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Lessons Learned: Using the Caprini Risk Assessment Model to Provide Safe and Efficacious Thromboprophylaxis Following Hip and Knee Arthroplasty

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Abstract

Two of the more common potential complications after arthroplasty are venous thromboembolism (VTE), which includes deep vein thrombosis (DVT) and pulmonary embolus (PE), and excess bleeding. Appropriate chemoprophylaxis choices are essential to prevent some of these adverse events and from exacerbating others. Risk stratification to prescribe safe and effective medications in the prevention of postoperative VTE has shown benefit in this regard. The Department of Orthopaedic Surgery at Syosset Hospital/Northwell Health, which performs over 1200 arthroplasties annually, has validated and is using the 2013 version of the Caprini Risk Assessment Model (RAM) to stratify each patient for risk of postoperative VTE. This tool results in a culling of information, past and present, personal and familial, that provides a truly thorough evaluation of the patient's risk for postoperative VTE. The Caprini score then guides the medication choices for thromboprophylaxis. The Caprini score is only valuable if the data is properly collected, and we have learned numerous lessons after applying it for 18 months. Risk stratification requires practice and experience to achieve expertise in perioperative patient evaluation. Having access to pertinent patient information, while gaining proficiency in completing the Caprini RAM, is vital to its efficacy. Ongoing, real time analyses of patient outcomes, with subsequent change in process, is key to improving patient care.

Keywords

venous thromboembolism, total hip arthroplasty, total knee arthroplasty, aspirin, risk stratification, COVID-19

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Historically, total joint arthroplasty (TJA) was a procedure requiring 3 to 5 days of medical and surgical stabilization in the hospital followed by extended postoperative rehabilitation at a subacute facility. Over the last few years, it has transitioned to an enhanced recovery after surgery (ERAS) process, with discharge to the home occurring within 1 to 2 days. This requires a collaborative team to optimize postoperative recovery and minimize complications. Two of the more common potential complications after arthroplasty are venous thromboembolism (VTE), which includes deep vein thrombosis (DVT) and pulmonary embolus (PE), and excess bleeding. Bleeding events include wound bleeding, hematoma, delayed wound healing, dehiscence, infection, compromised functional

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Table 1. Venous Thromboembolism Outcomes.

Age/ gender	Procedure	Risk group	VTE prophylaxis	VTE/POD	COMMENTS
57 F	Staged TKA	HIGH risk	Enox 30mg q12h after side 1; Apix 2.5mg q12h after side 2	Bilat PE POD1 after side 2	Patient primarily in bed after side 1. Preop Doppler performed Friday before side 2 (Monday)
59 M	Staged TKA	HIGH risk	Enox 30mg q12h after side 1; Apix 2.5mg q12h after side 2	DVT POD2 after side 1	Acute on chronic DVT. Caprini 12 for side 1
71 M	Staged TKA	HIGH risk	Enox 30mg q12h after side 1; Apix 2.5mg q12h after side 2	PE POD2 after side 2	History DVT; Caprini 11 for side 1
85 F	TKA	HIGH risk	Apix 2.5mg q12h	DVT POD3 Bilat PE POD6	Medically unstable; unable to ambulate until POD3
79 F	THA	HIGH risk	Apix 2.5mg q12h	DVT POD7	Patient readmitted with fever and DVT
60 M	THA	LOW risk	ASA 81mg q12h	DVT POD6	Preop hip fracture. Patient should have been high risk.
62 F	THA	LOW risk	ASA 81mg q12h	PE POD54	Pt instructed to separate ASA and Meloxicam but took them together
63 F	THA	LOW risk	ASA 81mg q12h	PE POD22	ASA and Celecoxib administered together at SAR

VTE: venous thromboembolism; POD: postoperative day; F: female; M: male; TKA: total knee arthroplasty; THA: total hip arthroplasty; Enox: enoxaparin; Apix: apixaban; ASA: aspirin; PE: pulmonary embolus; DVT: deep vein thrombosis; bilat: bilateral; preop: preoperative; AKI: acute kidney injury; SAR: subacute rehabilitation center.

outcome, and increased need for allogeneic blood transfusion.[1] Appropriate chemoprophylaxis choices are essential to prevent some of these adverse events and from exacerbating others. Risk stratification to prescribe safe and effective medications in the prevention of postoperative VTE has shown benefit in this regard.[2-4] Horner et al, performed a recent study to identify optimal chemoprophylaxis for patients requiring lower limb immobilization after injury. The authors described an urgent need for research to improve the evidence base with external validation studies looking for customizable tools to guide thromboprophylaxis.[5]

Without prophylaxis the reported rates of VTE were 40-60% after total hip arthroplasty (THA) and 40-85% after total knee arthroplasty (TKA).[6] Incidence of VTE has been profoundly reduced by a wealth of research that have led to effective national guidelines.[1,7] A recent publication by Warren et al, in reviewing VTE data from 2008 to 2016, found the 30-day incidence of VTE to be 0.6% for THA and 1.4% for TKA.[8] However, we are always driven to "chase zero" in an attempt to minimize the burden of these complications which not only increase morbidity and mortality, but are costly in terms of healthcare dollars.[9-11]

The Department of Orthopaedic Surgery at Syosset Hospital/Northwell Health, which performs over 1200 arthroplasties annually, has validated[12] and is using the 2013 version of the Caprini Risk Assessment Model (RAM)[13] to stratify each patient for risk of postoperative VTE. The Caprini score then guides the medication choices for thromboprophylaxis. All surgeons follow one protocol. THA patients scored as high-risk receive apixaban 2.5 mg twice daily for 35 days. TKA patients who score as high-risk receive apixaban 2.5 mg twice daily for 12 days followed by aspirin (ASA) enteric coated (EC) 81 mg twice daily for an additional 4 weeks. All patients classified as low-risk, after THA or TKA, receive ASA EC 81 mg twice daily for 6 weeks. Over the past 5 years, we have reduced the ASA dose from 325 mg twice daily, to 162 mg twice daily, and finally to 81 mg twice daily. Risk assessment has allowed us to confidently reduce the dose of ASA in low-risk patients to 81 mg twice daily based on published outcomes.[14-16] Patients report improved gastrointestinal tolerability with ASA EC 81 mg twice daily compared to the higher doses previously prescribed.

The Caprini score is only valuable if the data is properly collected, and we have learned numerous lessons after applying it for 18 months. First and foremost, a detailed personal and family history of thrombotic events in the patient or any relative is vital to this end.[17] Patients at our institution complete a patient-friendly version of the Caprini RAM in pre-surgical testing (PST), and are then further questioned if they indicate personal or family history of any known risk factors.[18] Simultaneously, well-trained clinicians complete the Caprini RAM, utilizing information from the history and physical performed in PST as well as the medical clearances required prior to surgery. BMI is accounted for only after the patient is weighed in the preoperative area on the day of surgery. The result is a culling of information, past and present, personal and familial, that provides a truly thorough evaluation of the patient's risk for postoperative VTE. This generates a Caprini score which allows us to assign the patient to low-risk (Caprini score < 10) or high-risk (Caprini score ≥ 10).[12] In 2019, 53% of our patients were low-risk and 47% of patients were high-risk.

Every member of the team, including surgeons, nurses, hospitalists, orthopaedic physician assistants, physical and occupational therapists, has been educated concerning the risk factors that could alter a patient's score. Specifically, during hospitalization, this includes blood transfusion,[19,20] inability to ambulate at least 30 feet continuously,[21] and placement of a brace that impedes contraction of the calf muscles during ambulation.[5] The team is fully engaged in this process and each

health care professional has been instrumental in identifying and communicating added risk factors to ensure the score is adjusted appropriately. Risk assessment continues from hospitalization to the home, by partnering with the surgeons' offices, since any additional risk factor(s) can change the patient's score and potentially alter the thromboprophylactic regimen during the 6 weeks after surgery.

We maintain a prospective joint arthroplasty registry for all surgical candidates. In addition, all patients are called 60 days after surgery to capture outcomes, both negative and positive. For the calendar year 2019, we identified 8 postoperative VTEs (Table 1). Since implementation of risk assessment with the 2013 Caprini RAM in mid-2018, our skill in assessing patients to prevent postoperative thrombosis has improved dramatically. We credit this to the utility and validity of the Caprini tool.

Three of the 8 postoperative VTE occurred in staged, bilateral patients. These patients underwent a total knee arthroplasty on the day of admission, remained in the hospital, and 5 days later underwent a contralateral second total knee arthroplasty. All patients received enoxaparin 30 mg subcutaneously q12 h beginning the morning of postoperative day (POD)1 with discontinuation after the morning dose on the day prior to the second surgery. All patients received a doppler of the lower extremities to rule out DVT prior to the second surgery. Of the 3 patients with postoperative VTE, 1 was not ambulating sufficiently after the first surgery, and bilateral PEs were identified on POD1 after side 2. This led immediately to a protocol revision; patients must ambulate at least 150 feet and be cleared by physical therapy to proceed with side 2. If this is not the case, the second surgery is canceled and rescheduled for a later date. The other 2 patients both had a personal history of DVT and developed a VTE (1 DVT, 1 PE) on POD2 after the second surgery. Again, the joint arthroplasty protocol was revised to contraindicate staged procedures in patients with a Caprini score of 10 or greater for the first surgery. If the patient requires bilateral arthroplasties, the surgeries are scheduled at least 3 months apart.

The remaining 5 patients were unilateral surgeries. Two were risk stratified to high-risk and 3 to low-risk. Both high-risk patients were older females (79 and 85 years of age). One was readmitted on POD6 with a fever and found to have a DVT. The other patient developed severe postoperative acute kidney injury and was bedridden for 3 days until she was medically stable to ambulate. Both patients received apixaban combined with mechanical prophylaxis (intermittent pneumatic compression) during hospitalization for prevention of VTE.

Of the low-risk patients, one was identified as having been diagnosed with a preoperative fracture that was not communicated to the team and was not captured in the Caprini score. This would have ranked the patient as high-risk rather than low-risk, which would have changed the thromboprophylaxis regimen. The surgeons were alerted that this was important historical information for risk stratification, and this further advanced our skill in stratifying patients.

Finally, 2 of the low-risk patients took the ASA prescribed for VTE prophylaxis and the NSAID, used for multimodal pain management (celecoxib 200 mg twice daily, meloxicam 15 mg once daily), together. We did not identify this drug interaction, whereby the NSAID may cause competitive inhibition of ASA at the platelet receptor site, until we reduced the dose to 81 mg twice daily.[22] Also referred to as a potential cause of "aspirin resistance,"[23] this interaction had been reported with traditional NSAIDs but not with cyclooxygenase (COX)-2 inhibitors.[24-27] A robust literature search revealed a drug interaction between ASA and higher-dose NSAIDs that possess greater cyclooxygenase (COX)-2 activity.[28-30] This interaction, however, was not found to occur when studying ASA in doses greater than 100 mg.[26,31] Thus, ASA is now administered at least 2 hours prior to celecoxib or meloxicam in the hospital. Additionally, our patients are fully educated about this drug interaction. All patients are provided with a personalized medication calendar upon hospital discharge to assist with medication compliance as well as safe timing of drug administration. To date, we have not had any further VTE events in this low-risk group.

The authors believe that appropriate thromboprophylaxis following total joint arthroplasty is optimally managed through risk stratification. It is not best addressed with a one-size-fits-all approach. Validation and acceptance of a risk stratification tool in the arthroplasty population is still controversial within the orthopaedic community. The goal is to create a process that is accurate, reproducible, and time efficient. Multiple attempts at creating a risk stratification tool have been published in the orthopedic literature. Mantilla et al, sought to create a targeted approach to thromboprophylaxis following TJA. Although they identified multiple factors associated with increased incidence of VTE, the quality of the data was solely dependent on the accuracy and completeness of medical records and information available through an institutional total joint registry.[32] Parvizi et al, also recognizing the advantages of a strategy to individualize anticoagulation choices based on patient stratification, identified several risk factors for postoperative PE.[33] The study identified comorbidities using ICD-9 codes, which are not always accurate, and only recorded PE if it was diagnosed at their own institution. In a subsequent publication, Parvizi et al, used the Nationwide Inpatient Sample (NIS) database, extracting diagnoses with ICD-9 codes to create a VTE estimator application; endpoints included only in-hospital VTE, and the study did not delineate the type of chemoprophylaxis used.[34] Bohl et al, developed a risk stratification system to identify risk of PE following TJA using the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP), a surgical registry, to capture patient clinical data.[35] The study included only 30-day followup, contained no history of VTE or thrombophilia (information not captured by the registry), and risk stratification was determined without knowledge of the chemoprophylaxis administered. The authors noted that their stratification system was "optimal for use in patients without severe risk factors" in a "standard-risk" population.[35] Bateman et al, tested the Caprini RAM in 363 arthroplasty patients and determined it was not clinically useful; the authors

Table 2. Performance Improvement Initiatives.

VTE occurrence	Performance improvement
Patient not ambulating sufficiently after side 1 of staged bilateral procedures	Patient must be ambulating 150 feet and cleared by physical therapy before surgeon may proceed with side 2
Preoperative finding of hip fracture prior to scheduled THA	Team educated that fracture increases risk of postop VTE and Caprini score and must be communicated
Low risk patients taking ASA EC 81mg q12h concurrently with NSAID	Patients given explicit instructions to take ASA 81mg at least 2 hours before NSAID to maintain ASA efficacy

VTE: venous thromboembolism; THA: total hip arthroplasty; ASA EC: aspirin enteric-coated; NSAID: nonsteroidal anti-inflammatory drug; postop: postoperative.

reported that the tool was completed accurately in only 7% of patients studied.[36] Kulshrestha and Kumar performed a randomized study looking at routine anticoagulation versus risk screening using their own risk assessment tool which was very similar to the Caprini RAM. They assigned a score equivalent to 7 as their cut-off for high risk. Although they found no difference in incidence of VTE, they identified a statistically significant increase in wound complications in the routine anticoagulation group (8.4% versus 4.4%; RR 1.9 [1.1 to 3.2]).[37] Finally, Warren et al, also used the NSQIP database to identify annual trends of VTE and mortality between 2008 and 2016 following joint arthroplasty; they specifically reported that although their analysis included several factors identified by the Caprini scoring system, it was also deficient in capturing other well-known variables such as patient history and/or family history of VTE, and genetic coagulopathies.[8]

Choosing appropriate chemoprophylaxis for VTE is a balance between efficacy and safety in order to optimize patient outcomes. It requires practice and experience to achieve expertise in perioperative patient evaluation. We credit the implementation of the 2013 Caprini RAM for these lessons learned, which have resulted in revisions to our protocols. Over the past 18 months, after implementing this process of risk stratification in prescribing VTE prophylaxis after TJA, every incidence of DVT or PE has been analyzed, and has led to protocol revisions with subsequent improvement in outcomes. If a patient is scheduled for staged, bilateral surgeries they must now be ambulating sufficiently and cleared by physical therapy before the second surgery is performed. Additionally, any patient who is deemed high-risk for VTE for the first surgery (each surgery adds 5 points to the Caprini score) will not be considered a candidate for staged procedures. Surgeons have been educated that if a patient who scheduled for elective THA is found to have a fracture prior to surgery, the team should be informed so the patient can be more accurately risk stratified. Finally, a significant drug interaction between ASA EC 81 mg and high-dose celecoxib or meloxicam was identified upon dose reduction of ASA EC from 162 mg to 81 mg. Comprehensive patient education in describing the importance of taking ASA at least 2 hours prior to the NSAID to maintain ASA efficacy is performed prior to discharge; no further incidence of VTE in patients taking these 2 medications concurrently has been identified since intensifying this educational component (Table 2).

The discussion of lessons learned must also address the importance of critical thinking and clinical judgment. The Caprini RAM, like any other risk stratification tool, provides guidance for prescribers. If it is determined that a patient would receive greater benefit from one regimen compared to another, this should ultimately drive practice. An example of this is a patient who had an undiagnosed patent foramen ovale (PFO) and subsequently developed a stroke with a paradoxical VTE after arthroplasty. Since then, any patient with a diagnosed PFO is considered high-risk and receives oral anticoagulation postoperatively regardless of their assessed score.

Individual risk assessment for thrombosis related complications has never been more important than during the Coronavirus pandemic. The Caprini RAM is a dynamic tool, requiring ongoing evaluation of the patient during the postoperative period.12 Patients with a previous history of Coronavirus infection should not be considered for surgical procedures for at least 3 months unless the surgery is considered urgent. Patients with active Coronavirus disease who require urgent surgery have a 50% chance of developing a postoperative thrombotic event as well as mortality rates of 25% or greater.[38] Preliminary data appear to suggest adding 2 points to the Caprini score for asymptomatic Coronavirus positive patients, 3 points if symptoms are present, and 5 points in Coronavirus positive patients with elevated D-dimer.[39]

On March 13, 2020, elective orthopaedic surgery resumed at our institution. It was necessary to implement new perioperative processes to ensure optimal patient outcomes. All patients must have a negative polymerase chain reaction (PCR) nasal swab within 48 hours of surgery. Additionally, the preoperative history now includes a detailed patient assessment for confirmed Coronavirus, either by nasal swab or antibody testing, or symptoms highly suspicious of the viral disease within the prior 6 months. Any patient with a known case of Coronavirus disease receive an additional 2 points on the Caprini RAM.[39] Patients hospitalized for severe COVID-19 disease, or those diagnosed with COVID pneumonia, require further diagnostic testing prior to surgery, including a D-dimer. COVID-19 has highlighted the necessity for any risk stratification tool to evolve in order to account for unforeseen events.

Having access to pertinent patient information, while gaining proficiency in completing the Caprini RAM, are both vital to its efficacy. Ongoing, real time analyses of patient outcomes, with subsequent change in process, is key to improving patient

care. Every new initiative has its own learning curve, but the knowledge acquired by implementing risk stratification for venous thromboprophylaxis has enriched our attention to detail in the quest for excellence following total joint arthroplasty.

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