Limited Preoperative Testing and Its Effect on Surgical Outcomes:

Implementing an Evidence Based Testing Protocol

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Abstract

The focus of preoperative testing has evolved from screening all preoperative patients to identify surgical risk, to targeting specific evaluations and treatments in patients only when clinically warranted. At an academic orthopedic hospital in an urban setting in the northeastern United States, preoperative testing is performed routinely prior to elective orthopedic surgeries. Even though these tests are considered routine practice, evidence does not support standard testing for all patients. Excess preoperative testing is a problem of healthcare waste at this facility, and limiting it is a necessary step towards both evidence-based practice and preserving hospital resources. To close the gap between excess and necessary testing for preoperative patients, a testing protocol was implemented to limit preoperative testing. The Ottawa Model of Research Use (OMRU) framework was used to engage stakeholders and promote the protocol. Providers attended webinars to reiterate the scientific evidence behind the protocol. Assessments of compliance with the testing protocol were made via chart review within the electronic medical record throughout 4 phases of the project. A scorecard of surgeon compliance was also created for department transparency and to assess for improvement opportunities. There was a downtrend of excess testing within the Preadmission Testing Department. However, it did not meet the original goal of 20% reduction in excess testing. Throughout the project timeline, the surgical complication rate was flat between 1.3% to 5.6%. No surgical complications could be directly attributed to lack of preoperative testing.

Keywords: preoperative testing, diagnostic testing, surgical outcome, surgical complication

Introduction

Preoperative testing is done to evaluate a patient's fitness for surgery with the primary purpose of limiting risk of untoward events perioperatively. Traditionally, preoperative tests, such as a complete blood count, basic metabolic panel, electrocardiogram, and chest x-ray, are performed routinely for patients being prepared for elective surgery. Surgeons typically do not perform preoperative evaluations themselves, and instead workups are outsourced to providers in other specialties such as Primary Care or Anesthesia (Riggs et al., 2017).

Experts generally do not recommend standard testing for all patients, as it often wastes healthcare resources, leads to additional diagnostic tests that can be harmful to the patient, and can postpone surgery unnecessarily. No standard exists for preoperative testing, and at times, testing is done out of routine practice (O'Donnell, 2016). There is variation on how preoperative testing is carried out across providers, with some providers engaging in excessive testing not based on evidence.

Background/Significance

Managing surgical risk in preparing a patient for surgery has evolved substantially in the last decade: the focus has changed from screening all preoperative patients, to targeting specific evaluations and treatments in patients only when testing has a reasonable chance of suggesting a need for an alteration in the perioperative management plan (Fleisher, 2017). In other words, testing patients who are low risk for surgery can be often wasteful and doesn't modify the surgical plan. The American College of Cardiology and the American Heart Association have also advocated for the use of functional capacity scoring to manage surgical risk, specifically aiding in determination of preoperative cardiac risk. Examples of this scoring

are the Metabolic Equivalent Tasks (METs) and The American Society of Anesthesiologist (ASA) classification system (Fleisher, 2017).

A patient's functional capacity can be measured in terms of ability to perform METs without being limited by symptoms. Examples of METs are walking uphill, climbing two or more flights of stairs. Symptoms include chest pain, dyspnea, orthopnea, palpitations, and recent syncope. Poor functional capacity or an inability to do such activities is associated with a two times greater risk of perioperative complications (Smilowitz & Berger, 2020). On physical exam, findings of murmurs, gallops, jugular vein distension, or edema all point to cardiovascular disease. If a patient has evidence of decompensated heart failure or acute coronary syndrome, non-cardiac elective surgery is generally not recommended. Lab testing is not included in this calculation. Cardiovascular testing is rarely indicated for patients with low risk of major adverse cardiovascular events (MACE) but is helpful to assess patients with poor functional capacity (Smilowitz & Berger, 2020). MACE is a classification system of surgeries based on their cardiovascular risk: the lowest risk (<1%) surgeries are, for example, cataract surgery and cosmetic plastic surgery. The highest risk surgeries (>/ 5%) include vascular, thoracic, and transplant surgery (Smilowitz & Berger, 2020).

The ASA classification system is another tool that assesses a patient's fitness for surgery. It involves a six-level ranking. Class 1 is a normal, healthy patient, whereas Class 6 is a brain-dead patient who is having their organs procured for donation. Classes 2 through 5 represent preoperative health states ranging from patients with mild systemic disease to severely ill patients not expected to survive a surgery. Notably, there are no further definitions for each ASA status so interpretation is quite subjective and can vary widely (Balk et al., 2014).

Despite this aforementioned transformation of thought, providers continue to order laboratory tests to evaluate fitness for surgery. Perhaps this is related to routines of practice but likely, is out of fear of not taking optimal care of their patients. An important question for providers preparing a patient for surgery is: will forgoing routine preoperative testing change outcomes for the patient?

A frequently cited study by Keay et al. (2019) reviewed the utility of routine preoperative medical testing for cataract surgery. Their review concluded that preoperative medical testing before cataract surgery did not increase safety of the surgery. Interestingly, the authors remarked that despite research results, practice change would be difficult. They go on to say that agencies such as health insurance carriers have the ability to force such change by no longer reimbursing for testing shown not to be evidence-based (Keay et al., 2019).

The Agency for Healthcare Research and Quality (AHRQ) published a comprehensive review in 2014 assessing 57 studies dealing with the utility of preoperative testing. The authors found that aside from cataract surgery, there was insufficient evidence regarding the effect of preoperative testing prior to other surgeries to offer evidence-based recommendations and suggested further research be conducted (Balk et al., 2014). Available evidence also shows that limiting preoperative testing is safe in the orthopedic surgery population.

“Choosing Wisely” is a campaign by the American Board of Internal Medicine to reduce waste in healthcare. Authors Onuoha, Arkoosh, and Fleisher developed a “top five” list of unnecessary medical services within anesthesiology as part of this campaign, which was published in the Journal of the American Medical Association. The authors surveyed over 200 anesthesiologists and consulted the American Society of Anesthesiologists using a 5-point Likert

scale questionnaire. Obtaining baseline laboratory studies such as comprehensive metabolic panels and complete blood counts for health ASA Class I or II patients was concluded to be the most common low-value practice preoperatively (Onuoha et al., 2014).

System Analysis

Macrosystem

The hospital involved in this quality improvement initiative is a 190-bed orthopedic specialty hospital located in an urban setting with the northeastern United States. It is one of four members of a regional health system. Led by a vice president, the hospital staff includes hundreds of physicians, advanced practice providers, and registered nurses. Executive administration is also composed of senior leaders from medicine, nursing, finance, operations, and human resources. The hospital values the highest quality evidence-based care for prevention, treatment, and rehabilitation of orthopedic, rheumatologic, neurologic, and musculoskeletal diseases; their primary stakeholder: the patient. This patient-centered focus has also encouraged the hospital to create a robust research program that strives to improve available treatments for patients with complex medical issues and disabilities, in order to improve their quality of life (Project Site Hospital (anonymized)).

Mesosystem

Perioperative Services is the mesosystem within which patients receive all care around their surgical procedure, including their visits to Pre-Admission Testing, and their stays in the Perioperative Holding areas and the Post-Anesthesia Care Unit. The Perioperative Services department is led by a senior director. Within perioperative services lies the department of Pre-Admission Testing, led by a medical director and the director of nursing. Perioperative Services

also works very closely with the Department of Orthopedics, led by the Vice Chairman of Clinical Affairs in Orthopedics, and the Department of Anesthesia. However, these departments are not under the Perioperative Services umbrella. The goals of Perioperative Services are to assess the patient's medical readiness for surgery, to refer patients for additional medical evaluations preoperatively, to choose appropriate anesthesia for the intraoperative period, and to ensure patients recover safely post procedure.

Microsystem

Pre-Admission Testing (PAT) is the microsystem and current entry point through which patients start their care. The purpose of PAT is to manage all patients pending surgery at the hospital, assessing their risk for surgery. A table linked to the electronic medical record (EMR) separates patients by risk into the "green pathway" and the "yellow pathway," which are shown in Appendix A. The "green pathway" encompasses all patients who are at minimal risk for surgery. Minimal risk refers to the following: patients with few or no medical problems, minimally invasive procedures with little or no blood loss, or procedures that could be done in an office setting but are being done in the operating room due to the use of anesthesia. Additionally, minimal risk patients do not take anticoagulant medications, antiplatelet agents, opioids, or steroids. "Green pathway" patients do not require a PAT visit but do receive a phone screen and complete a patient questionnaire that is reviewed by the PAT team. These patients also require no labs prior to surgery.

The majority of patients fall into the "yellow pathway" which encompasses all patients that have more-than-minimal risk for surgery. This group of patients requires a phone screen and an in-person visit to PAT. "Yellow pathway" patients have multiple medical comorbidities,

including but not limited to, diabetes, pulmonary disease, cardiovascular disease, obesity, cerebrovascular disease, organ failure of any kind, and history of complications with anesthesia. These patients also take medications that need closer monitoring, such as anticoagulants, antiplatelet agents, antiarrhythmics, diuretics, steroids, and opioids, to name a few. Additionally, patients that are undergoing significantly invasive procedures with expected blood loss, including but not limited to open exposure of internal organs or bones, placement or prosthetics, or resection of organs, are all included in this pathway. The "yellow pathway" table delineates which lab tests patients require based on their comorbidities.

Patients undergoing elective surgeries are at the center of this microsystem. They have a variety of medical comorbidities, and all require evaluation of their past medical history, past surgical history, medications, allergies, and airway. They are actively engaged in preparation for their surgeries via the use of the Epic MyChart application and are encouraged to voice their concerns regarding how extensive surgery will be, how their pain will be managed, how long recovery and their hospitalization will be, and when they will resume normal activity. Currently, they are expected to answer a health questionnaire via the Epic MyChart application prior to their PAT visit and come prepared to that visit with a list of their medications, allergies, past medical history, and past surgical history.

Problem Description

Preoperative testing is routinely performed within the PAT prior to elective surgeries at the hospital. Such testing includes complete blood count, basic metabolic panels, electrocardiograms, and chest x-rays. Even though these tests are considered routine practice, evidence does not support standard testing for all patients. As previously stated, such standard

testing can waste healthcare resources and can postpone surgery unnecessarily (O'Donnell, 2016). Excess preoperative testing is a problem of waste and unnecessary cost at the hospital, and limiting it is a necessary step towards both improving evidence-based practice.

The current state of workflow for preoperative surgery patients at the hospital allows surgeons to order preoperative testing in the electronic medical record (EMR), Epic, based on their patient's medical history as outlined in the "grid system" that suggests only certain tests to be ordered. However, providers can still order any additional tests desired. This allows for unneeded testing that increases the cost of care. Importantly, changes in insurer reimbursement now incentivize hospitals to meet performance benchmarks and such changes should motivate providers to rely on set guidelines, avoid wasteful testing, and provide cost effective care (O'Donnell, 2016). More specifically, streamlining preoperative testing is a priority for Perioperative Services. Initial data review of lab test ordering reveals that most providers are not following the existing grid system in Epic.

Available Knowledge

Five quantitative studies on limiting preoperative testing and surgical outcomes were reviewed and assessed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) tool (Guyatt et al., 2008). Level of evidence for the recommendations was scored based on Levin's level of evidence pyramid (Levin, 2011). A full Table of Evidence is included in Appendix B.

Beliveau et al. conducted a pre-post study at a county hospital in Texas in 2018 to determine whether implementation of an algorithm aimed at minimizing preoperative tests would result in decreasing associated costs of testing without compromising care. They

reviewed the number of lab tests ordered and canceled in the “before intervention” phase to the “after intervention” phase. No surgical cases were canceled due to lack of lab information and the number of patients requiring medical optimization decreased pre- to post-intervention (3.3% vs. 2.1% $p<0.01$). Cost savings were significant at $33,032 (Beliveau et al, 2018). This was a Level III study but with low quality of evidence. Despite asking a clear study question, because it failed to report patient outcomes, it is difficult to assess the full impact of this practice change or apply the findings to other settings.

Keshavan and Swamy’s (2016) prospective study examined the appropriateness of routinely ordered lab tests against the UK National Institute of Clinical Excellence (NICE) guidelines and analyzed their costs in a sample of 163 patients. NICE guidelines are based on a 4-level surgical severity grading system where “Grade 1 surgery” equates to minor surgery such as cataract excision. “Grade 4 surgery” is major surgery including total joint replacement, colon resection, and cardiac surgery (Balk at al., 2014). The study, which took place at a tertiary care center in India, found that only 43 (26%) patients had testing consistent with the guidelines. Of the tests that were not indicated, only 1.1% (a total of 7 tests) yielded abnormal results and none of these findings resulted in a change in surgical management (Keshavan & Swamy, 2016). This was a Level IV study but with moderate quality of evidence. The sample size was small, yet the authors used established guidelines to answer their clinical question. No patients were lost to follow up, and there was effort made to ensure inclusion of a balance of patients undergoing minor and major surgery (40% of patients in the sample received Grade 1 or 2 surgery, 47% received Grade 3 or 4 surgery). Weak aspects were the fact that there was no experiment or control group, and length of follow up for postoperative outcomes was unclear.

Nicholls et al. (2016) conducted a prospective study to assess the impact of introducing a guideline for preoperative testing on changes to anesthetic practices in the OR and costs. Their study took place at a single center in Barbados. The authors administered a questionnaire on preoperative evaluations to multiple Anesthesiologists- one questionnaire per patient case. Using convenience sampling from these Anesthesiologists, researchers obtained a total of 304 total patient cases and divided them into pre- and post-intervention groups. Formal guidelines for preoperative testing were disseminated at the center based on ASA grade, procedure type, and patient comorbidities. The mean number of tests obtained preoperatively decreased from 3.42+- 1.8 in the pre-guideline group to 2.89+- 1.98 in the post guideline group (p=0.042), a statistically significant change. When tests were performed despite not being consistent with guidelines, the percent of abnormal results ranged from 0-18%, yet no abnormal results changed anesthetic management in the operating room. The guidelines saved $7589 per 1000 patients, or $40,745.50 per year. This study was classified as a Level III evidence, moderate quality study. Authors addressed a clearly focused question and demonstrated significant cost savings. Convenience sampling may have produced biased results. Additionally, the authors did not control for the type of surgery performed, and the majority of procedures patients underwent were obstetric and gynecological. Therefore, it is unclear how this data could be applied to other surgical populations (Nicholls et al., 2016).

Santos and Iglesias (2017) studied the impact of using a preoperative testing request protocol to reduce intraoperative changes in the anesthetic management plan and perioperative complications. The study location was a single center, university hospital in Rio de Janeiro, Brazil. This was a randomized blinded clinical trial with a sample of 405 elective surgery

patients randomized into two groups: the routine ordering group (RG) and the protocol group (PG) that had diagnostic tests requested according to a preoperative exam request protocol. Once the patient's surgery was complete, an anesthesiologist blinded to group assignment evaluated the patient's record for the following: alterations in anesthetic management due to abnormal preoperative labs and procedural or perioperative complications. There were 1428 diagnostic tests ordered in the RG for 204 patients and 601 tests ordered in the PG for 201 patients, which was strongly significantly different (p=0.001). There was no statistically significant difference between the frequency of complications in the RG group (58 cases; 28.43%) and the PG group (54 cases; (26.86%), p=0.6. No significant difference was found between groups in diagnostic test-related changes in anesthesia plan (p=0.23). Santos & Iglesias' trial was a Level II study with moderate quality of evidence and strong recommendation for using their intervention. It was a randomized and blinded clinical trial with no apparent reporting bias and no patients lost to follow up. Patients in the RG and PG did not differ on gender, age, associated diseases, MET, ASA, surgery size, or type of anesthesia. One irregularity was the large confidence interval for assessment of surgical plan changes surrounding abnormal coagulation studies (*OR*=30.28, 95% *CI*= 5.17-177.55). It is difficult to interpret those results due to the fact that when data is assessed in the authors' tables, it appears that there were equal amounts of surgical plans changed based on both normal and abnormal coagulation results (Santos & Iglesias, 2017).

Sui et al. (2016) evaluated the impact of preoperative laboratory testing on postoperative complications in patients undergoing low risk ambulatory urologic procedures. While this study examined a narrower surgical population than the previous studies, it was

included in this review because it was a retrospective cohort study that used the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database. A total of 7378 patients over 18 years of age in Classes 1 to 3 were selected from the database (excluding patients in ASA Classes 4 and 5) and divided into two groups- those who received preoperative lab tests and those who did not. The authors found no significant difference in 30-day morbidity (p=.17), mortality (p=.28), deep incisional surgical site infections (p=.38), or readmissions (p=.63) between the two groups studied (Sui et al., 2016). This retrospective cohort study was classified as Level IV with a moderate quality of evidence (strengths included a very large sample size and a clear research question). The relatively narrow study populations limit generalizability of the findings to patients undergoing other types of surgeries and those in higher (more severely ill) ASA classes.

Finally, a qualitative study by Riggs et al. (2017) assessing surgeon practices and beliefs about preoperative medical evaluations (PME) was included in this review. Eighteen surgeons from diverse backgrounds and experience levels in Baltimore, Maryland agreed to semi-structured interviews that were audio recorded, transcribed, and analyzed using a conventional thematic content approach. Fifteen themes emerged that included practice variation, benefits versus harms of PME to patients, surgical risk assessment, and drivers of practice. Surgeons acknowledged that PME only benefits a minority of patients, and generally downplayed potential harms of PME. Interestingly, there was an apparent lack of knowledge regarding differential testing strategies-based risk scoring, which highlights a potential area for intervention. However, surgeons believed that PME reduced malpractice liability and mentioned satisfying hospital requirements. The authors concluded that there was a large

amount of variation in PME practices. Overuse of testing was of concern to some informants, but PME was generally considered beneficial to patients. For the most part, surgeons sought greater input into PME practices, and believed that PME should be more standardized. This appears to have been a carefully conducted qualitative study that followed many recommended practices. Limitations included the restriction of the sample to surgeons from a single geographic area. This was a Level V study with moderate quality of study evidence as it was qualitative research whose design suggests the results were trustworthy (Riggs et al., 2017). This study highlights a potential need for more education of surgical providers regarding risk assessment when planning preoperative evaluations.

Synthesis

The five quantitative studies appraised all aimed to assess how limiting preoperative testing would affect overall morbidity and mortality of the patient. Santos and Iglesias' 2017 randomized blinded clinical trial was clearly highly relevant. It showed no statistically significant difference in complication rates between the protocol and routine groups (Santos & Iglesias, 2017). Nicolls et al. (2016) interestingly added in their study that when tests were done despite not being indicated in their preoperative guidelines, even the results that were abnormal had no ultimate impact on the anesthetic plan. In their sample of over 7000 urologic surgery patients, Sui et al. (2016) found no evidence of any statistically significant differences in outcomes between patients who received preoperative lab tests and those who did not, when examining 30-day morbidity, mortality, deep incisional surgical site infections, or readmissions. Keshavan & Swamy (2016) found that patients in their institution were undergoing

preoperative lab tests as a matter of routine, rather than following widely accepted guidelines, and that the results of these routine tests, even when abnormal, were not acted upon.

One of the studies focused on cost reduction rather than patient outcome. Beliveau et al. (2018) measured lab test data and surgical case cancelation rates to assess whether cost was reduced when preoperative tests were limited. Unfortunately, because no mortality or morbidity data were included, it is not possible to say whether the cost savings were achieved without compromising patient safety, although other studies reviewed here suggest this may have been the case. Despite this weakness, this study suggests that reducing unnecessary testing may lead to cost savings. Findings in Nicolls et al. (2016) are similarly suggestive of possible cost savings that could accompany limiting preoperative testing prior to elective surgery. Their implemented protocol saved their institution $7589 per 1000 patients, or $40,745.50 per year (Nicolls et al, 2016). Keshavan & Swamy's prospective study (2016) measured the excess cost of the 52% of unindicated tests administered on their study population. Estimated cost savings at their tertiary care center in India was 171,358 Rupees or $2,312.29.

The qualitative study by Riggs et al (2017) suggests that surgeons have preconceived notions about preoperative testing and a potential knowledge gap regarding preoperative risk assessment. Testing seems to be done out of fear of malpractice or assumption of necessity rather than based on thoughtful assessment of patient risk (Riggs et al., 2017).

Specific Aims

To close the gap between excess and necessary testing for preoperative patients at the hospital, an evidence-based testing protocol was implemented. Based on each patient's

medical history and METs, providers were provided guidelines via the EMR to only order indicated tests and to document METs for each preoperative patient. These guidelines were reinforced through education of surgery providers and surgical coordinators. Educations consisted of webinars reviewing evidence-based preoperative testing, including the lack of impact on low-value testing on perioperative mortality. The specific outcomes measured included numbers of patient encounters with inappropriate diagnostic testing ordered during the intervention period compared to the pre-intervention time frame, in addition to patient morbidity outcomes. These outcomes after the intervention were compared against pre-intervention baseline measures that were collected during the week of September 13th, 2021. From this, "surgeon scorecards" were made for each orthopedic surgery team (including the surgeon and their associated Advanced Practice Providers), ranking who has been ordering appropriate tests most frequently. Data was subsequently manually collected for the post-intervention period, and new scorecards were again made public. For ongoing compliance monitoring, it will be recommended that a report be generated via the electronic medical record for ease of surveillance. The institution's IRB reviewed the quality initiative, and based on Federal Regulations 45 CFR 46.102, which provide the statutory definitions that guide human subjects research, the project was not considered research involving human subjects and did not require IRB review.

Stakeholders

Primary stakeholders for this initiative were the Director of Nursing in Preadmission Testing (PAT), the Director of Nursing in Perioperative Services, the Vice President of Nursing and Patient Care Services, and the Vice Chairman of Clinical Affairs in Orthopedics. All

stakeholders indicated their support for the project. As part of a top health system in the country, there is a need to rise to meet the latest recommendations of evidence-based practice. Additionally, reduction in overall tests will reduce the risk of iatrogenic harm by limiting unnecessary interventions and should increase surgical throughput by reducing delays in surgical cases related to abnormal test results.

Additional stakeholders included those directly involved in the process of preoperative testing: nurses and nurse practitioners in PAT, anesthesiologists in PAT, orthopedic surgeons referring patients to PAT, and their surgical coordinator staff who assist in ordering labs. Each of these clinicians and non-clinical staff needed to be aware of protocol changes in order to remain compliant with the changes. Patients were also key stakeholders. They have the right to appropriate, evidence-based care that follows guidelines and the latest research. Coming to a top institution in the country, there is an expectation that they are receiving world class care.

Study Question

Will the implementation of an evidence-based testing protocol limiting preoperative testing affect the amount of low value preoperative testing done at this facility? Will patient morbidity outcomes be affected by this change?

Rationale/Conceptual Model

This project was framed in the context of the Ottawa Model of Research Use (OMRU). OMRU is a comprehensive framework used to guide the implementation of research into real world practice. It is used by healthcare systems at any level to provide an organized means by which to change a process based on available research. Since the hospital does not use one specific model for quality improvement, OMRU was selected due to its focus on how

applications of research affect patients (Logan & Graham, 1998). OMRU is guided by assessment, monitoring, and evaluation (AME) of interventions beginning at their conception, during implementation, and at the end of projects to gauge their impact. The AME portion of OMRU is helpful in that it constantly refers to the research question, ensuring the environment is adapting to the change, and that the patient outcomes are being improved by the process change (Logan & Graham, 1998). This is very similar to Plan-Do-Study-Act (PDSA), which focuses on change and iterative tests of change (Reed & Card, 2016). Data was collected at multiple time intervals over a 10-month period before and after specific interventions were made, aimed at changing provider behavior when ordering preoperative lab tests. Data collected was numerical, without the use of research instruments such as surveys or questionnaires.

There are six elements of the OMRU process. The first is having a research-informed innovation and being able to clearly state why the innovation is needed and how it is based in research. This is also called the situational assessment. As aforementioned, limited preoperative testing is based on research (Rycroft-Malone, 2010). The Evidence Review section of this paper will delve deeper into the research. The second is identifying key individuals in the organization that are required to make the change. These would be the potential adopters, facilitators, and barriers to the innovation (Rycroft-Malone, 2010). As previously mentioned, this project had buy-in from both the nursing and medical directors of PAT. The third is the assessment of the practice environment. A full review of the environment where the innovation was implemented, including current practices and available resources, was necessary to be able to make changes to the environment (Rycroft-Malone, 2010). The fourth element of OMRU is implementation of the process. Using the situational assessment done at the beginning of the

process, strategies are selected to provide awareness of the intervention and followed up on to ensure adoption of the process (Rycroft-Malone, 2010). For this project, a hybrid model of implementation was needed: both changes to the electronic medical record (EMR), and live education of clinicians on the process of limited preoperative testing so that excess tests were no longer ordered. Surgeon scorecards were used to publicly rank compliance. The fifth OMRU element is monitoring adoption of the process. This includes evaluation of the adoption, determining how knowledge has spread, and determining if any implementation strategies need to change (Rycroft-Malone, 2010). Post intervention data review and updated surgeon scorecards in iterations helped to evaluate adoption of the testing protocol. Lastly, the sixth element of OMRU is evaluating the impact of the innovation on the elements of the healthcare system, patients, and providers to determine its effectiveness. Repeat assessment, monitoring, and evaluation of the process is key to its success (Rycroft-Malone, 2010). Future monitoring of compliance with the testing protocol, ideally in the form of a recurring report from the EMR, will be necessary.

Methods

Contextual Factors

For the duration of this project, the project lead met with leaders from the departments of orthopedics, anesthesia, and PAT who reviewed the project plan and goals. Success of this project depended on engagement of all three aforementioned groups. Prior to the webinars, the project lead presented pre-intervention and post-Epic change testing data to the orthopedic, anesthesia, and PAT leaders. This presentation included an initial surgeon scorecard ranking the proportions of each surgery team's patients who receive appropriate preoperative

testing. Communication of these outcomes reiterated the importance of disseminating evidence-based information on preoperative testing and encouraging webinar attendance by their staff. Repeat scorecards were presented in the weeks following the webinars to assess compliance with limiting preoperative testing. Summarizing clinical performance data via chart audits is a recommended implementation strategy according to the Expert Recommendations for Implementing Change (ERIC) study (Powell et al., 2015). Scorecards had also proven effective for compliance with other best practice initiatives, so it was expected that they would have a similar effect with this quality improvement project.

Interventions

To establish a relationship between the intervention and the outcome, this project took place in multiple phases. The first phase, or pre-intervention phase, consisted of initial data review of preadmission testing (PAT) patient visits for the month of February 2019. This chart review established the baseline number of patients receiving excess preoperative lab testing prior to the project.

Phase two of the project involved review of a second data set from PAT from September 2021. This data review again assessed the number of patients who received excess preoperative testing. However, these cases occurred after changes were made to the electronic medical record (EMR), Epic. Changes were made by the Perioperative Services Department and include tables visible in Epic suggesting specific orders to the provider based on evidence-based guidelines. These tables were also made available via the hospital intranet. It should be noted that these orders were simply recommendations but did not block providers from ordering any

tests they chose. Measures of test use following these EMR modifications (a limited intervention) will create a new baseline prior to more intensive intervention.

Phase three of the project consisted of educational webinars for those involved in ordering preoperative tests. During the week of June 13th, 2022, a total of five 10-minute webinars were presented to surgical coordinators. Each webinar presented the same content but was held on a variety of dates and times to engage as many staff members as possible. Webinars reviewed background on the project, the latest evidence-based preoperative testing guidelines, the process of ordering tests, and the preliminary data. It was initial thought that this group of staff ordered lab tests as a proxy for their surgeon counterparts. Following the webinars, a chart audit to assess compliance with the protocol was performed. After a subsequent data review and AME cycle, it was determined that webinars needed to be expanded to advanced practice providers, who had taken over ordering preoperative tests.

Phase four of the project was four additional webinars that took place during the week of June 27th, 2022. These webinars consisted of the same information, but targeted advanced practice provider staff. A final chart audit for compliance of the protocol was subsequently performed. The full implementation outline is included in Appendix C.

Engagement Procedures

There were three main ways staff were engaged in this initiative. The first was via multiple webinars with surgical coordinators and advanced practice providers that educated them on the latest evidence-based recommendations on preoperative testing. The second was by engaging leadership within the orthopedics and anesthesia departments. Leadership meetings were attended to present preliminary date prior to the educational intervention and

post-webinar data. Positive feedback on the initiative was gained from this leadership staff. The third engagement activity was the “surgeon scorecard.” The “surgeon scorecards” were created ranking those surgeons and their affiliated Advanced Practice Providers who were most compliant with limited testing guidelines through each phase of the project. The hospital has used surgeon scorecards in the past for other quality improvement initiatives involving physician driven metrics. This practice is culturally accepted in the institution and will foster a competitive atmosphere to encourage compliance.

Measures

This project involved collection of the number of patients who receive excess lab tests and specifically which tests are unnecessarily drawn at different time periods: pre-intervention, post Epic changes, and post both Epic changes and webinars with 2 AME iterations. According to Mishra et al. (2019), these kinds of descriptive statistics can be used to summarize data in a valid and meaningful way. Cases with surgical complications were also reviewed to ensure complications were not related to preoperative lab testing. Compliance with testing guidelines was calculated for each surgeon of record. This determined the results for the “surgeon scorecard.”

Process Measures

All PAT visits for specified weeks in February 2019, September 2021, June 2022, and July 2022 were reviewed. The time frames are before and after Epic changes were made with the grids to suggest appropriate preoperative testing, and after webinars focusing on different staff populations respectively. Each patient visit containing lab tests without a clear indication was flagged and the type of unnecessary test noted. Type of test refers to, for example, liver

function tests, lipid panel, thyroid function tests, to name a few. Knowing the type of test allowed supplemental education during webinars on why certain tests are not indicated for preoperative assessments. This data is valid as it is pulled directly from Epic and used for billing purposes. This data is valid as it is pulled directly from Epic and used for billing purposes. Reliability of data depends on clinicians' documentation within the EMR.

Outcome Measures

The primary outcome measure for this project was reduction in the number of patient visits to PAT with inappropriate, non-evidence-based, preoperative testing. The number of encounters with inappropriate testing was calculated at each time interval. These data were reliably pulled from the electronic medical record. Additionally, the most frequently inappropriately ordered tests were assessed. Surgical complication data for each time interval was monitored to ensure it did not increase in relation to changes in lab test ordering.

Data Collection Protocol

Methods and Procedures

Data was downloaded from the Epic EMR by an IT specialist into an Excel spreadsheet for the specified time frame of review. The spreadsheet listed patient information alongside the tests ordered and surgeon responsible for the patient case. Chart review occurred for each patient visit to understand the following information: past medical history, past surgical history, medications, surgical outcomes and potential complications, and excessive lab work ordered. Necessary lab work is determined by the type of surgery the patient underwent and their comorbidities. The hospital classifies surgeries into low, intermediate, and high-risk categories. Each category of surgery in addition to patient comorbidities determines which testing is

needed. Specified testing based on these factors is recommended to the provider in Epic via the grid system. Cases that contained excess labs outside of these evidence-based recommendations were flagged. Subsequently, the type of excess test was noted. Surgical complications within 30 days of surgery were also flagged for review.

Analysis

The data was summarized using descriptive statistics. Descriptive statistics are used to summarize data sets to communicate the largest amount of information in the simplest form (Mishra et al, 2019). These statistics were represented graphically via pie charts. Pie charts were selected as they pictorially represent parts of a whole, and they visually are simple to interpret (Sadiku et al., 2016). The number of patient visits with excess labs, in addition to the type of test was collected for each specified period (pre intervention, post Epic changes, post webinars and Epic changes). Canceled or rescheduled cases that are not rescheduled within the specified time-period will be removed from the dataset**.**

The percent of patients who received excess testing for each period was calculated and depicted via a pie graph. The numerator equaled the number of patients that received unnecessary testing and the denominator was the total number of cases for the time interval minus canceled or rescheduled cases. A table depicted which tests were ordered excessively most frequently.

Each time interval's surgeon team scorecard was created based on frequency of compliance with evidence-based testing. Highest ranking surgeon teams had the most compliance with the protocol and displayed in a list by name.

Ensuring Data Quality and Ethical Concerns

All patient lab data contained in the Excel spreadsheets was cross checked against EMR data. Any cases with unclear information were flagged and reviewed additional times. It was imperative to ensure that patient privacy is maintained throughout this project. The excel spreadsheets containing the data being reviewed were stored on an encrypted server that was hospital based. They were never downloaded onto any non-hospital devices, and only accessed through a virtual private network. Only deidentified, aggregate patient data was reported. There was a low potential of harm associated with this quality improvement project. One potential risk of harm was inaccurate attribution of data to a surgeon. However, data was cross checked between Excel and the EMR to reduce that risk.

Budget

Due to the association of this project with a doctoral education program, there were no direct costs to the site for this project. However, in order to replicate this project, it would be expected to incur costs for time spent conducting data collection, data review, and quality improvement by the project lead. At the clinical site where this project occurred, webinars to conduct education sessions incurred no cost, and web conferencing platforms were free to both the project lead and attendees.

Results

Data was obtained after changes to the EMR were made from the week of September 13th, 2021. It revealed that only 42% of patients in PAT were receiving appropriate preoperative testing, and 55% of patients were receiving excess testing. Three percent of patients received no testing, despite their comorbidities requiring testing. Hepatic panels, coagulation panels,

and lipid panels were the top three unnecessary tests ordered, respectively. Of the patients that received excess testing, 53% of them, more than half, had their lab work obtained outside of PAT, or by their own providers. The complication rate during this period was 2.67%, with a total of three patients suffering a complication post operatively. These complications included a surgical site infection requiring a return to the OR, an acute kidney injury related to non-steroidal anti-inflammatory drug use for pain control, and a stroke. Of note, after discussion with the orthopedic surgery stakeholders, none of these complications were preventable with preoperative lab testing. Surgeon scorecard data which evaluated a total of 28 surgeon teams was presented during a leadership meeting for orthopedic surgery and anesthesia operations. The average number of patient cases per surgeon was 4, with the middle 50% of surgeons scoring 14-67%. Feedback was that one week's worth of data was not indicative of their practice. The wide confidence bounds also questioned the statistical significance of the data. However, due to time constraints of the project timeline and manpower, one-week intervals of data was the maximum amount possible. The goal at this point was 20% reduction in excess testing after engagement and education of staff via the webinars and no changes in surgical complications.

The first set of webinars took place during the week of June 13th, 2022 engaging the surgical coordinator staff. Initially, leadership in PAT believed this was the best population to target, as they were responsible for ordering tests in the EMR, with surgeons cosigning their work. Five 10-minute webinars were held for the staff, all sharing the same information but held at a variety of dates and times to maximize engagement. These webinars were well attended, with 51.6% of the total surgical coordinator staff attending one of the sessions. This

was aided by the efforts of the operations manager, who imparted the importance of attendance on her staff. However, during the webinars, it came to light that this group of staff was no longer entering orders on behalf of surgeons, but that advanced practice providers seeing patients in the office had taken over that task.

Upon review of testing data for the week following this first set of webinars, it was clear that they had little impact. It was also evident that the major changes within PAT significantly impacted preoperative testing. Auditing of testing data for the week of June 20th, 2022 revealed that only 39% of patients received appropriate testing and 61% of patients received excess testing. A large portion of the excess testing, 80.9%, was obtained outside the hospital. That was a nearly 30% increase from the prior data set, though not unexpected after the changes made to the PAT department. Most frequently ordered unnecessary tests were again coagulation panels, hepatic panels, and lipid panels. The complication rate during this interval was 1.3%, with only one patient complication- a corneal abrasion. Again, this complication was not preventable with preoperative lab testing. Surgeon scorecards, evaluating 24 surgeon teams, reflected the dramatic increase in testing performed outside of the hospital- more than half of surgeons who had patients receive preoperative testing during the audit week scored 25% or less on compliance with the protocol.

After feedback regarding the target population for the webinars, an additional four 10-minute webinars were held for advanced practice provider staff during the week of June 27th, 2022. These webinars only had a 20% attendance rate. However, those who attended were highly engaged. Feedback obtained from one attendee expressed her appreciation to learn of preoperative testing guidelines, as she did not know what to order. Another attendee was

happy to see the testing grids up close because they also were unclear about the testing protocol in the past. Results of the chart audit during the week of July 4th revealed minimal change in compliance with the preoperative testing protocol. Only 44.4% of patients received appropriate testing, with 52.8% receiving excess testing, and 2.8% lacking testing when required. Of the patients that received excess testing, 52.6% was performed outside of the hospital. The complication rate was 5.56%, which comprised 2 patients. One patient had a nerve injury prolonging their postoperative hospital stay. The second had an Acute Kidney Injury. Surgeon scorecards evaluated 15 surgeon teams and revealed more than half scored 60% or less on compliance with the testing protocol. After both sets of webinars and subsequent data reviews, the results of the scorecards were again presented at the orthopedic surgery and anesthesia operations leadership meeting.

Missing Data

Research data obtained during preoperative testing was not counted and did not make a chart non-compliant. Conflicting information was received regarding certain tests being obtained for research purposes or not. These included albumin, prealbumin, fructosamine, and transferrin. Type and screen tests were also excluded from marking a chart as non-compliant. Per the protocol, patients without changes in their medical condition required labs within a 90-day time period. However, as a change in medical condition is open to interpretation, repeat labs within this 90-day time frame were not marked as non-compliant. Required state testing, such as hepatitis C screening, was excluded from marking a chart non-compliant. Charts with extra lab tests were not marked as non-compliant if patients obtained labs outside of PAT and those ordering providers documented other diagnoses related to the visit or visit reasons

besides “preoperative evaluation.” Importantly, the data set obtained for chart audit of cases from the week of July 4th was different from the other data sets due to the closure of the PAT department. This will be discussed further in the limitations section.

Discussion

Summary

Changing provider practice is a difficult undertaking. This quality improvement project revealed that despite Orthopedic and Perioperative Services leadership agreeing with the concepts and frontline staff being provided with education on these concepts that were already protocol at the institution, actual practice change was challenging to achieve. Overall, there was a downtrend of excess testing within the Preadmission Testing Department. However, it did not meet the original goal of 20% reduction in excess testing. Throughout the project timeline, the surgical complication rate was flat, hovering between 1.3% to 5.6%. No surgical complications could be directly attributed to lack of preoperative testing.

Strengths of the project include a structured implementation plan and data review strategy based on both an extensive literature review and the Ottawa Model of Research Use. As this project was undertaken by one person, organization was key in moving the project forward, staying on track with deadlines, and ensuring data quality. Appendix D depicts the summary graphically.

Interpretation

When comparing the results of this project with findings from other publications, the most glaring difference is suggesting versus mandating protocol changes. For example, in the Beliveau et al. study (2018), patients only received preoperative tests based on a protocol,

unless dictated by their medical history. Preadmission Testing nurses canceled tests outside of the protocol. In this quality improvement project, no providers were forced to follow the lab testing protocol for their patients. Similarly, in their randomized blinded controlled trial, authors Santos and Iglesias were able to divide patients into a protocol group and routine group for preoperative lab testing, with the protocol group mandated to only receive specific preoperative tests. They were able to reduce preoperative testing by 57.3% (Santos & Iglesias, 2017).

A similar, more large-scale study was undertaken at Vanderbilt University by Nelson et al. Their retrospective study analyzed over 56,000 patient cases before and after implementation of preoperative testing protocols. The study revealed a downtrend in all preoperative testing performed, for example basic metabolic panel draws were reduced by almost 20% and coagulation panels were reduced nearly 8%. The study also showed that reductions in preoperative lab ordering was successful when anesthesia teams took control of test ordering. It also proved that “preoperative evaluation centers” had the ability to reduce lab testing without adverse events. This was achieved by following evidence-based testing protocols from their institution (Nelson et al., 2019).

The idea of limiting unnecessary testing is grounded in value-based care principles. Authors Murrey et al. discussed why orthopedic residents should be taught value-based care in their 2021 article. One aspect of implementing value-based care is the need to change physician behavior. Managing variation in care is essential to ensuring every patient receives the same quality care. Standardizing care means getting buy-in from providers to change their practice from “their way” to the “same way” for all patients within an institution. Elements that lead to

success in implementing value-based care relative to preoperative testing include adopting evidence-based clinical pathways and establishing robust data collection and dissemination infrastructure (Murrey et al., 2021).

This project increased awareness of the existing testing protocol within the EMR. It also educated staff on the safety of ordering less blood tests for patients prior to orthopedic surgeries. Reasons for differences between the observed and anticipated outcomes are due to the changes made within the PAT department prior to the start of the implementation of this project, further discussed in the Limitations section.

Limitations

The outcomes of this project were clouded by the variety of changes that took place within the organization during the implementation period. Two unexpected and significant modifications made to the hospital's PAT department just prior to the start of this phase of the project. Firstly, the PAT department closed, with the health system opting to centralize preadmission testing to one location rather than two. Secondly, in order to limit patient visits to PAT and improve patient satisfaction, patients were encouraged to obtain preoperative lab work at their primary providers or cardiologists, in conjunction with their medical clearances needed prior to surgery. The PAT visit often became a telemedicine visit. These changes had a significant impact on the amount of testing performed there. Despite an existing preoperative lab protocol, the protocol was not followed by outside hospital providers. This greatly increased variability of preoperative testing and limited ability to control the preoperative evaluation. Outside hospital testing could also be considered a confounding bias, as the exposure of this factor into the quality improvement project mixed effects of implementing the protocol and

improving patient satisfaction, incurring a negative overall effect on compliance with the protocol. The project can be considered externally valid, as it could be easily reproduced at another institution. Results would be similar if practice changes were suggested and not mandated. Mandating practice changes would produce positive results.

Chart review to assess data compliance was not automated, but rather completed by hand by one person (the author). This created a risk of human error in the data collection process. Additionally, the number of charts that could be reviewed was severely limited by manpower and risked the project's internal validity. A higher number of chart audits may have further proven the problem of excess testing, as requested by the Orthopedic Surgery Department, but it would not have solved the problem. To minimize this issue, multiple smaller chart reviews were undertaken, which proved to have similar results. However, the small number of chart reviews per surgeon team yielded wide confidence bounds for the scorecard results, which questions their statistical significance.

During the chart review process, it was discovered that certain surgeons provided outside hospital providers performing the preoperative labs and medical clearance a memo listing required tests to be done. These memos contain labs that are not within the protocol and that are unnecessary for the preoperative evaluation. In other words, despite an existing protocol for preoperative labs, and agreement by leadership that certain tests are not indicated preoperatively, providers did not want to change their practice.

Orthopedic surgery leadership was also interested in knowing the financial impact of preoperative lab testing performed without indication. After discussions with the Finance department, it was determined that a drill-down specific to each lab cost per patient was

difficult to determine due to the hospital's negotiated fee with each insurance payor. Additionally, due to the global surgical charge, or cost of surgery including a patient's surgical-related services, cost coverage for each specific lab test was unclear. Using the hospital's charge list that outlines the cost for every product dispensed or test performed, a rough estimate of dollars wasted was calculated, which totaled $1.05 million dollars for the phase 2 period. This was not calculated for subsequent phases of the project based on the abstract nature of this cost.

The final data set obtained for chart audit of cases from the week of July 4th was not an exact comparison to prior data sets. Due to closure of the PAT department, this data set was obtained from the new centralized outpatient lab and filtered for ordering orthopedic providers practicing at the specified hospital location. The total number of cases was substantially lower than expected, roughly half the prior data set (77 patients versus 36 patients). Due to the close proximity of the patient's surgeries to the timing of chart audit, several patients were not yet discharged from the hospital, and could have yet to experience postoperative complications (i.e. surgical site infections). Additionally, due to the low total number of patients, the 2 minor surgical complications may have provided a misleading indication of true risk.

Conclusions

This project suggests that in order to evolve medical practice, protocols merely recommending workflow changes do not produce substantial change. Mandating such practice changes would result in a larger positive effect toward the change being made. It would not be sustainable for this type of chart auditing to continue. The Orthopedic Surgery Department has

suggested using interns to pull and review this data. However, the most efficient and exact way to review this data in the future would be an automated report from the Epic EMR.

This quality improvement project could be used to assess practice changes in other contexts. It would have a larger impact if used with a mandated practice change. Particularly for the PAT department, if practice change is still desired, outsourcing the preoperative work up will not achieve this change. A suggested next step would be requiring preoperative testing to be done within the health system and requiring strict adherence to the lab testing protocol. Alternatively, surgeon memos can be sent to outside hospital providers reinforcing the testing protocol.

Other Information

Funding

This project received no funding from any organizations.

Appendix A. *Grid System*

REQUIRED TESTING GUIDE--MINIMAL RISK SURGERY AN 'X' INDICATES THAT THE TEST IS REQUIRED FOR THAT PARTICULAR PATIENT		†Recent Medical Evaluation	Anesthesia Assessment
MEDICAL CONDITION	Age 75 and over	X	
	Cardiovascular Disease (including arrhythmia), Cerebrovascular Disease, or Peripheral Vascular Disease	x	
	ANY patient with a history of: 1. Cardiac stent(s); 2. EF <40%; 3. CHF; 4. Pacemaker or Defibrillator; 5. Severe Valvular Disease; 6. Complex Congenital Heart Disease; 7. Active symptoms	X	
	Poor Exercise Tolerance	x	x
	Severe COPD, pulmonary hypertension or recent pulmonary exacerbation requiring hospitalization in past 6 months, or on home oxygen	x	x
	History of obstructive sleep apnea or current use of CPAP or BiPAP **(See Footnote #1)**		
	Diabetic requiring insulin therapy OR A1c≥ 8 OR Glucose >180 on non-fasting BMP **(See Footnote #2)**	x	
	Hepatic disease (hx/current hepatitis, cirrhosis, alcohol abuse)	x	
	ESRD/renal failure **(See Footnote #3)** or renal insufficiency (Creatinine >2mg/dL)	x	
	Bleeding Disorder (Acquired or Congenital Abnormality)	x	
	Malignancy with IV chemotherapy within last 6 months	x	
	Hypertension on 2 or more meds or SBP>160mmHg or DBP > 100	x	
	History of anemia	x	refer to PAC
	Recent difficulty swallowing, dysphagia, dyspnea	x	x
	History of anesthetic complications or concerns		x
MEDICATION	Steroid Use (>20mg of prednisone per day within 3 months)	x	
	Anticoagulant/Antiplatelet use (including Aspirin) ∞	x	
	Active/Chronic Opiod use		x

All patients require a completed history and physical available in Epic **72 hrs** prior to surgery. Updated 5/13/2021

†Medical Evaluation refers to a preoperative medical or specialty consultation performed within last 90 days

∞ Refer to

PAC = Preoperative Anemia Clinic

Footnotes:

(1) Endoscopy to be done in hospital setting if prescribed CPAP or other sleep device

(2) Preoperative insulin recommendations

(3) ESRD/Renal failure-draw serum potassiumday prior or day of procedure (post dialysis)

REQUIRED TESTING GUIDE - INTERMEDIATE AND HIGH RISK SURGERY AN 'X' INDICATES THAT THE TEST IS REQUIRED FOR THAT PARTICULAR PATIENT		Anesthesia Assessment	†Recent Medical Evaluation	Recent EKG, Echo**, ST**	CBC	BASIC METABOLIC	PT/INR, aPTT	HEPATIC	Hgb A1C	POCT Urine HCG
AGE* & SEX	Female Patients of childbearing potential									12-45 yrs
	75 and over		x		x	x				
MEDICAL CONDITION	Cardiovascular Disease (including arrhythmia), Cerebrovascular Disease, or Peripheral Vascular Disease			x	x	x				
	ANY patient with a history of: 1. Cardiac stent(s); 2. EF <40%; 3. CHF; 4. Pacemaker or Defibrillator; 5. Severe Valvular Disease; 6. Complex Congenital Heart Disease; 7. Active symptoms	x	x	x**	x	x				
	Poor Exercise Tolerance	x	x	x**						
	Pulmonary Diseases (COPD and Emphysema) **(See Footnote #1)**			x	x	x				
	Severe COPD, pulmonary hypertension or recent pulmonary exacerbation requiring hospitalization in past 6 months, or on home oxygen	x	x	x**	x	x				
	History of obstructive sleep apnea or current use of CPAP or BiPAP **(See Footnote #2)**			x		x				
	Diabetes, oral meds only			x		x			x	
	Diabetic requiring insulin therapy OR A1c≥ 8 OR Glucose >180 on non-fasting BMP **(See Footnote #3)**	x	x	x		x			x	
	Morbid Obesity with BMI >50			x		x				
	Hepatic disease (hx/current hepatitis, cirrhosis, alcohol abuse) **(See Footnote #4)**	x	x	x	x	x	x	x		
	ESRD/renal failure **(See Footnote #5)** or renal insufficiency (Creatinine >2mg/dL)		x	x	x	x				
	Bleeding Disorder (Acquired or Congenital Abnormality)	x	x		x		x			
	Malignancy - chemotherapy within last 6 months **(See Footnote #4)**	x	x		x	x		x		
	Hypertension on 2 or more meds		x	x		x				
	Recent (< 4weeks) illness, difficulty swallowing, dysphagia, dyspnea	x	x							
	History of anemia (Hgb level < 12g/dL)	refer to PAC			x*					
	History of anesthetic complications or concerns	x								
MEDICATION	Diuretic Use					x				
	Steroid Use (>20mg of prednisone per day within 3 months)		x			x				
	Active/Chronic Opioid or Suboxone Use	x								
	Anticoagulant/Antiplatelet use (including Aspirin) ∞ **(! ONLY COUMADIN REQUIRES PT/INR)**		x		x		!			

All patients require a completed history and physical available in Epic **72 hrs** prior to surgery. Updated 5/13/2021

For patients who have no changes in their medical condition, laboratory results are acceptable for **90 days** unless abnormal or patient is in renal failure. EKG is valid for 12 months unless recent change in clinical status.

†Recent medical evaluation refers to a medical or specialty evaluation performed within last 90 days. **Does NOT need to be procedure specific and does NOT need to indicate "Clearance".**

**If available. Echo and stress test are acceptable for 2 years unless clinical status changes are noted.

∞ Refer to N

PAC = Preoperative Anemia Clinic , * Blood draw for iron studies

Footnotes:

(1) For active, acute processes such as COPD exacerbation, recent pneumonia, dyspnea, tachypnea, or malignancy in the thorax consider Chest X-Ray

(2) Endoscopy to be done in hospital setting if using CPAP

Appendix B. *Table of Evidence*

Study Citation (Authors & Date)	Study Purpose/Aims	Design/Sample/ Setting	Intervention/ Improvement	Findings/Author Conclusions	Level based on evidence	Reviewer's Comments (Strengths & Limitations)
Beliveau, L., Buddenhagen, D., Moore, B., Davenport, D., Burton, M., & Duane, T. (2018). Decreasing resource utilization without compromising care through minimizing preoperative laboratories. *The American Surgeon, 84*(7), 1185–1188. https://doi.org/10.1177/000313481808400735	To determine whether implementation of an algorithm aimed at minimizing pe-operative tests resulted in decrease in costs without compromising care	**Design:** pre -post trial **Sample:** - Lab tests conducted between the compared time frames of January 2016 through April 2016 (before intervention) to May 2016 through July 2017 (after intervention). -total preadmission tests ordered - Total laboratory tests canceled were evaluated. **Setting:** A single center county hospital in Texas (John Peter Smith Hospital)	Surgical procedures were divided into 2 groups: low risk procedures that required no testing, and intermediate and high-risk patients who underwent predefined basic lab testing following an algorithm unless otherwise indicated by patient factors.	**Findings:** -There were 22,175 lab tests in the post-intervention group, a decrease of 2.4% and an overall cost savings of $33,032. -The number of patients that needed medical optimization decreased post intervention (3.3% vs. 2.1% p<0.01). -No cases were canceled due to lack of lab information. - The overall lab test cancellation rate was 10.9 per 100 patient visits **Author Conclusions:** using an evidence-based algorithm significantly reduced # of routine preop tests without compromising patient optimization before surgery	Using the GRADE scale, this study would be classified as a **Level III study, but low quality of evidence** Regarding quality of evidence on patient outcomes, there was limited detail about actual patient outcomes, so it is difficult to apply this data to other patient populations	**Strengths:** -A clear study question was asked **Limitations:** -Despite one of the aims of the study being to see if care is compromised when cost is reduced, there was minimal discussion regarding patient outcomes -The focus of the sample size was number of lab tests and not number of patients, which I believe speaks to the fact that cost-savings was the priority area of interest in this study. -"Amount of tests cancelled" was an odd statistic to assess. It was unclear why the tests needed to be "cancelled" instead of "not ordered."

Study Citation (Authors & Date)	Study Purpose/Aims	Design/Sample/ Setting	Intervention/ Improvement	Findings/Author Conclusions	Level based on evidence	Reviewer's Comments (Strengths & Limitations)
Keshavan, V., & Swamy, C. (2016). Pre-operative laboratory testing: A prospective study on comparison and cost analysis. *Indian Journal of Anaesthesia, 60*(11), 838. https://doi.org/10.4103/0019-5049.193678	To look at the relevance of the lab investigations ordered routinely, and their cost implications compared with the National Institute of Clinical Excellence (NICE) guidelines	**Design:** Prospective Study **Sample:** **-**163 patients, majority of which were adults (152), scheduled for elective surgical procedures. -Surgical procedures were equally distributed between Grades 1 & 2 (40%) and 3 & $ (47%). The remaining procedures were neurosurgical and were separately considered per the NICE guidelines **Setting:** A tertiary care center in India- Sakra World Hospital, Bengaluru, Karnataka, India	NICE guidelines were compared to the data of the 163-patient study group to assess what was tests were obtained that were indicated and which were not.	**Findings:** -720 lab tests and 264 instrumental tests were performed. -Of the 163 total patients, only 43 patients or 26% were tested per the guidelines. -515 tests, more than 52% weren't indicated - Unindicated tests that were abnormal were only 1.1%, which amounted to 7 tests. - CXR was abnormal in two patients, but they underwent Grade 3 & 4 surgeries anyway without events - 1 EKG and 1 ECHO were abnormal in one patient each, both patients were young, healthy and ASA status 1, no further interventions were done. -Abnormal lab tests were not clinically correlated - Out of 88 (55%) of patients who had CXR 82 (93%) weren't indicated -For the 515 (52%) of unindicated tests, the total coast was 171,358 Indian Rupees, ($2312.29) **Author Conclusions:** Preoperative guidelines of lab testing in clinical practice could increase efficiency without affecting quality of care. Cost saving can be significant.	Using the GRADE scale, this study would be classified as a **Level IV study with moderate quality of evidence** This is a small sample, prospective study, but the authors used established guidelines to answer their question	**Strengths:** -A clear question was assessed -No patients were lost to follow up -Patients receiving a variety of elective procedures were included in the study **Limitations:** -The sample size was small - There was no control or comparison group -It is unclear how long the patients were followed post operatively to see if there were any adverse events related to the limited testing

Study Citation (Authors & Date)	Study Purpose/Aims	Design/Sample/ Setting	Intervention/ Improvement	Findings/Author Conclusions	Level based on evidence	Reviewer's Comments (Strengths & Limitations)
Nicholls, J., Gaskin, P. S., Ward, J., & Areti, Y. K. (2016). Guidelines for preoperative investigations for elective surgery at Queen Elizabeth Hospital: Effects on practices, outcomes, and costs. *Journal of Clinical Anesthesia,* 35, 176–189. https://doi.org/10.1016/j.jclinane.2016.07.008	To assess the impact of introduction of guideline for preoperative investigations (PIs) on anesthetic practices and costs, and compare their efficacy to current practice	**Design:** Prospective study **Sample:** -Convenience sample -304 total patients, 150 preintervention and 154 postintervention. The mean age of the pre-guideline group was 45.97+- 17.8 years and 45.89+- 21.4 years in the post-guideline group. Male to female ratio was 1:3 in the pre-guideline group vs 1:2,3 in the post-guideline group. Differences were not statistically significant. Both groups had similar comorbid conditions and no statistical significance was found between the number of patients in each surgical specialty ASA, or grade of surgical procedure between the groups **Setting:** Queen Elizabeth Hospital, Barbados	-Introduction of formal guidelines for PIs -Data collection happened in 2 parts 1) January to May 2010 before administration of the guidelines and November 2012 to March 2013 after administration of the guidelines -A questionnaire was given to anesthesia providers. Parameters were: patient demographics, type of procedure, comorbidities, ASA grade -Other data collected: 1. Type of surgery classified into surgical grades and specialty 2. Duration of procedure 3. presence of chronic illnesses 4. Investigations (diagnostic tests) ordered and the level of seniority of the person ordering the tests 5. Impact of each investigation on patient management a) no impact, b) adjustment in medications, c) postponement of procedure, d) referral to another specialty, e) change in anesthetic given, and f) a section for notes or case recommendations	**Findings:** -The mean number of tests decreased from 3.42+-1.8 in the pre-guideline group to 2.89 +- 1.98 in the post-guideline group (p=.042) -The number of CXRs decreased by 14.8% (p=.012) and CBCs decreased by 7.6% (p=.036). -it was observed that the mean number of tests increased with age p=.000 - The highest percentage of abnormal results was with ECGs -When tests were done despite not being indicated in the guidelines, the percentage of abnormal results ranged from 0-18%. However, the results appeared to have no impact on the anesthesia management -The implementation of guidelines saved $7589 per 1000 patients (equivalent	Using the GRADE scale, this study would be classified as a **Level III, moderate quality study, but with a low quality of evidence**. Since the study did not control for type of surgery performed conclusions based on the findings are difficult to interpret. Additionally, due to the convenience sampling, results could have been "cherry picked."	**Strengths** -Authors addressed a clearly focused question **Limitations** -Convenience sampling used- the authors state in their paper "the findings may not be representative" -The authors did not control for type of surgery performed. -as far as the discussion of cost reduction, I am unsure of the payor system in Barbados (i.e., socialized medicine vs. private payors) compares to that of the United States. However, it can be assumed that overall, less testing= less cost to the institution/patient -The majority of procedures patients underwent in the study were OBGYN procedures

			-Guidelines were developed for the preop testing by Anesthesia, the ICU, and review of international guidelines. The guidelines were disseminated, and providers were educated	to $40,745.50 per year) **Author Conclusions:** The introduction of guidelines reduced the amount of PIs, but further change is desired, Cost to the institution was decreased without compromising patient safety		

Study Citation (Authors & Date)	Study Purpose/Aims	Design/Sample/ Setting	Intervention/ Improvement	Findings/Author Conclusions	Level based on evidence	Reviewer's Comments (Strengths & Limitations)
Riggs, K. R., Berger, Z. D., Makary, M. A., Bass, E. B., & Chander, G. (2017). Surgeons' views on preoperative medical evaluation: A qualitative study. Perioperative Medicine (London, England), 6, 16. https://doi.org/10.1186/s13741-017-0072-5	To assess and explore surgeon's practices and beliefs about preoperative medical evaluation (PME)	**Design:** Qualitative Study **Sample**: 18 surgeons- diverse in practice type, education, surgical specialty, gender, and experience level - Women were oversampled - potential participants were contacted with the assistances of Johns Hopkins Clinical Research Network -participants were given monetary incentive (amount not disclosed) - interviews took place in person, typically in their own offices **Setting:** Baltimore, Maryland June 2015-May 2016	-semi-structured interviews with 18 surgeons in Baltimore, MD -interview guide developed by the paper authors and revised as interviews took place to include additional topics that arose -interviews audio recorded and transcribed -interviews analyzed using conventional thematic content analysis for theme identification -a codebook of descriptive codes was developed by the authors during transcript review and then the transcripts were coded using textual analysis software to assess for themes -the first author conducted the interviews (Riggs) -transcripts were re-coded after initial analysis so supporting/opposing instances of the theme	**Findings:** -15 themes: practice variation, benefits/harms of PME to patients, surgical risk assessment, drives of practice -split on preference b/t PCP vs anesthesia conducting the evaluations vs both -some surgeons want specialist consults but didn't necessarily wait for results before surgery -PME only benefits a minority of patients -harms of PME generally downplayed -surgeons don't use risk scoring -decr of malpractice risk by doing PME -satisfying hospital requirements via PME **Author Conclusions:** Large amount of variation of PME. Overuse is a concern but PME is considered beneficial to patients. Surgeons want more input on PME, and PME should be more standardized	Using the GRADE scale, this study would be classified as **Level V study with Moderate Quality of study evidence** as it qualitative research but had reliable data	**Strengths:** -the IRB at Johns Hopkins approved the study -reliability of data as it was coded by 2 team members -large sample for a qualitative study **Limitations:** -amount participants were compensated was not disclosed -surgeons were all sampled from the same geography -possible implicit bias by avoiding focus of interviews on low-value care

Study Citation (Authors & Date)	Study Purpose/Aims	Design/Sample/ Setting	Intervention/ Improvement	Findings/Author Conclusions	Level based on evidence	Reviewer's Comments (Strengths & Limitations)
Santos, M. L., & Iglesias, A. C. (2017). Impact of using a local protocol in preoperative testing: Blind randomized clinical trial. *Revista Do Colégio Brasileiro de Cirurgiões, 44*(1), 54–63. https://doi.org/10.1590/0100-69912017001015	To evaluate the impact of using a preoperative testing request protocol in order to reduce the number of changes in the anesthetic management plan and on perioperative complications	**Design:** Randomized blinded clinical trial **Sample:** N= 405 patient candidates for elective surgery randomly divided into two groups that differed in how preop exams were ordered. Routine group (RG): n=204, who requested diagnostic exams before a Preoperative Evaluation (POE) Protocol group (PG): n=201, who had diagnostics requested after a POE visit according to the Preoperative Exam Request Protocol (based on guidelines from the American Society of Anesthesiologists Task Force) **Setting:** Gaffree and Guinle University Hospital in Rio de Janeiro, Brazil	-On the day of the patient's surgery, once they were discharged from the post-anesthesia recovery room, patients were evaluated by an anesthesiologist to record the following parameters: **Outcome 1)** alteration in surgical anesthetic management due to absence of or abnormal results of preoperative exams **Outcome 2)** complications during the procedure or perioperative period (including hypotension, cardiac arrythmia in a patient without history of an arrhythmia or worsening of a preexisting disorder requiring treatment, hypertension, cardiac/respiratory arrest, hypoxemia, laryngospasm, bronchospasm, thoracic stiffness, residual neuromuscular blockade, difficult intubation, shock, nausea/vomiting, inadequate pain control, prolonged awakening, agitation , hypoglycemia, and total/partial block failure	**Findings:** -There were 1428 diagnostics in the RG and 601 in the PG p=0.001. -14.9% of the results were abnormal in the RG and 29.1% of the results were abnormal in the PG. -The PG underwent 57.3% less testing that the RG for all types of studies (including blood tests, CXR, EKGs) -There was also a "supplementary exam" category of testing based of the patient's medical history. The PG underwent more exams for this category than the RG. -A total of 7 surgical plans (1.8% of operations) were changed as a result of absence of or abnormal preoperative tests. 5 of these cases were in the RG (2.5%) and 2 cases in the PG (1%) p=0.231. -change in the surgical plan was 8.48 times	Using the GRADE scale, this study would be classified as a **Level II study, moderate quality of evidence and strong recommendation** for using this intervention. The results are consistent. Since it is a blinded study, there is no apparent reporting bias	**Strengths** -This is a strong study because it is a randomized blinded clinical trial -There was no statistically significant difference between the RG and PG regarding gender, age, associated diseases, MET, ASA, surgery size, and type of anesthesia -No participants were lost to follow up **Limitations:** -More research needs to be done regarding the actual exams that are necessary preoperatively. -Because this is a study from a Spanish speaking country, some of the language used is hard to decipher in the context of the study -There is a large confidence interval for assessment of surgical plan changes surrounding abnormal coagulation studies (OR=30.28, 95% CI= 5.17-177.55). Thus, it is difficult to interpret these results. When the data is assessed in the authors' tables, it appears that there were an equal amount of surgical plans changed based on both normal and abnormal coagulation results.

			Variables studied: -total number of exams requested -number of exams with abnormal results -number of exams additional to the protocol -difference in number of tests between the groups	higher for abnormal CBC vs normal CBC -change in surgical plan was at an even higher rate for abnormal coags (OR=30.28, 95% CI= 5.17-177.55). -Frequency of complications was 58 cases in the RG (28.43%) and 54 cases in the PG (26.86%), p=0.658 -There was an increase in the risk estimates when comparing associated diseases and hypotension- an increase in number of diseases put patients at higher risk of hypotension (OR=3.51, 95% CI= 1.41-8.73). -There was also a positive association between ASA and other cardiovascular complications (but these values were not statistically significant) -However, patients with more associated diseases with a MET's </ 4 were 3 times more likely to have complications when compared to those in		

				that disease group with a MET's >4 -The authors' found that lower the ASA score the less tests obtained in both groups **Author Conclusions:** The protocol eliminated excess testing and changes to the anesthetic plan without an increase in morbidity or mortality		

Study Citation (Authors & Date)	Study Purpose/Aims	Design/Sample/ Setting	Intervention/ Improvement	Findings/Author Conclusions	Level based on evidence	Reviewer's Comments (Strengths & Limitations)
Sui, W., Theofanides, M. C., Matulay, J. T., James, M. B., Onyeji, I. C., RoyChoudhury, A., & Rutman, M. (2016). Utilization of preoperative laboratory testing for low-risk, ambulatory urologic procedures. *Urology, 94*, 77–84. https://doi.org/10.1016/j.urology.2016.03.053	To evaluate the impact of preoperative laboratory testing on postoperative complications in patients undergoing low-risk ambulatory urologic procedures	**Design:** Retrospective Cohort Study **Sample:** - 7378 patients >18 years old gathered via CPT codes from 2005-2013 who underwent a variety of urologic procedures (grouped as scrotal surgeries, sling procedures, and transurethral procedures) -Patients who received a preoperative lab test were compared against those who did not. - Excluded patients operated on in the prior 30 days and emergency procedures - Excluded patients with ASA Class 4 or 5, chemo/radiation recipients, pts on dialysis, ventilators, SIRS, sepsis, cancer, wound infections. **Setting:** American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database	- Independent variables: serum chemistry, hematology, coagulation, liver function tests - Univariate analyses were used to test for differences amongst patient demographics, comorbidities, and postoperative complications - Multiple logistic regression analysis was used to identify predictors of lab testing use and to predict postoperative complications - Primary outcome= 30-day postop morbidity (as defined by the NSQIP database) including but not limited to DVT, pneumonia, AKI, stroke, MI, coma, unplanned intubation.	**Findings:** -Utilization of preoperative testing ranged from 67.7% (scrotal surgeries) to 74.8% (sling procedures), and 85.8% in transurethral procedures. - More testing done for: older, more obese, ASA III, more comorbidities, and those with bleeding disorders - Total complication rate was 2.9%; the most common complication: UTI - No significant difference between 30-day morbidity (p=.167), mortality (p=.275), deep incisional surgical site infections (p=.382), or readmissions (p=.633) between the two groups - Operative time was longer 53.9 vs 50.4 min p=.004 for the pre-op testing group	Using the GRADE scale, this study would be classified as **Level IV study with Moderate Quality of study evidence** as over 7000 patients were sampled from a national database and results were statistically significant.	**Strengths:** - Authors addressed a clearly defined question - Large sample size - Data is from the NSQIP database **Limitations:** -Limited to Urological Surgery procedures -Sample population excluded many chronically ill patients, which may have skewed the data more favorably.

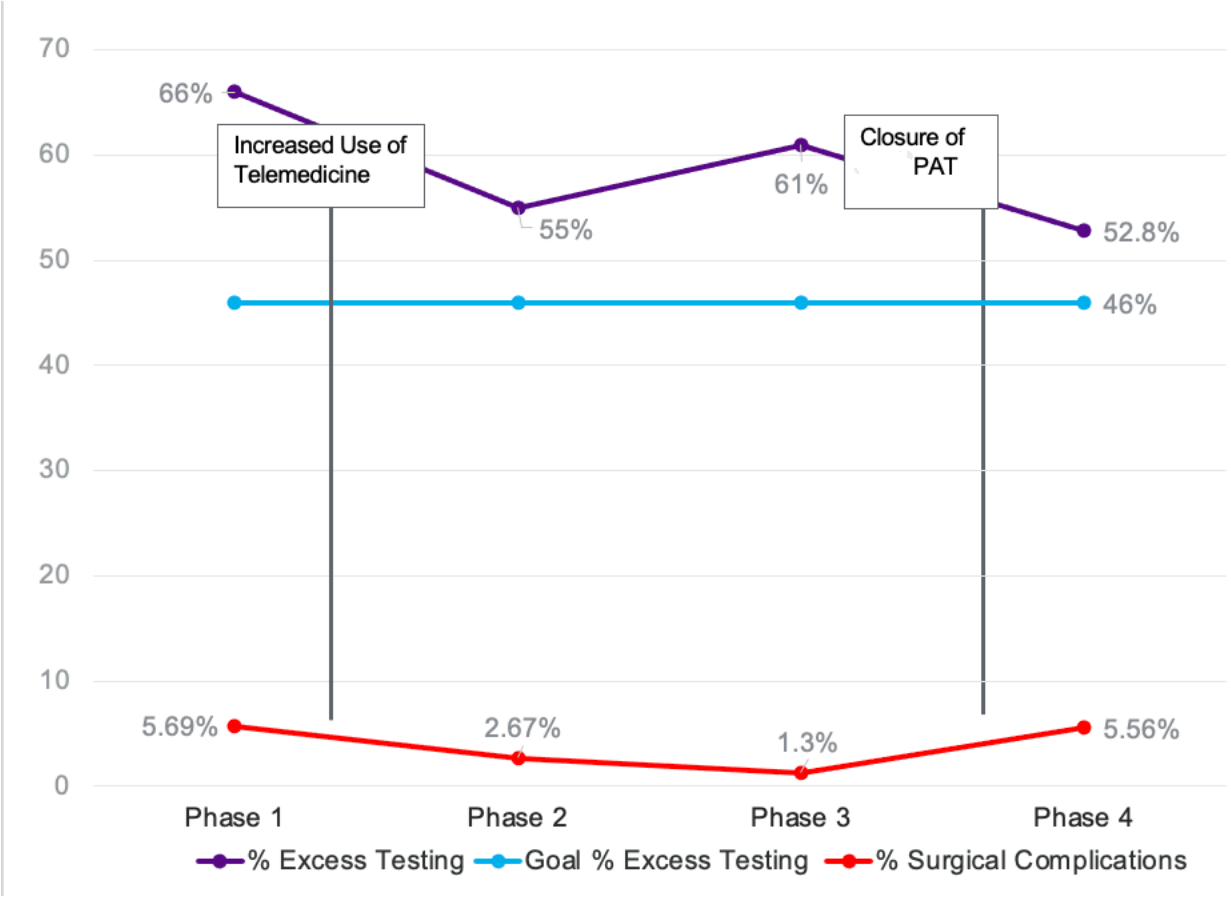
				Author Conclusions: For low-risk ambulatory urologic surgeries, the utilization of preoperative laboratory testing didn't show benefit in regard to acute postsurgical complications. Abnormal lab values did not significantly increase complication risk.		

Appendix C. *Implementation Outline*

Activity (based on OMRU)	Step and Function	By and To Whom	How and Where	When	AME
Research Informed Innovation	Literature review of evidence-based guidelines	DNP Student performed the search and presented to DNP team	Literature searches via PubMed, CINAHL, Cochrane databases	Fall/Winter 2020	Reviewed findings with professors and DNP team
Identify Key Individuals Required to Make the Change	Consulted with key stakeholders about the project and goals	DNP student conducted meetings and report back to DNP team	Meetings via Zoom and WebEx	Fall 2020, Winter & Spring 2021	Updated DNP team and arranged follow up meetings with stakeholders as needed
Assessment of the Practice Environment	Site visit to PAT, met clinician stakeholders and understood their workflow Reviewed pre intervention data	DNP Student performed site visit and data review report back to DNP team	In person at clinical site Data from PAT in excel format regarding preop testing (1 month data set-February 2019 data)	Fall 2020 Summer/Fall 2021	 Updated DNP team and stakeholders once completed
Implementation	EMR changes Webinars with Surgeon Scorecard	Perioperative Services Department and IT DNP Student created presentation gained feedback from DNP Team	Changes made in Epic Testing protocol and rationale presented to surgery staff through a total of 9 Webinars via Zoom	Fall 2021 Late Spring/Early Summer 2022	Gained staff feedback Gained staff feedback, engaged clinical leadership

Monitoring/Adoption	Reviewed post-intervention data Repeat surgeon scorecard	DNP Student performed data review and created new surgeon scorecard, reporting back to DNP team and stakeholders	Data set from PAT in excel format regarding preop testing from 2 weeks in June and July 2022	Summer 2022	Process completed in June and repeated in July after gaining stakeholder feedback
Evaluation of the impact	Met with stakeholders and gained their feedback Set up long-term data review or compliance plan	DNP student conducted meetings and reported back to DNP team	Zoom	Summer 2022	

Appendix D. *Evolution of Testing During Project*



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NYU RORY MEYERS COLLEGE OF NURSING

Kimberly S. Glassman, PhD, RN, NEA-BC, FAONL, FAAN
Senior Associate Dean of Academic Affairs
Clinical Professor

April 14, 2022

Dear Alexandra Hawkins,

I have reviewed your project, Limited Preoperative Testing and Its Effect on Surgical Outcomes: Implementing an Evidence Based Testing Protocol, and it does not meet the federal requirements for research requiring human subject's protection, and does not require IRB review.

Findings from projects that are not deemed research involving human subjects *may be published.* Should a journal request information on IRB status, the following statement may be included: **Based on Federal Regulations 45 CFR 46.102, which provides the statutory definitions that guide human subjects research, this project is not considered research involving human subjects and hence does not require IRB review.**

You are approved to conduct your quality project at NYU Rory Meyers College of Nursing, under your faculty chair supervision.

Sincerely,

DocuSigned by:
Kimberly S Glassman
0FB79DA97072458...

Kimberly S. Glassman, PhD, RN, NEA-BC, FAONL, FAAN

cc: S. Clarke
A. Moynihan

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