4-2015

Assessment Of The Preoperative Assessment: A Case Study

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Anticipated Date of Graduation August 21st 2015

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Keywords: Anesthesia Preoperative assessment, cardiovascular, respiratory, renal, frailty

The geriatric population defined as individuals 65 years of age or older is expected to increase to 20% of the total population by the year 2020.[1] This population currently makes up one-third of the surgical population and is projected to double by 2020.[2] The perioperative risks for this population are also increased and pose significant increases in morbidity and mortality. The need for a detailed preoperative assessment is crucial in any surgical patient. It is increasingly imperative for the geriatric surgical patient as assessment is vital for the surgical team to make decisions regarding the projected necessity, plan and desired outcome for a given surgery.

Case Report

A sixty seven year old female presented for elective right total knee arthroplasty (TKA) for knee degenerative joint disease that did not responded to conservative treatment. The patient weighed 61 kg, and was 137 cm tall with a BMI of 31. The patient had a history of kyphoscoliosis (with surgical repair as a child) with severe restrictive and obstructive lung disease. The patient was oxygen dependent on three liters nasal cannula during the day, and four liters at night with additional use of non-invasive positive pressure ventilation (BiPAP). A recent pulmonary function test showed a forced expiratory volume in one second (FEV1) of 0.68 and forced vital capacity (FVC) of 0.87. Consultation done with her pulmonologist indicated increasing levels of night time BiPAP pressures, and that tracheostomy might be considered in the near future due to repeated respiratory failure. A preoperative blood gas revealed a pH of 7.47, pCO2 of 55, PaO2 of 42 and HCO3 of 40, identifying a partially compensated metabolic alkalosis, secondary to chronic respiratory acidosis. A recent echocardiogram revealed pulmonary hypertension, an ejection fraction of 65%, and right ventricular (RV) overload with a RV systolic pressure of 64 mmHg. The patient was also medically managed for hypertension and hyperlipidemia. Preoperative consultation with anesthesia noted that the patient was expected to have a prolonged postoperative period, which could include an intensive care stay, intubation and vasoactive agents for blood pressure control. The surgeon had requested from the anesthesia team that the TKA be done under spinal anesthesia with Monitored Anesthesia Care for sedation. On the day of surgery the Anesthesia Care Team (ACT) decided that given the patients comorbid state, the likelihood of major postoperative complications would be extremely high. The ACT discussed these concerns with the patient and it was decided by the team and the patient to cancel the surgery. The following day the patient was brought to the Emergency Department after

suffering a fractured right ulnar after opening the trunk of an automobile. Surgery was needed to reduce and fixate the fracture and was subsequently done four days later under the use of an axillary and supraclavicular block without sedation. Although the patient did suffer some alteration in breathing (as noted by subjective complaints from the patient as mild shortness of breath) second to phrenic nerve involvement of the regional anesthetic, the postoperative course was otherwise uneventful and the patient was discharged the following day. At the time of writing this case study, the writer has no knowledge of reconsideration of TKA for the above mentioned patient.

Discussion

The need for elective vs. emergent surgery obviates differing decision making in planned surgical and anesthesia care. None the less, it does not change the need for a thorough preoperative assessment. Within the context of the preoperative assessment, there are currently no concrete current guidelines for the provider to weigh relative risk vs. benefit of elective surgery. Certain risk factors, however, have been shown to predict postoperative complications in non-cardiac surgery patients. These assessments are grouped into a body system approach (i.e. respiratory, cardiac, and renal) however other indicators outside a body system approach have emerged in the literature. Within the scope of this case study the major body systems evaluated are respiratory, cardiac and renal. However, pertinent to this case study, are preoperative assessments regarding functional dependence and frailty.

The American College of Physicians guideline for preoperative assessment of postoperative pulmonary complications (PPC's) have identified age greater than sixty-five, obstructive lung disease, congestive heart failure, decreased functional dependence and increased American Society of Anesthesiologists (ASA) score as independent risk factors for PPC's.[3] Interestingly, sub-optimal spirometry levels have not been shown to increase perioperative complications and no threshold exists to definitively obviate risk for a particular surgery.[3] Low levels of albumin (<36g/L) have also been shown to be an important predictor of postoperative pulmonary complications showing increased 30-day morbidity and mortality in the non-cardiac surgery population. [3]

Preoperative cardiovascular assessment is also crucial in the evaluation and proper risk stratification of patients undergoing non-cardiac surgery. Currently, the American College of Cardiology and the American Heart Association's (ACA/AHA) 2007 guidelines are used to screen surgical patient's preoperatively.[4] Within these guidelines, known and possible coronary artery disease is evaluated. The presence of one or more of the following risk factors is considered reason to cancel elective surgery, those being unstable angina, recent (< than 6 months) myocardial infarction, decompensated heart failure, significant arrhythmias and severe valvular disease.[4] With the use of a cardiac stress test, the guidelines approach assessment of perioperative risk by evaluation of possible ischemia, which is graded into risk categories from low to high.[4] Generally, hypertension, congestive heart failure, cardiomyopathy, valvular disease, arrhythmias, conduction defects, pacemakers and pulmonary-vascular disease are associated with increased morbidity and mortality within the surgical patient and their presence should guide further detailed assessment.[4] The guideline uses a 5 step algorithm for evaluation of surgical cardiac risk using both risk factors and proposed surgery in the decision tree analysis.[4]

Preoperative renal risk assessment literature has largely centered on cardiovascular surgery, however some studies have focused on general surgery. Most notably the Acute Kidney Injury Network (AKIN) has implemented standard definitions for acute kidney injury in the postoperative period which has helped to frame ongoing reserach.[5] Several independent risk factors for AKI in general surgery have been identified in the literature; those being a higher body mass index, diabetes mellitus, the number of baseline antihypertensive medications, vascular disease, general anesthesia, and perioperative blood transfusions.[6]

Although a systems approach is the mainstay of the preoperative assessment, there is much research that points to other indicators and scales to assess postoperative outcomes. These indicators include preoperative cognition, functional independence in activities of daily living (ADL), nutrition, medication, social support and continence.[7] The Edmonton Frailty Index, (a ten point frailty questioner) has been successful in predicting post-operative complications, increased length of stay and an inability to be discharged back to independent living in a small cohort of geriatric orthopedic surgical patients.[8]

With regards to the case study discussed, the patient was clearly at risk for perioperative pulmonary complications based on her respiratory assessment and a likely an unknown frailty index. Her risk for cardiac complications however could not be weighed accurately in the current application of risk indicators as the research does not consider right heart failure in the assessment. Although research has shown less postoperative complications with spinal anesthesia compared to general, the patient's kyphoscoliosis and obstructive/restrictive lung disease increased the likelihood of a failed or high spinal which might require conversion to general anesthesia. It is also possible that even an appropriately placed spinal anesthetic could impair accessory respiratory muscle function crucial to the patient's currently already tenuous respiratory needs. It is in the context of this case study that a certain gray area develops with regards to postoperative risk and likelihood of complications, and it is at this junction that the clinician although objective in their assessment might need to subjectively consider the entire picture. With the use of current tools for preoperative risk stratification it is possible to make a less subjective assessment. In the case study mentioned above the risks were fully elucidated to the patient; this also helped the care team's decision to cancel surgery as the patient was, at this point, unlikely to proceed with surgery.

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Elective surgery for the geriatric population is being performed at a growing rate and at an increasing age within the context of cumulative comorbidities of health. Advancements of surgical technique along with safer and more reliable anesthetics have made modern surgery a possibility for many different emergent and elective needs in the aging population. (Harmel et al., 2005). It seems, however, that with an increase in surgical safety there has been a trend to make elective surgeries available to an aging population in which perioperative risks might indeed outweigh the benefits of treatment. Through the use of a thorough preoperative assessment, the clinician (whether that be primary care, surgeon, or anesthetist) is tasked with weighing the risk against the benefits of the proposed surgery, and from that, formulating a plan to proceed. Within this literature review, an assessment of the current research with regards to the preoperative assessment is discussed. Areas within that assessment begin with a body systems approach, focusing on respiratory, cardiac and renal systems. New approaches to preoperative assessments are then mentioned, with emphasis predominantly on patient frailty as a predictor of perioperative complications.

The use of the preoperative assessment in the planning of a surgical procedure is necessary whether the surgery is emergent or elective. In the context of elective surgery, however, time can be used to the clinician's benefit in conducting a thorough assessment that yields information helpful to the planning of an intended surgery. In a systems approach of the preoperative assessment, respiratory function is an important area of focus and has been shown to predict perioperative risk of postoperative pulmonary complications (PPC's) in certain populations. It has been stated that PPC's are the number one reason for in hospital morbidity

and mortality and that through proper assessment and possible modification of risk factors, a benefit to the surgical population can be gained (Sabate, Mazo & Canet, 2014). In the American College of Physicians (ACP) 2006 seminal guideline, the authors note that all patients undergoing non-cardiothoracic surgery should be evaluated for significant risk factors of PPC's such as chronic obstructive pulmonary disease, age over 60, ASA class greater than 2, functional dependence and congestive heart failure (Qaseem, 2006). The guideline also indicated low albumin levels (<3.6g/dL) to be an important predictor of postoperative pulmonary complications and increased 30-day morbidity and mortality (Qaseem, 2006). It is also mentioned that although spirometry is used to evaluate extent of obstructive lung disease, it does not by itself translate into preoperative risk prediction for individual patients. A more recent European based study Canet et al. (2010) found that PPC's such as respiratory infection, failure, pleural effusion, atelectasis, pneumothorax, bronchospasm and aspiration were strongly associated with preoperative risk factors such as a low preoperative SpO2, a less than one month history of lung infection and anemia. Independent surgical related risks were intrathoracic/upper abdominal/emergent surgery, and duration of procedure. These authors found, as did the ACP guidelines, age as an independent risk factor for PPC's. Using the Canet (2010) study as a framework, Mazo et al. (2014) attempted the first externally validated risk score for PPC's in Europe; and found these risk factors successfully determined PPC's in several surgical populations. These authors do mention, however the need for calibration adjustments (based on location) within the tool. The identification of independent risk factors have allowed for development of strategies in which modifiable risks could possibly help to lower PPC's in both cardiothoracic and non- cardiothoracic surgical patients, however at this time research in this area is still lacking (Sabate, Mazo & Canet, 2014).

In the preoperative assessment of the cardiovascular system, much research has been built on the foundations of the 1977 study by Goldman et al. which created the "Goldman Criteria". Within this study it was found that preoperative identifiable risks such as a third heart sound, jugular venous distention, myocardial infarction within six months, >5 premature ventricular contractions, non-sinus rhythm or presence of premature atrial contractions on preoperative electrocardiogram increased the likelihood of perioperative cardiac complications (PCC's). Also included with these risk factors were age greater than 70, intraperitoneal, intrathoracic, aortic or emergency surgery, valvular aortic stenosis and poor general medical health. In 1999, Lee et al. modified and improved the predictability of the Goldman criteria creating the Revised Cardiac Risk Index (RCRI) Score. The RCRI created six independent variables of risk stratification. These variables were high risk surgery, history of ischemic heart disease, history of congestive heart failure, cerebral vascular disease, insulin controlled diabetes and serum creatinine greater than 2.0 mg/dL.

Today, current guidelines for preoperative cardiovascular risk stratification have been built on the Goldman and Lee studies and validated by the American College of Cardiology and American Heart Association's (ACC/AHA) 2002 and later revised 2007 Guidelines on Perioperative Cardiovascular Evaluation and Care for Non-cardiac Surgery. Within the current guidelines the highest risk indicators are now termed active cardiac conditions and contain acute coronary syndrome, decompensated heart failure, significant arrhythmias and severe valvular disease as strong indicators for PCC's (Fleisher et al., 2007). Intermediate risk factors associated with PCC's are history of ischemic heart disease, cerebrovascular disease, diabetes mellitus and renal insufficiency. Minor predictors are age greater than 70, abnormal ECG, non-sinus rhythm and uncontrolled hypertension. Surgical risk stratification is also included in the newest

guideline which tiers high, intermediate and low levels of certain surgeries. With this framework, a five-step algorithm is constructed for the clinicians use to direct proper pre-operative evaluation and direct the surgical process in the context of preoperative cardiac risks (Fleisher et al., 2007).

Newer research is pointing to the significance of diastolic dysfunction in predicting perioperative complications in surgical patients. Implicating the importance of this evidence Aljaroudi et al. 2012 found that weakening diastolic function independently increased all-cause mortality even amongst normal left ventricular ejection fraction. Dong-Hyuk et al (2013) also found an increase in major cardiac and pulmonary complications in non-cardiothoracic surgery when diastolic dysfunction was present. Diastolic dysfunction was presumed on evaluation of an E/e´ > than 15, pulmonary artery systolic pressure > 35 and left ventricular hypertrophy.

Because preoperative cardiopulmonary assessment has been at the forefront of clinical inquiry to a patient's overall risk of surgery, it seems that renal assessment has often been overlooked. Acute kidney injury (AKI) in the postoperative period has been defined by the Acute Kidney Injury Network (AKIN) consensus group as an abrupt (within 48 hours of surgery) reduction of kidney function seen as a 1.5 times increase in serum creatinine from baseline or a less than 0.5ml/kg of urine output in 6 hours (Metah et al., 2007). The AKIN also came to consensus of a three tier staging system (developed from earlier work from the RIFLE study), with stage three being the most severe AKI. AKI in elderly patients is an independent risk factor of in hospital mortality, longer hospital stay, increased utilization of resources and a higher all-cause 6-month mortality (Barrantes et al., 2009).

Current research with regards to preoperative risk factors for AKI is largely procedure focused with much attention on cardiovascular surgery. Smaller numbers of studies have shown

independent risk factors for AKI within the general surgery population. Kheterpal et al., (2009) in a retrospective study (of non-cardiovascular patients) found 9 risk factors for AKI in general surgery. These risk factors were, age greater than 56, male gender, active congestive heart failure, ascites, hypertension, emergency surgery, intraperitoneal surgery, mild to moderate renal insufficiency, and medication controlled diabetes. These risk factors were accompanied in the study with a 5 level risk stratification tool that interpreted % incidence of AKI and hazard ratios based on the number of risk factors a patient had. In a similar retrospective study, Abelha et al. (2009) using multivariate regression analysis found four independent risk factors for AKI in general surgery; those being increased ASA score, Revised Cardiac Risk Index, high risk surgery and congestive heart disease. This research differed from the Kheterpal et al. (2007) study in that it did not include patients with baseline kidney disease (those with a creatinine level over 1.6mg/dL for men and1.4mg/dL for women). More recently, Weingarten et al. (2012) evaluated orthopedic joint replacement patients risk for AKI. Using over 9,000 patients within this retrospective study it was found that body mass index (BMI), diabetes mellitus, hypertension, vascular disease, general anesthesia, and blood transfusions were independent risks for development of postoperative AKI. With the help of the RIFLE and then AKIN studies, definitions and stratification of AKI were made, however, the research guiding current preoperative assessments in certain surgical patients is still developing. Increasing the evidence base of this subject will help guide future research in risk modification for patients at risk for AKI.

Patient frailty is commonly used as an indication of patient aging and or the loss of physiologic reserve. Defined by Kim, Brooks & Groban (2014) it is a “state of increased vulnerability resulting from age-associated declines in reserve and function across multiple

physiologic systems, such that the ability to cope with every day or acute stressors is compromised" (p. 13). Many frailty indexes have been studied which have shown varying predictability in outcomes of geriatric surgical patients. Robison et al. 2011 evaluating predictability of frailty indictors found that a Charlson Comorbidity index greater than or equal to three, a timed get up and go speed greater than or equal to 15 seconds and any functional dependence were closely related to postoperative need of institutionalized care. Other indicators that were used in the study were, ASA score, number of outpatient medicines, hematocrit less than 35%, albumin level < 3.4g/dL, BMI, weight loss greater than 10lbs in the last six month, mini mental exam less than or equal to three, positive depression scale, and number of falls in last six months. Robinson et al. (2013) later evaluated seven of the most significant frailty indicators (timed get up and go speed, independent ADL's, mini mental exam, Charlson index, anemia, low albumin, recent falls) to predict complications in the postoperative period after elective cardiac and abdominal surgery. This study found patients defined as frail (having 4 or more attributes) were 50% more likely than controls to have in hospital complications, as well as longer lengths of stay and 30 day readmission rates (Robinson et al, 2013).

Another commonly used index of surgical risk is the metabolic equivalent of task (MET). MET's and stair climbing have traditionally been used preoperatively to assign postoperative risk of complications in surgical patients. One MET is equal to the basal metabolic rate and is considered 3.5 ml/kg/min of oxygen (Biccard, 2005). Stair climbing although not completely standardized, has been used to measure MET level, where meeting 4 or greater MET's was distinguished as able to climb 2 flights of stairs (Biccard, 2005). A study pioneering its use showed in major non-cardiac (high risk) surgery, the inability to climb two flights of stairs had a

positive predictive value of 82% for postoperative cardiac complications or death within 30 days of surgery (Girish, 2001).

With obvious reference to overall patient frailty, cognition (albeit less studied) has been shown to be a preoperative predictor of postoperative complications. Impaired cognition, or more clinically defined dementia, has been shown to be associated with adverse health outcomes outside of surgery such as pneumonia, febrile episodes, eating problems and a high six month mortality (Mitchel et al., 2009). Less is known about the surgical risk of impaired cognition. Robinson et al. (2012) showed an increase in postoperative complications in patients identified with cognitive impairment (dementia) undergoing elective surgery when compared to non-cognitively impaired controls. This finding was independent of advanced age, a higher cardiovascular disease burden, prior stroke, history of hypertension, and ASA score. Statistically significant endpoints found increased hospital length of stay, discharge to rehabilitative care, 30 day readmission and in-hospital delirium in the cognitive impairment group. Delirium was also found in this study to be an event modifier for time to death, implicating that those with cognitive dysfunction are more prone to delirium thus increasing odds of in and out of hospital mortality (Robinson et al., 2012).

Preoperative cognitive dysfunction was shown by Aykut (2013) to predict PPC's in a prospective cohort control study in patients undergoing elective cardiac bypass surgery. Within the study, the researchers noted that the non-impaired vs. impaired cognition groups shared similar preoperative comorbidities, however the impaired cognition group was less likely to participate successfully in pulmonary toilet and other respiratory treatments, leading to atelectasis and increasing the odds of PPC's (Aykut, 2013). Although the mentioned study was

done on cardiac surgery patients, it would be warranted to evaluate similar studies on other surgical populations with cognitive dysfunction.

The preoperative assessment of the older adult for elective surgery is a crucial first step process to the success of the entire perioperative period and ultimately the future morbidity and mortality of the patient. Even in the most desirable conditions in a planned surgery there are possibilities for unexpected complications to arise. Without appropriate evaluation of the patient, surgery and consideration for the postoperative period, complications can quickly unfold into life changing events within the perioperative period. It is hoped that with proper preoperative assessment, certain measures can be taken to optimize the patients' health status and help to provide the best possible conditions for a specific surgical intervention. Within this literature review a discussion of the major preoperative assessment parameters are explained. Using a body systems approach, cardiac, respiratory and renal preoperative assessment was discussed in context with the growing body of evidence. This literature review then examined the use of frailty in assessing the geriatric adult with mention of preoperative cognition as a risk of postoperative complications. As the body of evidence for population and surgical based preoperative assessment grows and standardizes, it will likely bring new ideas for patient preoperative optimization. With the optimization of certain physiologic body systems it is anticipated that patient surgical outcomes will be positively affected.

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