population seen in the clinic for the month of September 2015. Syndicated data collection for the PACE interface and clinical tool access frequency was automatically downloaded within the system. Analysis of the frequencies of PACE interface access and clinical tool page was compared to adult patient volume and more specifically the volume of adult patients with
an ASA Physical Classification of III or greater. The majority of the clinical tools are not applicable to patients that are generally in good health (ASA class I and II), which validated the approach to data collection and analysis. End user observation, informal interviews, and voluntary feedback provided qualitative data.

**Protection of Human Subjects**

The goal of this project was to improve the efficiency in the access of evidence-based health assessment tools within the PACE clinic. Lynn et al. (2007) defines Quality Improvement (QI) as systematic, data-guided activities designed to bring about immediate improvements in health care delivery in particular settings. Not being research, most QI activities do not require IRB review; however, they do come under local professional managerial review and supervision as required by the organization's arrangements to ensure accountability for the ethical conduct of QI and health services delivery. (p. 671)

Upon review and approval of the project proposal by the project chair, project committee and the California State University (CSU) DNP Consortium, obtained permission to implement this project from the LLUMC IRB and the CSULB IRB. LLUMC and CSULB. Both entities informed the author that because this QI project did not involve research or generalizable knowledge, IRB approval was not required. However, both entities receive appropriate documentation for IRB review and confirmation.
RESULTS

The successful development and implementation of the PACE interface evolved through a well thought out coordinated plan, interdepartmental collaboration, end user involvement and administrative support. Promotion and marketing of the PACE interface within the institution occurred as previously described. Data for the first month of interface use provided the evidence of the outcomes for this project.

There were 1,938 pediatric and adult patients who received pre-anesthesia consultations by the PACE department for September 2015. The adult patient volume of 908 was included in the analysis. The demographics table (Table 2) reports patient volume, age, sex, and ASA classification for the sample. Patients seen in the PACE clinic whose procedures were cancelled were not included in the results.

Table 2

Demographics for Patient Population with ASA Classification

<table>
<thead>
<tr>
<th>Age</th>
<th>M</th>
<th>F</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-20</td>
<td>9</td>
<td>12</td>
<td>5</td>
<td>10</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>21-29</td>
<td>18</td>
<td>34</td>
<td>13</td>
<td>29</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>52</td>
</tr>
<tr>
<td>30-39</td>
<td>25</td>
<td>57</td>
<td>11</td>
<td>49</td>
<td>21</td>
<td>1</td>
<td>0</td>
<td>82</td>
</tr>
<tr>
<td>40-49</td>
<td>44</td>
<td>71</td>
<td>7</td>
<td>64</td>
<td>40</td>
<td>4</td>
<td>0</td>
<td>115</td>
</tr>
<tr>
<td>50-59</td>
<td>65</td>
<td>116</td>
<td>7</td>
<td>89</td>
<td>79</td>
<td>6</td>
<td>0</td>
<td>181</td>
</tr>
<tr>
<td>60-69</td>
<td>90</td>
<td>136</td>
<td>2</td>
<td>89</td>
<td>125</td>
<td>9</td>
<td>1</td>
<td>226</td>
</tr>
<tr>
<td>70-79</td>
<td>73</td>
<td>85</td>
<td>0</td>
<td>52</td>
<td>97</td>
<td>9</td>
<td>0</td>
<td>158</td>
</tr>
<tr>
<td>80+</td>
<td>31</td>
<td>42</td>
<td>0</td>
<td>15</td>
<td>52</td>
<td>6</td>
<td>0</td>
<td>73</td>
</tr>
<tr>
<td>Total</td>
<td>355</td>
<td>553</td>
<td>45</td>
<td>397</td>
<td>429</td>
<td>36</td>
<td>1</td>
<td>908</td>
</tr>
</tbody>
</table>

Note. This table displays the number of adult patients in each demographic group for age, sex, and ASA classification for September 2015.
Nearly half of the adult patients (n = 452) had an ASA class of III or above (Table 3), which demonstrated the level of complexity of the population and the opportunity for using clinical tools for assessment to support clinical decisions.

Table 3

*Weekly Page Views and ASA III-V Adult Patient Volume*

<table>
<thead>
<tr>
<th></th>
<th>Page view</th>
<th>Patient volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>216</td>
<td>80</td>
</tr>
<tr>
<td>Week 2</td>
<td>62</td>
<td>95</td>
</tr>
<tr>
<td>Week 3</td>
<td>66</td>
<td>104</td>
</tr>
<tr>
<td>Week 4</td>
<td>122</td>
<td>124</td>
</tr>
<tr>
<td>Week 5</td>
<td>49</td>
<td>49</td>
</tr>
<tr>
<td>Total</td>
<td>515</td>
<td>452</td>
</tr>
</tbody>
</table>

*Note.* This table displays the daily and weekly number of ASA III-V adult patients and the weekly number of web page views for September 2015.

**Effectiveness**

Effectiveness is operationalized in this project as the frequency of web page views. The PACE web interface was accessed 515 times in September, with 216 views in week one. The clinical tool web page (where the NSQIP tool and the STOP-Bang are located) had 85 views for the month. These reports may underestimate actual interface use as providers may leave the interface open during the day for multiple patient encounters. The highest volume of page views was on the first day of the site’s availability. The novelty of the site may have contributed to the high number of views. Some employees within the institution visited the site out of curiosity and may not have necessarily become end users.

There were 452 patients (49.8%) who were classified as ASA III or greater (the population most appropriate for clinical tool application). The frequency of interface
views starts to reflect the volume of higher acuity patients, ASA class III-V by the last 2 weeks of the month (Figure 2). Nevertheless, no evidence was found for NSQIP tool access from the website during the implementation period. However, PACE interface reports may not reflect actual tool usage since the user may choose to leave the PACE interface and access the tool via the Internet.

**Efficiency**

Kubler et al. (2014) defines efficiency is operationalized as the least amount of time it complete required tasks (the number of clicks). To access clinical tools the user must select the intranet link to the LLUMC home page (also referred to as the “VIP” page; 1-click), select the department’s name on the PACE interface (1-click; 2 clicks total). The PACE “welcome page” appears with an introduction to the department, department leaders, and basic contact information. A click on the clinical tool page brings a list of all clinical tools, departmental guidelines, and links that are applicable to direct patient care (1-click). Four clicks are required to gain access to the clinical tool web page from sign-on to the VIP page. Switching between clinical tools require a single click once the web page has been opened (see Appendix D and E to view screen shots of the PACE interface web pages).

Before interface implementation, to access clinical tools providers exited the institutions’ VIP page (1-click), and re-entered a user name and password to access an outside website of clinical tools. At times web site access was limited due to institutional restrictions, which decreased workflow efficiency. Once inside the search engine, the provider identified the desired clinical tool (1-click, >15 seconds). Additional access to clinical tools required a repeat in the process (>15-30 seconds). Paper-based tools
required a physical search to locate, if the provider did not carry them from room to room. The length of time to use paper-based tools varied among providers.

A quality control chart (Figure 2) examined the frequency of interface access in relation to ASA class III or greater patient volume over time. As time progressed, the interface use was congruent with the patient population that would most benefit from the use of clinical tools on the interface. The quality control data guide the development of performance goals for interface use. Variation or stabilization may guide quality improvement efforts to support appropriate tool use and encourage concise clinical documentation.

![ASA III-V Patient Volume and Web Page Views](image)

**Figure 2.** ASA III-V patient volume and web page views. This control chart illustrates September 2015 frequency of web page views in relation to ASA class III-V adult patient volume.
Satisfaction

Kubler et al. (2014) defines user satisfaction as the “perceived comfort of use and acceptability while using the product in the physical and social setting” (p. 7). Clinicians and support staff reported the PACE interface was easy to access and did not interfere with workflow. In addition, providers reported the content of each webpage was clear and easy to locate. Providers within the PACE department could access the PACE interface at the point of care during patient interviews as well as from their designated workstations. The use of user-centered design was pivotal in ensuring provider satisfaction with the interface. In fact, the individuals who were most involved with the interface development reported an increased likelihood of using the interface consistently.
DISCUSSION

The PACE web interface was developed as a simple solution for clinicians to access evidence-based practice tools. Simple, yet innovative IT interfaces improve productivity and support the decision making process (Kibbe & Bard, 1997). Health care providers can replicate the processes described in this paper on smaller scales to influence patient outcomes. The PACE interface was effective in improving accessibility of evidence-based decision tools, and for many providers, improving clinical workflow. The benefits of HIT to support efficiency and quality of care will require ongoing strategic marketing to administration, supportive staff, and providers.

During the development the web-based interface, successful collaboration with the IT staff and the administration was essential in meeting deadlines and outcome goals. Collaborative relationships fostered open and clear communication, which was especially important during the numerous iterations of the interface. Having a web design team open, responsive to ideas, and available resulted in a seamless development and implementation. The LLUMC integrates IT as a part of its culture.

A point of interest for the author, was the need for ongoing “at the elbow support” to ensure comfort and continued use of the interface. An environment that fosters and encourages communication and feedback ensures involvement with end users and creates opportunities for assimilation of technology into practice (Police, Foster, & Wong. 2010). Along these lines, end users preferred face-to-face interactions to communicate feedback and questions. In addition, provider satisfaction was positive during informal interviews.

Throughout this DNP project, the collaboration with end users, stakeholders, and supporting departments was essential for the successful development and implementation.
of the web interface. Collaboration across disciplines influenced success and added richness through the exchange of ideas that enhanced the usefulness of the PACE interface. In the future, the author will be developing patient centered interfaces for the PACE department.
SUMMARY

The clinical application of informatics, with the potential for quality and organizational gains, is considered a worthwhile investment (Kibbe & Bard, 1997). Doctorate of Nursing Practice (DNP) clinicians must be at the forefront of health care leadership to integrate EBP into information systems and technology to improve patient care processes and outcomes. As many institutions embrace multidisciplinary strategies to health care delivery, DNP prepared clinicians will emerge with the prerequisite organizational and leadership skills to apply evidence based practice guidelines to improve quality. IT provides a mechanism to apply practice tools to support and improve patient care (American Association of Colleges of Nursing, 2006).

This project is an example of DNP leadership to improve evidence-based care in a complex, health care system. The author presents a roadmap employing user-centered design methods to integrate evidence-based clinical tools to support the daily demands of clinical practice. The growing importance of information management systems for clinical decisions require a commitment and investment of personnel, resources, and technology to achieve internal and external goals for concise clinical documentation. DNP prepared clinicians must continue to address current practice needs, emerging trends, evolving practice realities and forecast future health care needs (American Association of Colleges of Nursing, 2006).
REFERENCES


## APPENDIX A

### DEVELOPMENT AND IMPLEMENTATION OF A PERIOPERATIVE WEB-BASED INTERFACE TIMELINE

Table A1: PACE Web Development and Implementation Phases and Key Tasks

<table>
<thead>
<tr>
<th>Phases</th>
<th>Key tasks and date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Planning (Input)</strong></td>
<td>- Needs assessment through literature reviews, direct observation of workflow and physician/medical director recommendation upon IRB approval.</td>
</tr>
<tr>
<td></td>
<td>- Identify general information needed at point of care to support workflow (June 30, 2015).</td>
</tr>
<tr>
<td></td>
<td>- Select clinical tools for implementation (June 30, 2015).</td>
</tr>
<tr>
<td><strong>2. Development (Output)</strong></td>
<td>- Partnership with IT web development, interaction with end user. Submit web design and specification (June 30, 2015).</td>
</tr>
<tr>
<td></td>
<td>- Develop web-based interface with ongoing end users observation for testing and development (beginning July 1, 2015).</td>
</tr>
<tr>
<td></td>
<td>- Define outcome elements (July 15, 2015).</td>
</tr>
<tr>
<td></td>
<td>- Implementation and observation of end users. (Beginning August 15, 2015).</td>
</tr>
<tr>
<td></td>
<td>- System modification (August 15 to September 1, 2015).</td>
</tr>
<tr>
<td><strong>3. Implementation and adoption (Outcome)</strong></td>
<td>- Conduct training and demonstration (August 15 to September 1, 2015).</td>
</tr>
<tr>
<td></td>
<td>- Installation Go-live (September 15, 2015).</td>
</tr>
<tr>
<td></td>
<td>- Utilize end user observation during testing.</td>
</tr>
<tr>
<td></td>
<td>- OUTCOME measurement: effectiveness, efficiency and user satisfaction. Frequency of accessing web-site and frequency of utilization of NSQIP and STOP-Bang tool (Beginning from go-live).</td>
</tr>
<tr>
<td></td>
<td>- Ongoing training and system modification (Beginning from go-live and on-going as needed).</td>
</tr>
<tr>
<td><strong>4. Sustainability (Long term outcomes)</strong></td>
<td>- End user feedback for future integration of additional web-based tools.</td>
</tr>
<tr>
<td></td>
<td>- Qualitative assessment of impact and utilization, system modification, resolutions of issues, requirement for replication (Beginning December 2015 and on-going).</td>
</tr>
<tr>
<td></td>
<td>- Develop quality initiative based on evaluation and utilization data (2016).</td>
</tr>
<tr>
<td></td>
<td>- Provide recommendation to share to other departments for other site development within the institution. (2016).</td>
</tr>
</tbody>
</table>
Staff Corner (Accessible to PACE staff only)

- Staff education and in-services
- Links to OR and Anesthesia web site

Directory

- Staff gallery – Check us out!! Put a face with the name.
- Frequently requested PACE extensions

FAQ

- Questions frequently asked by patients such as:
  - why do I need a PACE appointment
  - what to bring
  - who to call with questions, etc.

Feedback/Suggestions

- Let us know if there is anything we can add or improve to support the PACE process.
- Suggestions and ideas to improve our website can be shared via
  - Website Feedback/Suggestions link located on our home page
  - Or send us an email option
APPENDIX C

PACE WEB-BASED INTERFACE WELCOME PAGE
APPENDIX D

PACE WEB-BASED INTERFACE CLINICAL TOOLS PAGE
# APPENDIX E

## ASA PHYSICAL STATUS CLASSIFICATION SYSTEM

<table>
<thead>
<tr>
<th>ASA PS Classification</th>
<th>Definition</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASA I</td>
<td>A normal healthy patient</td>
<td>Healthy, non-smoking, no or minimal alcohol use</td>
</tr>
<tr>
<td>ASA II</td>
<td>A patient with mild systemic disease</td>
<td>Mild diseases only without substantive functional limitations. Examples include (but not limited to): current smoker, social alcohol drinker, pregnancy, obesity (30 &lt; BMI &lt; 40), well-controlled DM/HTN, mild lung disease</td>
</tr>
<tr>
<td>ASA III</td>
<td>A patient with severe systemic disease</td>
<td>Substantive functional limitations; One or more moderate to severe diseases. Examples include (but not limited to): poorly controlled DM or HTN, COPD, morbid obesity (BMI ≥40), alcohol dependence or abuse, moderate reduction of ejection fraction, ESRD undergoing regularly scheduled dialysis, premature infant PCA &lt; 60 weeks, history (&gt;3 months) of MI, CVA, TIA, or CAD/stents</td>
</tr>
<tr>
<td>ASA IV</td>
<td>A patient with severe systemic disease that is a constant threat to life</td>
<td>Examples include (but not limited to): recent (&lt; 3 months) MI, CVA, TIA, or CAD/stents, ongoing cardiac ischemia or severe valve dysfunction, severe reduction of ejection fraction, sepsis, DIC, ARD or ESRD not undergoing regularly scheduled dialysis</td>
</tr>
<tr>
<td>ASA V</td>
<td>A moribund patient who is not expected to survive without the operation</td>
<td>Examples include (but not limited to): ruptured abdominal/thoracic aneurysm, massive trauma, ischemic bowel in the face of significant cardiac pathology or multiple organ/system dysfunction</td>
</tr>
<tr>
<td>ASA VI</td>
<td>A declared brain-dead patient whose organs are being removed for donor purposes</td>
<td></td>
</tr>
</tbody>
</table>


*The addition of “E” denotes emergency surgery. (An emergency is defined as existing when delay in treatment of the patient would lead to a significant increase in the threat to life or body part.).
APPENDIX F

STOP-BANG QUESTIONNAIRE

Snoring?
Do you Snore Loudly (loud enough to be heard through closed doors or your bed-partner elbows you for snoring at night)?

Tired?
Do you often feel Tired, Fatigued, or Sleepy during the daytime (such as falling asleep during driving)?

Observed?
Has anyone Observed you Stop Breathing or Choking/Gasping during your sleep?

Pressure?
Do you have or are being treated for High Blood Pressure?

Body Mass Index more than 35 kg/m²?

Age older than 50 year old?

Neck size large? (Measured around Adams apple)
For male, is your shirt collar 17 inches / 43 cm or larger?
For female, is your shirt collar 16 inches / 41 cm or larger?

Gender = Male?

Scoring Criteria:
For the general population
- Low risk of OSA: Yes to 0-2 questions
- Intermediate risk of OSA: Yes to 3-4 questions
- High risk of OSA: Yes to 5-8 questions
  or Yes to 2 or more of 4 STOP questions + male gender
  or Yes to 2 or more of 4 STOP questions + BMI>35kg/m²
  or Yes to 2 or more of 4 STOP questions + neck circumference 17 inches/43 cm in male or 16 inches/41 cm in female

APPENDIX G

SAMPLE OUTPUT OF NSQIP TOOL

147600 - Cholecystectomy

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Estimated Risk</th>
<th>Chance of Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serious Complication</td>
<td>25%</td>
<td>Above Average</td>
</tr>
<tr>
<td>Any Complication</td>
<td>33%</td>
<td>Above Average</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>6%</td>
<td>Above Average</td>
</tr>
<tr>
<td>Cardiac Complication</td>
<td>3%</td>
<td>Above Average</td>
</tr>
<tr>
<td>Surgical Site Infection</td>
<td>7%</td>
<td>Average</td>
</tr>
<tr>
<td>Urinary Tract Infection</td>
<td>2%</td>
<td>Above Average</td>
</tr>
<tr>
<td>Venous Thromboembolism</td>
<td>1%</td>
<td>Above Average</td>
</tr>
<tr>
<td>Renal Failure</td>
<td>3%</td>
<td>Above Average</td>
</tr>
<tr>
<td>Return to OR</td>
<td>6%</td>
<td>Above Average</td>
</tr>
<tr>
<td>Death</td>
<td>6%</td>
<td>Above Average</td>
</tr>
<tr>
<td>Discharge to Nursing or Rehab Facility</td>
<td>25%</td>
<td>Above Average</td>
</tr>
</tbody>
</table>

Predicted Length of Hospital Stay: 4.0 days

**How to Interpret the Graph Above:**

- Your Risk
- Average Patient Risk
- Your % Risk

## APPENDIX H

### TABLES OF EVIDENCE

#### Evidence Table 1. Qualitative Studies

<table>
<thead>
<tr>
<th>Aims (Author(s), Year)</th>
<th>Study Design, Theoretical Underpinnings</th>
<th>Sample &amp; Setting</th>
<th>Data Collection Process, Management, and Analysis</th>
<th>Results or Themes</th>
<th>Conclusion And Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>To illustrate how quality methods and user-centered design approach can support the development of customized HIT tools for federally funded health centers to keep kids insured. (DeVoe et al., 2014)</td>
<td>Not specified</td>
<td>8 FQHCs Oregon</td>
<td>Needs assessed through observation of clinic flow through site visits and interviews with family and staff regarding current clinical workflow and suggestions for improvement Work flow diagrams were created. HIT tools developed, customized and integrated into workflow</td>
<td>HIT found useful in identifying, tracking and communicating with families regarding insurance</td>
<td>Existing HIT tools adjusted to support insurance enrollment and retention. Transferability: Tools can be specified to meet the needs of varying health care settings</td>
</tr>
<tr>
<td>To develop a HIT-based data infrastructure for multiple palliative and hospice sites (Abernethy et al., 2011)</td>
<td>Not specified</td>
<td>N = 1500 North Carolina</td>
<td>Phase 1: Data elements defined, data dictionary developed, data elements programmed, software integration, data collection form created Phase 2: training,</td>
<td>Successful integration of HIT data collection process into workflow Quality metrics generated reports through database mapping. Metrics updated monthly based on needs Reports utilized to</td>
<td>Integration of HIT in clinical workflow can facilitate process improvement in data management and quality. Tech savvy support needed at pilot site Site-based champions needed for support Stakeholder support needed</td>
</tr>
<tr>
<td>Aims (Author(s), Year)</td>
<td>Study Design, Theoretical Underpinnings</td>
<td>Sample &amp; Setting</td>
<td>Data Collection Process, Management, and Analysis</td>
<td>Results or Themes</td>
<td>Conclusion And Limitations</td>
</tr>
<tr>
<td>------------------------</td>
<td>----------------------------------------</td>
<td>-----------------</td>
<td>-------------------------------------------------</td>
<td>------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>To document planning and implementation of a HIT systems for AHRQ funded HIT grantees (Damberg et al., 2009)</td>
<td>Phenomenology</td>
<td>104 AHQR grantees/IT projects, 41 states</td>
<td>mentoring, file transfer protocol developed, governance and collaboration model developed  Implementation: data collected by tablet computer, electronic pen and traditional pen &amp; paper</td>
<td>address patients’ needs and concerns based on data Generated data used to evaluate program outcomes</td>
<td>• Ongoing project promotion needed throughout the process  • Frequent/bi-weekly collaboration very helpful  • End user needs must be accommodated  • Realistic appraisal of HIT capabilities is essential</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Adoption phase: design, specification, modifications based on end user needs  Implementation phase (pilot testing): installation, modification, and implementation  Sustainability phase: included performance assessment, ongoing training, and system modification</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>End user involvement in needs assessment, purpose, priority setting, content and testing of HIT was emphasized as critical</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Key factors to success:  • Effective communication  • Good project manager process to detect and correct malfunction  • Customize system to minimize impact on work flow  • Interface tailor to make end users job easier.  • Considers end user education level</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Willingness to adopt may be related to end user age</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Evidence Table 2: Quantitative Studies

<table>
<thead>
<tr>
<th>Purpose (Author(s), year)</th>
<th>Design and Key Variables</th>
<th>Sample and Setting</th>
<th>Measurements, Operational Definitions of Variables</th>
<th>Results or Findings</th>
<th>Conclusions and Limitations</th>
</tr>
</thead>
</table>
| To assess the accuracy of NSQIP risk calculator in predicting outcomes at a single institution (Cologne et al, 2015) | Prospective IV: NSQIP calculated results. DV: LOS, complications and death | N = 116 California | Outcome measured as the difference in actual vs. predicted outcomes from the NSQIP risk calculator for all variables | Observed LOS was shorter than predicted (LOS mean ± SD 3.31 ± 2.30 days vs. predicted 4.05 ± 1.14 days; p = 0.0020) Complications lower than predicted (13.2% vs. 19.4%; p = 0.009) No significant difference in death | Surgical risk calculator was effective in evaluating average surgical-risk patients  
Limitations: Accuracy in predicting inpatients with one or more serious complications is limited |
| To monitor and document safety and cost effective of NSQIP in a surgical ICU (McNelis & Castaldi, 2014) | Prospective observational IV: 21 preoperative factors including comorbidities and procedures DV: Post op infection and prolonged intubation | N = 1081 SICU patients New York | Data was monitored over 2 years IDV: age, sex, functional status, ASA class, wound class, steroid use, ascites, systemic sepsis, ventilator dependent, and disseminated cancer DV: Pneumonia rate and V48 | Pneumonia rates decreased from 1.36% to 1.2% Statistical significance (p< .05) V48 decreased from 1.9% to 1.11% Statistical significance (p < .05)  
Net cost savings associated with avoiding pneumonia ($707,104.00 per year) and V48 ($4,424,640.00 per year) | NSQIP data supported tracking and benchmarking progress, which facilitated implementing corrective measures for process improvement to improve safety and decrease cost |
<p>| To determine the impact of combinations of predictive factors on the specificity of the Cohort | Cohort IV: STOP-Bang score, age, gender, BMI, neck | N = 516 Canada | Data from 3 predictive factors from the STOP-Bang questionnaire: BMI&gt;35kg/m2, Neck circumference &gt;40cm | Male gender, neck circumference and BMI&gt;35kg/m2 was more predictive than age | Specific combinations of predictive factors can help differentiate and improve stratification of OSA risk |</p>
<table>
<thead>
<tr>
<th>Purpose (Author(s), year)</th>
<th>Design and Key Variables</th>
<th>Sample and Setting</th>
<th>Measurements, Operational Definitions of Variables</th>
<th>Results or Findings</th>
<th>Conclusions and Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>STOP-Bang tool (Chung et al., 2014)</td>
<td>circumference DV: Severity of OSA</td>
<td>and male gender compared with polysomnogram report</td>
<td>STOP-Bang score of 5-8 has high specificity to rule in sleep apnea STOP-Bang score ≥ 3 offers gives a high specificity for OSA and can be used for screening for OSA When combined with any 2 STOP items specificity increased as follows: BMI 85% (95% CI: 80.6-88.7) Neck Circumference 79% (95% CI: 71.8-81.3) Male gender 76.8% (95% CI: 71.8-81.3)</td>
<td>Author proposes a 2-step strategy to use STOP-Bang tool: STOP-Bang scoring and examination of specific combination of factors Limitations: Self-selection bias with higher pretest OSA prevalence compared with the general population Central sleep apnea was not identified separately</td>
<td></td>
</tr>
<tr>
<td>To develop a universal surgical risk estimation tool (Bilimoria et al., 2013)</td>
<td>Prospective IV: 21 preoperative factors demographics, comorbidities and procedures DV: Surgical outcomes</td>
<td>Heart disease, COPD etc. What were the procedures (1500 CPT codes) and the comorbidities? The 30-day post op mortality and morbidity outcomes DV is 30 day morbidity</td>
<td>NSQIP surgical risk calculator performance for mortality (c-statistics = 0.944; Brier score = 0.011) and morbidity (c-statistics = 0.8816; Brier score = 0.069)</td>
<td>NSQIP surgical risk calculator was developed as a decision support tool that can be used to estimate surgical risk and provide counsel to patients and families for elective surgeries Limitations: Sample size representative of only ~10% US hospitals Only clinical pre-op variables were collected</td>
<td></td>
</tr>
<tr>
<td>To analyze preoperative STOP-Bang scores as an indicator of postoperative</td>
<td>Retrospective IV: pre-op STOP-Bang scores</td>
<td>Association of STOP-Bang scores, age, asthma, OSA, ASA status with rate of critical care admission</td>
<td>Higher pre-op STOP-Bang scores of 6 or more were associated with five-fold increase in rate of Post-</td>
<td>In addition to ASA scores, STOP-Bang scores can be an indicator for post-op CC admission</td>
<td></td>
</tr>
<tr>
<td>Purpose (Author(s), year)</td>
<td>Design and Key Variables</td>
<td>Sample and Setting</td>
<td>Measurements, Operational Definitions of Variables</td>
<td>Results or Findings</td>
<td>Conclusions and Limitations</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>---------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>admission to critical care (Chia et al., 2013)</td>
<td>DV: Post-op critical care admission rate</td>
<td>Singapore</td>
<td>operative CC admissions</td>
<td>Odds ratio (95% CI) 5.1 (1.8 - 14.9) ( p &lt; .002 )</td>
<td>Limitation: Unable to confirm OSA since polysomnography was not a part of the study</td>
</tr>
<tr>
<td>To develop and validate a risk calculator based on pre-op factors associated with increase risk of PRF (Gupta et al., 2011)</td>
<td>Retrospective</td>
<td>2007 N = 211,410</td>
<td>PRF defined as unplanned intubation, post op reintubation and post op ventilator use &gt;48hr</td>
<td>The risk calculator was developed using a validated model</td>
<td>Study supports use of the risk calculator in identifying high risk patients, predicting PRF, supporting informed consent, and supporting post-op bed placement</td>
</tr>
<tr>
<td></td>
<td>IV: 21 pre-op factors including comorbidities and procedures</td>
<td>2008 N = 257, 385</td>
<td>PRF was associated with multiple variables ( p &lt; .0001 ) for all)</td>
<td>Patients with PRF had significantly higher death rates within 30 days ( 25.62% ) vs. ( 0.98%; ) ( p .0001 )</td>
<td>Study encourages clinician to take advantage of computer-based technology to use clinical management guidelines</td>
</tr>
<tr>
<td></td>
<td>DV: PRF, LOS, mortality and morbidity</td>
<td>PRF N = 6531</td>
<td></td>
<td></td>
<td>Limitations: NSQIP database did not include co-morbidities of OSA and DVT, PFT results and hospital volume</td>
</tr>
<tr>
<td>Comparison of four screening tool for SBD (Silva et al., 2011)</td>
<td>Prospective multicenter cohort</td>
<td>N = 4770</td>
<td>Scores from four-variable screening tool, STOP questionnaire, STOP-Bang questionnaire, and ESS questionnaire</td>
<td>STOP-Bang questionnaire for moderate to severe disease SBD: Sensitivity % = 87.0 Specificity = 43.3 STOP-Bang questionnaire for severe SBD: Sensitivity % = 70.4% Specificity = 59.5</td>
<td>The STOP-Bang questionnaire/tool is simple, easy to use and an excellent method to predict severe SBD for standard preoperative evaluations. This tool identified more patients with moderate to severe disease and severe SBD</td>
</tr>
<tr>
<td></td>
<td>IDV: Severity of OSA.</td>
<td>10 states</td>
<td>Sleep home questionnaire results compared to baseline SHHS data</td>
<td></td>
<td>Limitations: Study focused on screening for moderate to severe disease and severe SBD only</td>
</tr>
<tr>
<td></td>
<td>DV: Scores from 4-variable screening tool, STOP questionnaire, STOP-Bang questionnaire, and ESS questionnaire</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purpose (Author(s), year)</td>
<td>Design and Key Variables</td>
<td>Sample and Setting</td>
<td>Measurements, Operational Definitions of Variables</td>
<td>Results or Findings</td>
<td>Conclusions and Limitations</td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------------------------</td>
<td>-------------------</td>
<td>-------------------------------------------------</td>
<td>-----------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>To determine correlation of high STOP-Bang scores with higher rates of complications (Vasu et al., 2010)</td>
<td>Historical /retrospective cohort</td>
<td>N = 135 (56 high risk scores for OSA)</td>
<td>STOP-Bang questionnaire. Score of 3 or more classified as high risk</td>
<td>High risk scores of OSA associated with approximately 10-fold risk of post-op complications</td>
<td>STOP-Bang screening questionnaire is clinically useful in elective surgical population. High scores are associated with increased incidence of post-op complications</td>
</tr>
<tr>
<td></td>
<td>IV: High risk Pre-op STOP-Bang scores</td>
<td>Pennsylvania</td>
<td>Clinical records review for demographics, ASA class, surgery type and length, comorbidities, LOS, cardiac and pulmonary complications</td>
<td>Sensitivity = 91.7% (95% CI, 61.5%-99.8%). Specificity 63.4% (95% CI, 54.3%-71.9%)</td>
<td>Limitations: Diagnosis of OSA not confirmed by polysomnography</td>
</tr>
<tr>
<td></td>
<td>DV: Number and type of post-op pulmonary and cardiac complications, LOS</td>
<td></td>
<td>Predictive values for post-op complications: Positive =19.6% (95%CI, 10.2%-32.4%) Negative = 98.7% (95% CI, 93.1%-100%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. ASA = American Society of Anesthesiologist; BMI = Body max index, CC = Critical care; CG = Control group; COPD = Chronic Obstructive Pulmonary Disease; CHF = Congestive Heart Failure; CPT = Current Procedure Terminology; CV = Confounding variable; DM = Diabetes Mellitus, DV = Dependent variable; EC = Exclusion criteria; ESS = Epworth Sleepiness Scales; FQHCs = Federally Qualified Health Centers; GA = General Anesthesia; GERD = Gastro esophageal reflux disease, HIPAA = Health Insurance Portability and Accountability Act; HIT = Health Information Technology; HSE = Health Service Execute; ht = height; ICU = Intensive Care Unit; IG = Intervention Group; IDV = Independent Variable; LR = Likelihood ratio; LOS = Length of stay, NP = Nurse Practitioners; MI = Myocardial Infarction; NSQIP = National Surgical Quality Improvement Program; OSA = Obstructive sleep apnea, PFR = Postoperative Respiratory Failure; Pre-op = Pre-operative; Post op = Postoperative; PVD = Peripheral Vascular Disease; RCT = Randomized Clinical Trial; RF = Renal Failure; SHHS = Sleep Heart Health Study population; SG = Study Group; SBD = Sleep Breathing Disorder; SSFS = Statistical Package for the Social Sciences; STOP-Bang = Snoring, Tiredness, Observation, Blood pressure, BMI, Age, Neck circumference, Gender; TIA = Transient Ischemic Attack; US = United States; VA = Veterans Affair; VAS = Visual Analog Scales; V48 = prolonged ventilation days ≥48 hours; wt = weight.