



Graduate Theses, Dissertations, and Problem Reports

2014

Clinical Practice Guideline for Venous Thromboembolism

Angela Miller

Follow this and additional works at: <https://researchrepository.wvu.edu/etd>

Recommended Citation

Miller, Angela, "Clinical Practice Guideline for Venous Thromboembolism" (2014). *Graduate Theses, Dissertations, and Problem Reports*. 7112.

<https://researchrepository.wvu.edu/etd/7112>

This Dissertation is protected by copyright and/or related rights. It has been brought to you by the The Research Repository @ WVU with permission from the rights-holder(s). You are free to use this Dissertation in any way that is permitted by the copyright and related rights legislation that applies to your use. For other uses you must obtain permission from the rights-holder(s) directly, unless additional rights are indicated by a Creative Commons license in the record and/ or on the work itself. This Dissertation has been accepted for inclusion in WVU Graduate Theses, Dissertations, and Problem Reports collection by an authorized administrator of The Research Repository @ WVU. For more information, please contact researchrepository@mail.wvu.edu.

Clinical Practice Guideline for Venous Thromboembolism

Angela Miller MSN, FNP-BC, ONP-C

Doctoral Capstone Project submitted to the
School of Nursing
at West Virginia University
in partial fulfillment of the requirements
for the degree of

Doctorate
of
Nursing Practice

Dr. Marilyn Smith, Chair

Dr. Gregory Krivchennia II

Dr. Jesse Ada

School of Nursing

Morgantown, West Virginia

2014

Keywords: thromboembolism, guideline, clinical practice

Copyright 2014 Angela Miller

Abstract

Clinical Practice Guideline for Thromboembolism

Angela Miller MSN, FNP-BC, ONP-C

Background: The morbidity associated with venous thromboembolism often goes unrecognized. Identifying patient populations at risk for venous thromboembolism and implementing evidence-based guidelines can decrease the number of untoward effects of this disease. Clinical pathway guidelines are valuable tools needed by nurses in the prevention and treatment of disorders for patients. Education of the guideline can increase knowledge and understanding of what prevention, interventions, and treatment are available for the orthopaedic patient and how to apply this knowledge to everyday patient care.

Objective: To educate orthopaedic nurses on the clinical practice guidelines of thromboembolism.

Method: Incorporate the education of thromboembolism in an orthopaedic class intended for registered nurses studying for the national orthopaedic exam.

Population: Twenty-three registered nurses from the Mid-Ohio Valley employed at Selby General Hospital.

Expected Outcome: To calculate a statistically difference in the scores of a pre test and a post test given to the nurses enrolled in the class on the prevention and treatment of thromboembolism.

Contents

Introduction.....2

Purpose.....2

Definition of Problem.....2

Goals of Clinical practice Guideline.....3

Search Strategy.....4

Assessment of Scientific Evidence.....4

Gaps in the Literature.....7

Pathophysiology.....8

Patient Care Management.....10

Assessment.....12

Trends and Controversies.....27

Project Description/Theory.....28

Capstone Project Design.....29

Project Evaluation.....31

Results of Project.....31

Discussion.....34

References.....35

Appendix A.....43

Appendix B.....46

Introduction

Thromboembolic disease or venous thromboembolism (VTE) is an important public health problem. A total of two million Americans suffer from VTE each year; approximately 200,000 deaths annually result from pulmonary embolism (PE) (Fekrazad et al. 2009). The morbidity associated with VTE often goes unrecognized. The morbidity includes serious long term complications such as chronic edema, chronic venous insufficiency, chronic pain, and recurrent venous ulceration which are known as post-thrombotic syndrome (Kahn 2006). VTE is preventable in many instances. Identifying patient populations at risk for VTE and implementing evidence-based guidelines can decrease the number of untoward effects of this disease (Passman, 2010).

Purpose

The purpose of the VTE guideline is to provide evidence-based information that assists in the identification of populations at risk for the disease as well as provide evidence-based interventions aimed at prophylaxis and prevention. Empowering nurses with the guideline would allow the nurse to take responsibility for assessing patients for VTE and provide appropriate prophylaxis. This allows nurses to help reduce the number of VTE incidences and the associated consequences. Nurses are in a crucial position to help improve orthopaedic outcomes in relation to thromboembolism of the patient by providing evidence-based care.

Definition of Problem

Approximately 700,000 primary total hip and knee replacements are performed each year in the United States. The number is expected to grow to over 3.5 million in 2030 (AAOS, 2011).

On average, about 2 to 3% of people undergoing total joint replacement would end up with a symptomatic DVT or PE (AAOS, 2011). The orthopaedic nurse needs competency in performing two critical procedures in detecting thromboembolism. First, educate patients on prevention of thromboembolism. Second, identify signs and symptoms of thromboembolism for timely intervention.

Goals of Clinical Practice Guideline

The goal for the guideline is the significance of addressing orthopaedic trauma and total joint patients in developing VTE. Orthopaedic trauma and total joint patients are among the highest risk groups for developing VTE. The guidelines would provide evidence-based interventions aimed at decreasing VTE events. VTE is considered to be one of the most preventable causes of death in the hospital (Mitchota, 2007). Typically hospitals adhere to the ACCP guidelines. However, the AAOS guidelines are more appropriate for orthopaedic patients. Therefore, it is important to educate orthopaedic nurses on the differences of these guidelines and the care needed for the orthopaedic patient.

During the last decade, the American College of Chest Physicians (ACCP) and the American Academy of Orthopaedic Surgeons (AAOS) developed their own guidelines for prevention of venous thromboembolism which were not in agreement which posed dilemmas for those managing the care of these patients. The guidelines were also not congruent with the guidelines set forth by the Surgical Care Improvement Project (SCIP). The SCIP is a national partnership that was developed in 2003 by the Centers for Medicare and Medicaid Services (CMS), and the Centers for Disease Control (CDC). Other SCIP steering committee organizations include the American College of Surgeons, the American Hospital Association, The Joint Commission, the American Society of Anesthesiologists, the Association of PeriOperative Registered Nurses

(AORN), the Agency for Healthcare Research and Quality, and the Department of Veterans Affairs. These organizations are committed to improving the safety of surgical care through the reduction of postoperative complications by utilizing evidence-based core measures (Drake, 2011).

Search Strategy

The following databases were searched: National Guidelines Clearinghouse, The Cochrane Library, PubMed, CINAHL, Medline, and Academic Search. The search was limited to only articles written in English. No limits were placed when the articles were published. Only original studies were used from peer reviewed journals. The following key words were included in the search: pulmonary embolism; venous thromboembolism; deep vein thrombosis; and clinical guidelines.

Assessment of Scientific Evidence

Prior to 2012, the ACCP and the AAOS independently published guidelines for prevention of VTE in the orthopaedic patient. These guidelines proposed very different approaches to managing these patients which caused confusion and wide variations in practice. The ACCP 8th Consensus guidelines were the most widely used in most clinical practices but often resulted in excessive bleeding (Bozic, Vail, Pekow et al., 2010). The differences in guidelines were as a result of each different organization using different endpoints for evaluating the efficacy of VTE prophylactic drugs. The ACCP used venographically proven DVT as its endpoint while the AAOS used excessive bleeding as its endpoint. The problem with bleeding as an endpoint is that the ACCP defined major bleeding as life threatening intracranial, intraabdominal or intraocular bleeding and requiring at least two units of packed red cells or decrease of hemoglobin more than

2 g/dL compared with relevant postoperative level (Bozic, Vail, Pekow et al., 2010). Those criteria rarely apply to arthroplasty patients. Galat et al (2009) reported that patients with wound complications of bleeding requiring reoperation within 30 days of TKA were 10 times more likely to have subsequent major surgery and associated morbidities than those without. However, failure to meet the ACCPs strict criteria of major bleeding event resulted in under reporting of bleeding complications in many studies. There were also concerns about conflicts of interest that appeared in the ACCP guidelines.

Due to the many concerns raised regarding the ACCP guidelines, the AAOS formed its DVT/PE workgroup in 2007 and issued its own revised recommendations in 2011 by reviewing the available literature on VTE with symptomatic DVT, PE, and mortality as endpoints (Mont et al., 2011). The goal was to achieve more balance between minimizing risk and maximizing efficacy, while minimizing conflicts of interest during the guideline development. Patients were classified based on their medical history to identify their risk of VTE and bleeding. The AAOS guidelines were in conflict with the ACCP guidelines until the ninth edition of the ACCP recommendations, which was published in 2012 (Falck-Yetter et al. as cited in Bozic, Vail, Pekow et al., 2010). Both of those guidelines, for the first time, included aspirin as an accepted therapeutic modality for the prevention of VTE.

The alignment of the major recommendations between the AAOS and the ACCP also are now aligned with the SCIP VTE guidelines.

The SCIP VTE guidelines set forth include:

* **SCIP-VTE-1**. This measure states that surgery patients will have recommended VTE prophylaxis ordered. VTE prophylaxis starts with identification of risk factors, including the

patient having surgery (higher risk with hip or knee surgery), trauma to lower extremities, increasing age (older than age 40), hormonal therapy, chemotherapy, central line catheter placement, immobility, obesity, varicose veins, and pregnancy (antepartum and postpartum). There are a number of risk assessments scoring tools available to assist in the determination of patient risk severity. Determining if the patient is at low, moderate, or high risk for VTE will guide the team to select the prophylactic treatment. As soon as a patient is admitted to the inpatient unit or is known to be staying more than 24 hours, a risk assessment needs to be completed. After the risk level is assigned, the appropriate intervention can be ordered and implemented.

Interventions are separated into two categories: nonpharmacologic and pharmacologic. The first intervention is frequent and early ambulation. The second nonpharmacologic intervention is the use of graduated compression stockings or intermittent pneumatic compression devices. Nurses need to know the importance of applying and using these devices for patients with limited mobility. Patients identified as moderate or high risk will also receive pharmacologic intervention of a low-dose unfractionated or low-molecular-weight heparin.

* **SCIP-VTE-2**. This measure states that surgical patients will receive appropriate VTE prophylaxis within 24 hours before surgery to 24 hours after surgery. Again, the timing of post-op medication administration is important. Organizations using best practice alerts may improve their outcomes by getting prophylaxis ordered and implemented early (Drake, 2011).

Although guidelines issued by the AAOS and the ACCP are valuable resources on the use of VTE prophylaxis, only the SCIP VTE prophylaxis measures are tied to CMS pay-for-performance programs. Thus, hospitals must ensure that they conform to the SCIP measures for

VTE prophylaxis to qualify for bonus payments (McKee, 2013). This is critical information for the nurse caring for the high risk orthopaedic patient to know.

Gaps in the Literature

There is considerable evidence in the literature that provides a vast array of treatment for thromboembolism, however there continues to remain a gap in the implementation of these treatments (Passman, 2010). The guidelines have been vastly underused even with all of the supporting evidence. One reason for the lack of implementation may be the lack of consensus among providers for the best treatment options. The Surgical Care Improvement project (SCIP) was established as a collaborative effort between the Centers for Medicare and Medicaid Services (CMS) and the Joint Commission (Passman, 2010). In 2010 the SCIP project included the Agency for Healthcare Research and Quality, American College of Surgeons, American Hospital Association, American Society of Anesthesiologists, Centers for Disease Control and Prevention, CMS, Department of Veterans Affairs, Institute for Healthcare Improvement, and the Joint Commission. The focus of the SCIP project was to prevent surgery complications that have a relative high incidence and cost. The SCIP program targeted VTE. Haralson describes the four measures that relate to the SCIP guideline for VTE.

Thromboembolism has become a mandated quality of care, however the economic manifestations of this care have yet to be realized (Passman, 2010). There continues to remain data that accurately assess the total economic burden for VTE. The estimated total cost on the United States for VTE is \$3.2 to \$15.5 billion per year (Cundiff, 2004). In the United States there are as many as 900,000 that develop a DVT or a PE per year and as many as 300,000 deaths are attributed to VTE per year (Heit, Cohen, & Anderson, 2005). The AHRQ Healthcare

and Utilization Project estimated the cost for an inpatient to be \$10,000 per DVT and \$20,000 per PE (Maynard & Stein, 2008). Another study found direct patient cost for DVT to be \$17,512 and \$18,310 for a PE (MacDougall et al. 2006). Also, an estimated \$18,310 can be added to hospital costs for added complications from a VTE (Dimick et al. 2004). The patient that sustains a VTE not only has the acute hospital costs, but also chronic complication costs. It is estimated that a patient that sustains a VTE has an incidence of 7-13% to have a recurrence within a year and a 30% recurrence within 5 years (Cushman et al. 2004).

Further research is needed to determine the most efficient translation of recommendations from research to the actual treatment of the patient. Both the ACCP and AAOS agree that the most important goal is to prevent a pulmonary embolism. The ACCP looks at both pulmonary embolism and deep vein thrombosis as a measurable outcome and the AAOS looks at only a pulmonary embolism as a measurable outcome. Therefore, the AAOS concentrates primarily on pulmonary embolism only and does not test routinely for deep vein thrombosis. The ACCP includes both asymptomatic and symptomatic deep vein thrombosis detected by venography as a measure of the efficiency of thrombophylaxis in the prevention of VTE. The AAOS rejects this and states that the link between DVT and VTE has not been proven (Eikelboom et al. 2009). The ACCP believes that the AAOS recommendations were based on experts rather than scientific research. The AAOS states that the ACCP fails to look at the increased bleeding risk associated with their recommendations (Knesk, Peterson, & Marke, 2012). The increased bleeding risk associated with the post surgical patient may put the patient at increased infection risk.

Pathophysiology

Venous thrombosis is the formation of blood clots in low blood flow veins that are composed mainly of red blood cells trapped in a fibrin network. In orthopaedic patients, clots frequently are seen in deep veins in the calf or thigh vessels. Clots tend to form at valve cusps in these veins. These clots are known as venous thrombosis. A pulmonary embolism (PE) is a clot that has broken free from the inner layer of the vein. The clot travels through the venous system and eventually migrates to the pulmonary venous circulation and blocks blood flow resulting in serious interruption in oxygen exchange at the alveolar-capillary membrane. If the clot is large enough to totally occlude the pulmonary vein, abrupt and often fatal right sided heart failure (called cor pulmonale) can occur (Patel & Brenner, 2014; Schwartz & Rote, 2014).

Virchow (Welsh, 2010) identified the triad of factors which contribute to clot formation. The triad describes how venous stasis-alterations in blood flow can lead to sluggish circulation. This happens after surgery when immobile patients have a reduction in the contractions of muscles in the lower leg. The reduction in the contractions of the muscles leads to stagnant blood that can trigger endothelial wall damage and lead to thrombus formation (Welsh, 2010). Vessel wall damage occurs by the kinking of major vessels (hip dislocation), trauma, indwelling catheters, or scarring by previous clots. Endothelial damage to the vein wall can occur which can activate the clotting cascade leading to increased thrombosis (Coleridge-Smith, 1990).

Blood coagulability in the process of clot formation can be due to inherited disorders (Factor V Leiden, protein C or S deficiency), cancer, estrogen therapies and major surgery. Patients that have congenital thrombophilia generally remain asymptomatic until their clotting disorder faces a challenge such as surgery (Mammen, 1992). It is often a combination of factors which leads to clot formation.

Orthopaedic patients are at risk for all three factors of Virchow triad in the perioperative period: changes in blood coagulation, changes in the vessel wall, and changes in blood flow. In addition the following risk factors put the orthopaedic patient at risk: surgery; trauma, especially to the lower extremities; immobility; malignancy; history of DVT; older age; pregnancy or postpartum period; taking estrogen-containing oral contraceptives; inflammatory bowel disease; obesity; smoking; and varicose veins (Geerts et al. 2008).

Patient Care Management

A multi-modal approach to VTE prevention is the accepted standard of care with orthopaedic joint replacement and hip fracture patients. The ACCP (2012) recommends a combination of pharmacologic and mechanical thromboprophylaxis for patients undergoing major orthopaedic surgery such as total hip arthroplasty (THA), total knee arthroplasty (TKA), and hip fracture surgery (HFS). The use of dual therapy with pharmacologic and mechanical prophylaxis was found to be superior to no prophylaxis. For patients undergoing a THA or a TKA the use of an intermittent pneumatic compression device (IPCD) is recommended with one of the following pharmacologic measures for a minimum of 10 to 14 days- low-molecular-weight heparin (LMWH), fondaparinux, apixaban, dabigatran, rivaroxaban, low-dose unfractionated heparin (LDUH), warfarin therapy, or aspirin. For patients undergoing HFS, the recommendation is to use an IPCD with one of the following for a minimum of 10 to 14 days; LMWH, fondaparinux, LDUH, adjusted-dose VKA, or aspirin. Though the minimum recommendation for the length of treatment is 10-14 days it is also the recommendation of ACCP to extend the thromboprophylaxis in the outpatient period for up to 35 days from the day of surgery. Additionally, though ACCP supports the use of the above listed pharmacologic prophylaxis options for THA, TKA, and HFS patients the recommended preference for pharmacologic

prophylaxis is LMWH. For patients receiving LMWH as thromboprophylaxis the recommendation is to start the medication either 12 hours or more preoperatively or 12 hours or more postoperatively rather than within 4 hours or less preoperatively or 4 hours or less postoperatively.

Thromboprophylaxis increases the risk for bleeding. If patients are at an increased risk for bleeding the recommendation is to use an IPCD or no prophylaxis. When patients decline treatments or are unable or unwilling to do injections or use IPCDs it is recommended to use apixaban or dabigatran (alternatively rivaroxaban or adjusted-dose VKA if apixaban or dabigatran are unavailable). When there are contraindications to both pharmacologic and mechanical thromboprophylaxis the patient is at risk for increased risk of bleeding, the recommendation is against the use an inferior vena cava (IVC) filter placement for primary prevention.

The AAOS (2011) recommend against routine post-operative duplex ultrasonography screening of patients who have undergone elective THA or TKA. Patients undergoing elective THA or TKA are already at an increased risk of VTE As these patients are already at an increased the recommendation is to identify and assess those patients at a higher risk for VTE development. The practitioner should evaluate the patient and determine whether these patients have a history of venous thromboembolism. Patients undergoing elective THA or TKA which/who are at risk for bleeding and bleeding-associated complications should be assessed for known bleeding disorders like hemophilia and presence of active liver disease which further increase the risk for bleeding and bleeding-associated complications.

Another recommendation is that patients should discontinue antiplatelet agents (e.g., aspirin, clopidogrel) before undergoing elective THA or TKA. The use of pharmacologic agents and/or mechanical compressive devices for the prevention of VTE disease in patients undergoing elective THA or TKA is dependent on the patient's risk. For patients not at elevated risk of VTE, beyond that of the surgery, the recommendation is to use pharmacologic agents and/or mechanical compressive devices. For patients who have had a previous VTE, the recommendation is to use pharmacologic prophylaxis and mechanical compressive devices. Though there is not strong evidence, patients undergoing elective THA or TKA and who have a known bleeding disorder (e.g., hemophilia) and/or active liver disease, the recommendation are to use mechanical compressive devices for preventing VTE. Additionally, early mobilization following THA or TKA is recommended. Early mobilization is of low cost, minimal risk to the patient, and consistent with current practice. Neuraxial anesthesia (such as intrathecal, epidural, and spinal) was recommended for patients undergoing elective THA or TKA. Neuraxial blocks have been shown to have no effect on the evidence of VTE and may also help to limit blood loss during surgery. The use of an inferior Vena Cava (IVC) filter was not recommended for or against.

Assessment

All patients should be assessed pre-operatively for elevated risk of VTE. A written thromboprophylaxis policy should be in place for the institution along with preprinted orders, periodic audit, and feedback.

The physical exam for DVT includes

- pain and tenderness at or below the site of the thrombosis;

- swelling of the affected leg;
- elevating the leg may lessen the swelling, however, the swelling returns with ambulation;
- pitting edema confined to the symptomatic leg;
- redness of the affected extremity; and
- homan's sign (forced dorsiflexion of the foot causing discomfort in the calf) is present in less than one third of the patients and not specific or sensitive for DVT

The physical exam should be documented in the pre assessment nursing notes prior to surgery.

Current mainstay for determining DVT probability is the Wells Score.

Risk score interpretation (probability of DVT): 3 points: high risk (75%); 1 to 2 points: moderate risk (17%); < 1 point: low risk (3%).

Active cancer?	+1
Bedridden recently >3 days or major surgery within four weeks?	+1
Calf swelling >3cm compared to the other leg?	+1
Collateral (nonvaricose) superficial veins present?	+1
Entire leg swollen?	+1
Localized tenderness along the deep venous system?	+1
Pitting edema, greater in the symptomatic leg?	+1
Paralysis, paresis, or recent plaster immobilization of the lower extremity	+1
Previously documented DVT?	+1
Alternative diagnosis to DVT as likely or more likely?	-2

(Adapted from Duggar, 2014)

The physical exam for PE includes

- severe dyspnea;
- chest pain;
- hypoxia;
- apprehension;
- confusion;
- anxiety;
- Tachypnea;
- Tachycardia;
- diminished breath sounds;
- fever;
- diaphoresis;
- hemoptysis;
- pleuritic chest pain; and
- a Split S2 may be heard which is a systolic murmur over the pulmonary artery due to an obstruction.

The physical exam for the PE should be documented in the pre assessment nursing notes prior to surgery.

The medical management of DVT includes physical measures, mechanical prophylaxis, and pharmacological agents with contraindications. Physical measures of DVT include:

- Patients are to be out of bed, sitting in a chair several times a day, and ambulating as tolerated.
- Elevate the foot of the bed. and

- Patients to be instructed to actively dorsiflex and plantar flex the ankle and toes. This exercise should be performed in sets of 10 to 20 every half hour when the patient is awake.

Mechanical prophylaxis for DVT assists with the venous return in patients and can be intermittent external pneumatic compression (IPC) or anti-embolism stockings (AES). Intermittent external pneumatic compression (IPC) provides external compression of the lower extremities, promoting venous return. Contraindications of IPC includes

- a known or suspected DVT;
- local leg conditions;
- arteriosclerosis vascular disease or neuropathy;
- massive edema of legs or pulmonary edema;
- extreme deformity of the legs; and
- patient refusal to wear correctly (Welch, 2010).

Anti-embolism stockings (AES) provide continuous stimulation of linear blood flow, prevent venous dilation (Coleridge-Smith et al., 1991), and stimulate endothelial fibrinolytic activity (Arcelus et al., 1995). Contraindications of AES includes

- local leg conditions;
- arteriosclerosis vascular disease or neuropathy;
- massive edema of legs or pulmonary edema;
- extreme deformity of the legs;
- allergy to material; and
- patient refusal to wear correctly (Welch, 2010).

Multiple pharmacologic agents can be used with thromboembolism. It is important to start treatment with parenteral anticoagulation for DVT or PE while awaiting diagnostic test results unless low clinical suspicion of VTE (LMWH or fondaparinux recommended over heparin). Continue treatment at home if circumstances allow. If contraindications for pharmacologic therapy, the use of mobile IPC is recommended as long as there is a chip that can be interrogated to check for compliance.

Therapy length is based on underlying risk factor. Post-operative patient is 3 months. Provoked non-surgical with transient risk is 3 months (assuming that risk factor is resolved). Unprovoked proximal is 3 months, then reevaluate for risk-benefit (may stop if high bleeding risk, otherwise extended therapy is recommended). Unprovoked isolated distal DVT is 3 months. Second unprovoked VTE needs extended therapy. Therapy is only 3 months for patients at a high bleeding risk. Active cancer needs extended therapy. Reassess extended therapy patients for continued treatment at periodic intervals.

Unfractionated heparin works by Heparin-activation of antithrombin III that inactivates thrombin and factor Xa in the coagulation process. Unfractionated heparin requires monitoring with the goal of maintaining an elevated activated partial thromboplastin time (APTT) (Knesek et al., 2012). Heparin is given in a bolus of 80units/kg or fixed 5000 units. Continuous infusion at 18units/kg/hr or fixed 1000 units/hr is maintained. Outpatient therapy is 333 units/kg as the first dose, then 250 units/kg (no aPPT monitoring recommended).

Warfarin-affects prothrombin time by competing with vitamin K. Warfarin is given as 10mg daily for 2 days, then dose per INR for sufficiently healthy patients, otherwise start with 5 mg daily. Start warfarin on day 1 or 2. Once the patient is stabilized on a specific dose, INR measurements are done at 1 to 2 week intervals (Knesek et al., 2012).

Low molecular weight heparin (LMWH) is administered via the subcutaneous route with daily or twice daily dosing without coagulation monitoring. LMWH reduces hypercoagulability by inhibiting coagulation proteins through increased antithrombin action (Knesek et al., 2012). Use LMWH over dabigatran or rivaroxaban if unable to take warfarin (lack of data when 2012 CHEST guidelines published). Use LMWH over warfarin in cancer patients for long term treatment.

Factor Xa inhibitors-Rivaroxaban (Xarelto) should be taken orally once daily in 10-mg doses. The initial dose should be taken 6 to 10 hours after surgery, provided that hemostasis has been established. Recommended treatment durations are 4 weeks for patients having major hip surgery and 2 weeks for patients having major knee surgery (Eymin & Jaffer, 2013).

Discontinue injectable anticoagulation when starting rivaroxaban. Factor Xa inhibitor Fondaparinux (Arixtra) is a synthetic polysaccharide derived from the antithrombin-binding region of heparin. Fondaparinux is administered via the subcutaneous route once daily (Yamaguchi et al., 2010).

Aspirin inhibits the production of thromboxane creating an antiplatelet effect (Autar, 2006). The AAOS recommends the use of ASA for patients with no history of malignancy, no previous clots, and no history of thrombophilia for the prevention of VTE (Knesek et al., 2012). Optimal dose is 160 mg by mouth every day.

Contraindications of pharmacological prophylaxis includes

- active bleeding;
- bleeding disorders such as liver failure and hemophilia;
- concurrent use of anticoagulants;

- lumbar puncture, epidural or spinal anesthesia within the previous 4 hours, or expected within the next 12 hours;
- acute stroke;
- platelets less than $75 \times 10^9/l$; and
- hypertension (230/120 mmHg or more) (Welch, 2010).

Treatment of DVT includes anticoagulation for 3 months, noninvasive tests for 10 to 14 days, or surgery.

Management of PE can be done with medication or surgery. The anticoagulation medication can be Heparin, LMWH, or Warfarin. Thrombolytic therapy is used with massive PE in combination with heparin. Agents used include: streptokinase, urokinase, and recombinant tissue-type plasminogen. Surgical and invasive procedures can be an IVC filter, prophylactic IVC filter, pulmonary embolectomy, and or supplemental oxygen. Contraindications of pharmacological prophylaxis includes

- active bleeding;
- bleeding disorders such as liver failure and hemophilia;
- concurrent use of anticoagulants;
- lumbar puncture, epidural or spinal anesthesia within the previous 4 hours, or expected within the next 12 hours;
- acute stroke;
- platelets less than $75 \times 10^9/l$; and
- severe hypertension (230/120 mmHg or more) (Welch, 2010).

There are certain pregnancy and lactations considerations

- LMWH preferred over unfractionated heparin;
- Warfarin is contraindicated (able to be used in breastfeeding);
- Patients on warfarin should be changed to therapeutic LMWH when positive;
- Avoid fondaparinux or parenteral direct thrombin inhibitors;
- Avoid oral dabigatran and rivaroxaban or similar agents;
- Continue acute VTE treatment for at least 6 weeks postpartum for minimum of total therapy of 3 months; and
- Discontinue therapeutic LMWH at least 24 hours before labor injection or neuraxial anesthesia

There are a number of diagnostic tests for DVT. One test is the venous ultrasonography which is a noninvasive sensitive and accurate test to locate a thrombus in the deep and superficial venous system. Another test is the venous doppler which is a noninvasive continuous wave doppler used to evaluate venous flow patten. Sensitive to proximal vein thrombosis; however, it has poor sensitivity to calf vein thrombosis. The gold standard test is a Venography which is the use of dye injected into a vein to assess for a thrombosis (Maher, Salmond, & Pellino 2002).

Also, a lab test called a D-dimer may be used for a diagnostic test in evaluating for a DVT. A D-dimer is a lab test showing protein derivatives of fibrin found in plasma. Plasma concentrations are raised during a thromboembolism, infection, malignancy, pregnancy, and after an operation. A negative test can rule out a VTE.

There are a number of tests used in the diagnosing and managing a PE. The diagnostic tests and management tests for a PE include the following:

- Ventilation/Perfusion scan which is a less invasive test that uses x-ray and dye to assess ventilation and pulmonary perfusion.
- Pulmonary angiography which is an invasive test that uses a catheter inserted into the pulmonary artery for the injection of dye.
- Spiral test computed tomography scanning which is a noninvasive test that uses x-ray to show pulmonary vasculature and parenchyma.
- D-dimer which is a lab test showing protein derivatives of fibrin found in plasma. Plasma concentrations are raised during a thromboembolism, infection, malignancy, pregnancy, and after an operation.
- Arterial blood gas which is a lab test used to show hypoxia.
- Electrocardiogram (ECG) which may show nonspecific ST and T-wave changes. This test is not used to make a diagnosis of PE, however; is used in the management of PE.
- Echocardiogram is used to evaluate for intracardiac clot. and
- Chest radiography is not conclusive for a PE, however; it may show effusion, infiltrate, atelectasis, elevated hemidiaphragm, and be used to rule out other conditions (Maher, Salmon, & Pellino, 2002).

There are risk identification factors for DVT and PE. The risk identification factors fall into three categories. They are inherited, acquired, and additional risk factors. The inherited risk factors includes

- antithrombin III deficiency;
- Protein C deficiency;
- Protein S deficiency;

- Dysfibrinogenemia;
- disorders of plasminogen and plasminogen activation;
- Factor V; and
- Von Willebrand disease

The acquired risk factors includes

- lupus anticoagulant;
- nephrotic syndrome;
- paroxysmal nocturnal hemoglobinuria;
- cancer;
- malignancy;
- stasis (cardiac heart failure, myocardial infarction, cardiomyopathy, constrictive pericarditis, anasarca);
- sepsis;
- immobilization;
- stroke;
- polycythemia rubra vera;
- inflammatory bowel disease;
- obesity; and
- prior thromboembolism (Maher, Salmond, & Pellino, 2002).

The additional risk factors are

- surgery;

- trauma-especially to the lower extremities;
- immobility;
- history of DVT;
- advancing age;
- pregnancy or postpartum;
- estrogen therapy or taking estrogen-containing oral contraceptives;
- smoking; and
- varicose veins (Geerts et al. 2006).

Nursing interventions need to be a part of the management of DVT and PE. The nursing diagnosis is made and nursing interventions along with nursing outcomes are used in the care and treatment of the patient.

Nursing Interventions are included in the following table:

Nursing Diagnosis (NANDA)	Nursing Intervention Classification (NIC)	Nursing Outcome Classification NOC)
Anxiety	Active listening, anticipatory guidance, anxiety reduction, calming techniques, coping enhancement, emotional support, presence, relation therapy.	Anxiety self-control Concentration Coping

Gas exchange, impaired	Airway management, cough enhancement, embolus care, laboratory data interpretation, oxygen therapy, respiratory monitoring.	Respiratory status: gas exchange Respiratory status: ventilation Tissue perfusion Vital signs
Knowledge deficit	Risk identification, disease process, teaching, prescribed medications, procedures and treatments	Knowledge: medication Knowledge: pain management Knowledge: prescribed activity Knowledge: treatment procedures Knowledge: treatment regimen
Mobility: physical, impaired	Analgesic administration, bed rest care, body mechanics promotion, exercise promotion (strength training), exercise promotion, fall prevention,	Ambulation Body mechanics Body positioning: self-

	pain management, self-care assistance, teaching (prescribed activity/exercise)	initiated Client satisfaction: functional assistance Mobility Transfer performance
Pain, acute	Analgesic administration, coping enhancement, environmental management (comfort), pain management, positioning, simple guided imagery, simple message, simple relaxation techniques, teaching (prescribed medication)	Client satisfaction: pain management Discomfort level Medication response Pain control Pain level
Peripheral neurovascular dysfunction, risk for	Bed rest care, embolus precautions, neurologic monitoring, pressure management	Circulation status Neurological status: peripheral Tissue perfusion: peripheral
Tissue Perfusion, peripheral,	Promotion of arterial circulation, circulatory care (venous	Circulation status Fluid overload severity

ineffective	insufficiency), circulatory precautions, fluid/electrolyte management, fluid management, hemodynamic regulation, hypervolemia management, neurologic monitoring	Tissue integrity: skin and mucous membranes Tissue perfusion: peripheral
-------------	---	---

Education is an important nursing consideration for patients and family in the management of DVT and PE. Patient education on signs and symptoms of DVT & PE as well as risk of bleeding while taking anticoagulants should be addressed.

DVT education should include the the patient will have pain tenderness over area of clot, swelling of the thigh, tightness of the calf, and discoloration of the skin. PE education should include that the pt may experience

- dyspnea;
- anxiety;
- restlessness;
- increased respirations;
- cough, hemoptysis;
- tachycardia;
- syncope; and
- diaphoresis.

Patient education for prevention with lifestyle changes for DVT and PE includes

- smoking cessation;
- weight loss;
- blood pressure control;
- avoid prolong sitting or standing;
- frequent exercises of lower calf muscles; and
- use of compression stockings as directed.

Patient education on medication for DVT and PE should include that the patient should not take any over-the-counter medications, supplements, or herbal remedies before telling the provider. Protect self from injury. Take the anticoagulant at the same time every day. If a dose is missed take as soon as possible unless it is time for next dose. If it is time for next dose do not take a double dose just take the regular dose for the day. Have blood tests as often as directed. Tell any healthcare provider seen for care (such as doctors, dentists, chiropractors, and home health nurses) about taking an anticoagulant. Use a soft-bristled toothbrush. Use an electric razor to shave. Many foods contain vitamin K, which helps blood clot. Foods high in vitamin K may include asparagus, avocado, broccoli, and cabbage. Do not change the amount of these foods usually ingested. Do not drink alcohol. Report any of the following: nausea; diarrhea; poor appetite; bleeding that doesn't stop in 10 minutes; coughing or throwing up blood; dark-colored urine or black stools; red or black-and-blue marks on the skin; dizziness or fatigue; and chest pain or trouble breathing.

Education of the patient and family members regarding signs and symptoms of DVT, the prophylaxis protocol being used, and the importance of early ambulation needs to be included in

the nursing education. The delivery of the education should be verbally and in written form. If the patient is unable to understand the information, provide the information to the caregiver.

Discharge education should include

- means of preventing a DVT;
- importance of early ambulation;
- benefits of prescribed prophylaxis;
- signs and symptoms of DVT and PE;
- generic and trade names of all medications prescribed;
- early ways to recognize complications of treatment; and
- any medical contact numbers.

The discharge destination for the patient is based on the level of skilled care needed by the patient and the functional status of the patient at discharge. The optimal destination would be the patient's home with full return to functional status. Assistance may be needed for skilled care and rehabilitation at a skilled facility, which should be established prior to discharge.

Trends and Controversies

Developments of the new oral anticoagulants' positive effects include efficacy, predictability and consistency, clinical monitoring, adherence to use and duration, and convenience. Negative effects include issues of bleeding complications, liver enzyme elevation, influence on renal disease, drug-to-drug interactions, no antidote to reverse bleeding, and no reliable assay to measure effects (Nutescu et al., 2005).

Cost consideration needs to be taken into account with any new treatment modality. A cost effectiveness analysis should be performed to include reviewing improved effectiveness, greater

efficacy, and reduced complications. VTE continues to remain a significant concern. Use of automated computer prompts and admission protocols may lead to using more routine prophylaxis. It will take all health care providers, patients, and hospitals working as a team to ensure adequate prophylactic treatment for DVT.

Project Description/Theory

The project was developed with the intent to develop a clinical guideline for nurses on the prevention of thromboembolism in the orthopaedic patient. The final project will be presented to the National Association of Orthopaedic Nurses for review and publication. The strength of the project will be calculated from a pre and post test on thromboembolism that will be presented to a group of nurses at Selby General Hospital in Marietta Ohio studying for the national orthopaedic certification test.

The Knowles (1998) learning theory will be used in teaching the thromboembolism guideline. The theory has six principles of learning. Knowles identified six principles. The first principle is the need to know. Adults need to know why they should learn, the reason to learn, and how it will benefit them. The nurses participating in the orthopaedic class need to learn what will be on the certification test and what areas they need to further study. This will help them in completing their certification as an orthopaedic nurse. The second principle is self-concept. Adults need to be moved into a self-directed learner where they are responsible for their own learning and the direction it takes. The nurses will need to evaluate their own knowledge to stimulate themselves to study on their own. The third principle is the role of experience. An adult's experience should be used in their new learning and the technique should include ways to include the adult's knowledge as a tool that they can draw upon from their experiences. The nurses will draw upon

their past experience and education to aid them in providing evidence based-care and in studying for the certification test. The fourth principle is readiness to learn. The nurses signed up for the class are already expressing their readiness to learn. The fifth principle is orientation to learning. New learning should clearly define how it will apply to life. The class will help each nurse in providing confident and competent care to the orthopaedic patient. The sixth principle is motivation to learn. Internal motivators are more important than the external motivators that adults may receive for more learning. These internal motivators can come in the form of increased job satisfaction, self-esteem, and quality of life. All of the nurses can take away a higher sense of self-esteem expanding their current knowledge and providing a well educated service to the nursing profession.

Knowles (1975) suggests the following: learners who take the initiative learn more and better; enter into learning more purposefully and with greater motivation; and tend to retain better and longer. The nurses in the orthopaedic class are volunteering their time to learn more about their profession. They want to further their education by obtaining certification in their field and advance their professionalism.

Capstone Project Design

The capstone project began with a pretest to be given to a class of orthopaedic nurses prior to an education course. After the course the same test was administered again to see if there was a change in the initial score. The course consisted of classes that span over a five week time period. The nurses for the course came from the Mid-Ohio Valley and were employed at Selby General Hospital in Marietta Ohio. The nurses took the class to prepare them for the National Association of Orthopaedic exam to become certified as an orthopaedic nurse. A copy of the

course is listed in Appendix B. There were three objectives identified for the course. The first objective was for the participating nurses to complete the Orthopaedic Nurse Exam (ONC). The ONC exam is based on an analysis of the practice of thousands of orthopaedic nurses across the United States. The second objective was to encourage self study for the ONC exam. This includes identifying a list of topics needed to cover during the individual course of study. Encourage a collection of professional resources to use as study aids including the national association of nurses online store. The third objective was to establish a basic foundation for the use of evidence-based practice (EBP) in nursing. EBP is a thoughtful integration of the best available evidence, coupled with clinical expertise that enables nurses to address healthcare questions with an evaluative and qualitative approach. EBP allows the nurse to assess current and past research, clinical guidelines, and other information resources in order to identify relevant literature while differentiating between high-quality and low-quality findings. To implement the understanding that EBP nursing consists of the following: formulating a well-built question; identifying articles and other evidence-based resources that answer the question; critically appraising the evidence to assess its validity; apply the evidence; and re-evaluate the application of evidence and areas for improvement. The exact content of the classes are explained in Appendix B. During week three the pre and post test was given for the capstone project. A copy of the test is listed in Appendix A.

The capstone project clinical guideline was submitted to the National Association of Orthopaedic (NAON) executive board for review. Recommendations from the executive board were given and the paper returned for any changes. It was revised and returned to the executive board for placement on the NAON website for suggestions from other orthopaedic certified nurses. From this point all suggestions was considered and rewrites performed. It was then

submitted for publication to the Orthopaedic Nursing Journal. This submission was part of the Evidence Based Practice and Research committee. The purpose of the committee was to promote and facilitate orthopaedic nursing practice and research initiatives to meet the needs and desires of NAON members and other orthopaedic health care providers. The scope of the committee was to develop, implement, and evaluate strategies for enhancing evidence-based orthopaedic nursing practice and research activities and tools. This clinical pathway was one of four pathways that the committee is developing.

Project Evaluation

Evaluation of the project was the improvement of scores on the post test after the instructional course of the class. The ultimate final evaluation was the implementation of the clinical guideline by the National Association of Orthopaedic Nurses (NAON). The clinical guideline went through a rigorous panel of experts for evaluation and rewrites and was approved for final publication onto the web based site and in the journal. The panel consisted of active certified orthopaedic registered nurses and NAON members. The members had least a baccalaureate degree and had recent practice experience within the specialty of orthopaedic nursing and/or familiarity with healthcare research.

Results of the Project

Twenty-three registered nurses took the class and consented to participate with the pre test and posttest on thromboembolism. The results of all twenty-three participants are demonstrated in the following graph displaying the pretest and the posttest.

The data was as follows:

Participant	Pretest	Posttest
1	72	90
2	80	94
3	84	98
4	60	98
5	78	100
6	90	100
7	62	98
8	60	94
9	70	98
10	72	96
11	80	98
12	84	100
13	62	96
14	78	98
15	78	98
16	60	100
17	68	98
18	74	100
19	80	98
20	84	100
21	70	94

22	78	98
23	74	94

Group	pretest	posttest
Mean	73.83	97.45
SD	8.74	2.56
SEM	1.82	0.55
N	23	23

Graph pad software (2014) was used to calculate the results. A paired t test with one tail was used to calculate the results. The P value and statistical difference was as follows: The two-tailed P value is less than 0.0001.

By conventional criteria, this difference is considered to be extremely statistically significant. The confidence level was as follows: The mean of pretest minus posttest equals -23.64
95% confidence interval of this difference: From -27.42 to -19.85. Intermediate values used in calculations: $t=12.9753$, $df=21$, standard error of difference= 1.822

From the above results it was demonstrated that the class did increase their knowledge from the pre and post test on the management and treatment of thromboembolism.

Discussion

The morbidity associated with venous thromboembolism often goes unrecognized and is preventable in many instances. Identifying patient populations at risk for venous thromboembolism and implementing evidence-based guidelines can decrease the number of untoward effects of this disease. Clinical pathway guidelines are valuable tools needed by nurses in the prevention and treatment of disorders for patients. A clinical pathway guideline on thromboembolism is a valuable tool in for the orthopaedic nurse. Education of the guideline can increase knowledge and understanding of what prevention, interventions, and treatment are available for the orthopaedic patient and how to apply this knowledge to everyday patient care. Competency in identifying signs and symptoms of thromboembolism and in education of patients and family on prevention of thromboembolism empowers the orthopaedic nurse to give the highest quality care to the orthopaedic patient.

This clinical practice guideline provides as an educational tool based on an assessment of current scientific and clinical research information. This tool is not intended to replace a clinician's independent judgment and critical thinking, but to enhance the clinician's knowledge base regarding the detection and prevention of venous thromboembolism in the orthopaedic patient. The purposes of the venous thromboembolism guideline is to empower the nurse with the best evidence-based information to assist in the identification of populations at risk for thromboembolism and provide the best care available in the treatment and prevention of thromboembolism.

References

- American Academy of Orthopaedic Surgeons. (2011). Preventing venous thromboembolic disease in patients undergoing elective hip and knee arthroplasty. Retrieved from the American Academy of Orthopaedic Surgeons website:
http://www.aaos.org/research/guidelines/VTE/VTE_guideline.asp
- American College of Chest Physicians. (2012). The antithrombotic therapy and prevention of thrombosis, 9th edition: CHEST evidence-based clinical practice guidelines. Retrieved from the American College of Chest Physicians website:
<http://www.chestnet.org/Guidelines-and-Resources/Guidelines-and-Consensus-Statements/Antithrombotic-Guidelines-9th-Ed>
- Arcelus J. I., Caprini, J. A., Hoffman, K. N. (1995). Modifications of plasma levels of tissue factor pathway inhibitor and endothelial-1 induced by a reverse trendelenburg position: influence of elastic compression-preliminary results. *Journal of Vascular Surgery*, 22(5), 568-572.
- Beckman, M. G., Hooper, W. C., Critchley, S. E., & Ortel, T.L. (2010). Venous thromboembolism: A public health concern. *American Journal of Preventative Medicine*, Apr: 38 (4 Suppl), S 495-501. Doi: 10.1016/j.amepre.2009.12.017
- Bozic, K. J., Vail, T. P., Pekow, P.S. et al. (2010). Does aspirin have a role in venous thromboembolism prophylaxis in total knee arthroplasty patients? *Journal of Arthroplasty*, 25, 1050-1060. doi: 10.1016/j.arth.2009.06.021.
- Budhiparama, N. C., Abdel, M. P., Ifran, N. N., & Parratte, S. (2014). Venous thromboembolism

- (VTE) prophylaxis for hip and knee arthroplasty: Changing trends. *Current Review of Musculoskeletal Medicine*, 7(2), 108-116. . doi: [10.1007/s12178-014-9207-1](https://doi.org/10.1007/s12178-014-9207-1)
- Coleridge-Smith P. D. (1990). Venous stasis and vein lumen changes during surgery. *British Journal of Surgery*, 77(9), 1055-1059.
- Coleridge-Smith P. D., Hasty J. H., & Scurr, J. H. (1991). Deep vein thrombosis: Effect of graduated compression stockings on distention of the deep veins of the calf. *British Journal of Surgery*, 78(6), 724-726.
- Colwell, C W., Jr, Froimson, M.I., Mont, M.A., et al. (2010). Thrombosis prevention after total hip arthroplasty: a prospective, randomized trial comparing a mobile compression device with low-molecular-weight heparin. *Journal of Bone and Joint Surgery (American)*, 92, A, 527–535.
- Cundiff, D., (2004). Anticoagulation therapy for venous thromboembolism. *Medscape General Medicine*, 6 (3), 5.
- Cushman, M., Tsai, A., White, R., Heckbert, S., Rosamond, W., & Enright, P. (2004). Deep vein thrombosis and pulmonary embolism in two cohorts: the longitudinal investigation of thromboembolism etiology. *The American Journal of Medicine*, 117, 19-25.
- Dimick, J., Chen, S., Taheri, P., Henderson, W., Khuri, S., & Campbell, D. (2004). Hospital costs associated with surgical complications: a report from the private sector National Surgical Quality Improvement Program. *Journal of the American College of Surgeons*, 199 (4), 531-537.
- Drake, K. (2011). SCIP core measures: Deep impact. *Nursing Management*, 42(5), 24-30

- Duggar, K (2012). Acute treatment for venous thrombosis: Clinical use of heparin, low molecular weight heparins LMWH, and alternatives. *Anticoagulation Management Certificate Program. University of Southern Indiana*. Retrieved from https://blackboard.usi.edu/webapps/portal/frameset.jsp?tab_tab_group_id=_2_1&url=%2Fwebapps%2Fblackboard%2Fexecute%2Flauncher%3Ftype%3DCourse%26id%3D_9923_1%26url%3D.
- Eikelboom, J., Karthikeyan, G., Fagel, N. Hirsh, J. (2009). American Association of Orthopaedic Surgeons and American College of Chest Physicians guidelines for venous thromboembolism prevention in hip and knee arthroplasty differ: What are the implications for clinicians and patients? *Chest*, 135(2), 513-520.
- Eymin, G., Jaffer, A. K. (2013). Evidence behind quality of care measures for venous thromboembolism and atrial fibrillation. *Journal of Thrombosis and Thrombolysis*, 37(2), 87 – 96.
- Falck-Yetter, Francis, C. W., Johanson, N. A., Curley, C., Dahl, O. E., Schulman, S., Ortel, T. L., Pauker, S. G., & Colwell, C. G. (2012). Prevention of VTE in orthopaedic surgery patients: Antithrombic therapy and prevention of thrombosis 9th ed. American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. *Chest*, 141(2), suppl e278S-e325S. Doi: 10:1378/chest.11-2404
- Fekrazad, M. H., Lopes, R.d., Stashenko, G. J., Alexander, J. H., & Garcia, D. (2009). Treatment of venous thromboembolism: guidelines translated for the clinician. *Journal of Thrombolysis*, 28(3), 270-275.
- Galat, D.D., McGovern, S.C., Larson, D. R., et al. (2009). Surgical treatment of early wound

- complications following primary total knee arthroplasty. *Journal of Bone and Joint Surgery (American)*, 91, A:48–54. doi: 10.2106/JBJS.G.01371
- Geerts, W. H., Bergqvist, D., Pineo, G.F., Graham, F., Heit, J., Samana, C., & Lassen, M. (2008). Prevention of venous thromboembolism: American College of Chest Physicians evidence-based clinical practice guidelines (8th ed.). *Chest*, 133- (6 supp), 381S-453S.
- Gordon, H., Guyatt, E. A., Akl, M., Crowther, M., Gutterman, D. D., & Schunemann, H. J. (2012). Executive Summary: Antithrombotic therapy and prevention of thrombosis, 9th ed: American College of Chest Physicians evidence-based clinical practice guidelines. *Chest*, 141: 7S-47S. doi 10. 1378/chest.1412S3
- GraftPad Software. (2014). Retrieved from the Graftpad software site <http://www.graphpad.com/quickcalcs>.
- Heit, J. A., Cohen, A. T., Anderson, F. A. (2005). VTE impact assessment group. Estimated annual number of incident and recurrent, non-fatal and fatal venous thromboembolism (VTE) events in the US. *Blood*, 106, 910.
- Johanson, N., Lachiewicz, P., Lieberman, J. Lotke, P., & Parvizi, J. (2009). Prevention of symptomatic pulmonary embolism in patients undergoing hip or knee arthroplasty. *Journal of American Academy of Orthopaedic Surgery*, 91(17), 183.
- Kahn, S. (2006). The post-thrombotic syndrome: The forgotten morbidity of deep vein thrombosis. *Journal of Thrombosis and Thrombolysis*, 21(1), 41-48.
- Knesek, D., Peterson, T. C., & Markel, D.C., (2012). Thromboembolic Prophylaxis in Total Joint Arthroplasty. *Thrombosis*, 2012, Article ID 837896, 8 pages, 2012. doi:10.1155/2012/83789.

- Knowles, M. (1998). *The Adult Learner: A Neglected Species*, (5th Ed.). Houston: Gulf.
- Knowles, M. (1975). *Self-Directed Learning: A guide for Learners and Teachers*. Chicago: Follet.
- Kurkowski, C. (2013). Appendix: Nursing diagnosis. In L. Schoenly (Ed.), *Core Curriculum for Orthopaedic Nursing*, (7th ed., pp. 619-678). Chicago, IL: National Association of Orthopaedic Nurses.
- MacDougall, D., Feliu, a., Boccuzzi, S. Stephen, J., & Lin, J. (2006). Economic burden of deep-vein thrombosis, pulmonary embolism, and post-thrombotic syndrome. *American Journal of Health System Pharmacists*, 63, 5-15.
- Mammen, E. F. (1992). Pathogenesis of venous thrombosis. *Chest*, 102 (6), 640-644.
- Martinelli, I., De Stefano, V., & Mannucci, P. M. (2014). Inherited risk factor for venous thromboembolism. *Nature Reviews Cardiology*, 11, 140-156.
doi:10.1038/nrcardio.2013.211
- Maynard, G., Stein J. (2008). Preventing hospital acquired venous thromboembolism: A guide for effective quality improvement. AHRQ publication Rockville, MD Agency for Healthcare Research and Quality.
- McKee, J. (2013, November). SCIP VTE measures changing in 2014: New measures go into effect on Jan. 1, 2014. *AAOS Now*. Retrieved from <http://www.aaos.org/news/aaosnow/nov13/cover2.asp>
- Melnyk, B. M., & Fineout-Overholt, E. (2010). Evidence-based practice in nursing & healthcare. A guide to best practice (p. 10). Philadelphia: Lippincott, Williams, & Wilkins.

- Michota, F. (2007). Bridging the gap between evidence and practice in venous thromboembolism prophylaxis: the quality improvement process. *Journal of General Internal Medicine*, 22 (12), 1762-1770.
- Mont, M.A., Jacobs, J. J., Boggio, L.N., Bozic, K.J., Valle, C.J.D., Goodman, S.B., et al. (2011). AAOS clinical practice guideline: preventing venous thromboembolic disease in patients undergoing elective hip and knee arthroplasty. *Journal of the American Academy of Orthopaedic Surgeons*, 19, 777–778.
- National Association of Orthopaedic Nurses (2013). Core Curriculum, for Orthopaedic Nursing (7thEd.). Chicago, IL.
- Nichols-Willey, J., & Orlosky-Novack, J. (2013). Enhancing patient outcomes with sequential compression device therapy. *American Nurse Today*, 8(8). Retrieved from <http://www.americannursetoday.com/enhancing-patient-outcomes-with-sequential-compression-device-therapy/>
- Nutescu, E., Shapiro, N., Chevalier, A., & Amin, A. (2005). A pharmacologic overview of current and emerging anticoagulants. *Cleveland Clinic Journal of Medicine*, 72, (Supplement 1), S2-S6.
- Parker, R. (2013). Orthopaedic complications. In L. Schoenly (Ed.), *Core Curriculum for Orthopaedic Nursing*, (7th ed., pp. 191-216). Chicago, IL: National Association of Orthopaedic Nurses.
- Passman, M. (2010). Mandated quality measures and economic implications of venous thromboembolism prevention and management. *The American Journal of Surgery*, 199(1S), 21-31.

- Patel, K., & Brenner, B. E. (2014). Deep venous thrombosis. *Medscape Drugs and Diseases*. Retrieved from <http://emedicine.medscape.com/article/1911303-overview>
- Pellino, T. A., Preston, M. A., Bell, N., Newton, M. J., & Hansen, K. (2002). Complications of orthopaedic disorders and orthopaedic surgery. In A. B. Maher, S. W. Salmond, & T. A. Pellino (Eds.), *Orthopaedic nursing* (3rd ed.)- pp. 230-268). Philadelphia, PA: W.B. Saunders.
- Previtali, P., Bucciarelli, P., Passamonti, S. M. & Martinelli, I. (2011) Risk factors for venous and arterial thrombosis. *Blood Transfusion*, 9(2), 120–138. doi: 10.2450/2010.0066-10
- Raskob, G. E., Silverstein, R., Bratzler, D. W., Heit, J. A., & White, R. H. (2010). Surveillance for deep vein thrombosis and pulmonary embolism: recommendations from a national workshop. *American Journal of Preventative Medicine*, 38(4 Suppl):S502-9. doi: 10.1016/j.amepre.2010.01.010.
- Sachdeva, A., Dalton, M., Amaragiri, S. V. & Lees, T. (2010). Elastic compression stockings for prevention of deep vein thrombosis. *Cochrane Database Systemic Review*, 7(7), CD001484. doi: 10.1002/14651858.CD001484.pub2.
- Schwartz, A., & Rote, N. S. (2014). Alterations of leukocyte, lymphoid, and hemostatic function. In K. L McCance, S. E Huether, V. L Brashers, & N. S Rote (Eds), *Pathophysiology: The biological basis for disease in adults and children* (7th ed., pp. 1008-1054.). St. Louis, MO: Elsevier-Mosby.
- Stewart, D. W., & Freshour, J. E. (2013). Aspirin for the prophylaxis of venous thromboembolic events in orthopedic surgery patients: A comparison of the AAOS and ACCP Guidelines with Review of the evidence. *The Annals of Pharmacotherapy*, 47(1), 63-74.

Surgical care improvement project national hospital inpatient quality measures. (2010).

Specifications Manual for National Hospital Inpatient Quality Measures 3Q10. Retrieved online from,

<http://qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier4&cid=1228754600169>.

Vasquez, S. R., & Kahn, S. R. (2010). Postthrombotic syndrome. *Circulation, 121*, e217-e219
doi: 10.1161/CIRCULATIONAHA.109.925651

Welch, E. (2010). Venous thromboembolism: A nurse's guide to prevention and management. Hoboken, NJ: Wiley.

Wilbur, J., & Shian, B. (2012). Diagnosis of deep venous thrombosis and pulmonary embolism. *American Family Physician, 86*(10)9, 13-919.

Yamaguchi, T., Hasegawa, M., Niimi, R., & Sudo, A. (2010). Incidence and time course of asymptomatic deep vein thrombosis with fondaparinux in patients undergoing total joint arthroplasty. *Thrombosis Research, 126*(4). 323–326.

Appendix A

Pre-Test Examination for Thromboembolism

Translating Evidence Based Research on Venous Thromboembolism into Practice

Purpose/Goal

To educate orthopaedic nurses about evidence-based practice to improve outcomes for orthopaedic surgical patients at risk for thromboembolism.

Objectives

After instructional course on evidence-based practice and VTE the orthopaedic nurse will be able to:

1. Explain how evidence-based practice can improve patient outcomes with VTE
2. Define VTE
3. Describe the vascular pathophysiology that results in deep vein thrombosis and pulmonary embolism
4. Discuss the effects of VTE
5. Describe why surgical patients are at an increased risk for developing VTE
6. Compare prevention and treatment options for VTE

Questions

1. The components of Virchow's triad include venous stasis, vessel wall damage, and

- a. vessel length
- b. coagulation treatment
- c. coagulation changes
- d. vessel repair

2. Which of the following is a symptom or symptoms of a deep vein thrombosis?

- a. warmth to the area

- b. localized tenderness or pain
- c. localized skin redness
- d. all of the above

3. Venous thromboembolism consists of which of the following?

- a. deep vein thrombosis
- b. pulmonary embolism
- c. a only
- d. a & b

4. Which of the following is the most deadly complication of a deep vein thrombosis?

- a. atherosclerosis
- b. pulmonary embolism
- c. vascular rupture
- d. infection

5. Factors that predispose orthopaedic surgical patients to the development of a VTE include:

- a. dehydration
- b. immobility
- c. b only
- d. a & b

6. Nurses should encourage patients to:

- a. mobilize early
- b. perform breathing exercises
- c. a only
- d. a & b

7. The primary complication of intermittent pneumatic devices is

- a. noncompliance
- b. delayed ambulation
- c. a only
- d. a & b

8. Symptom or symptoms of a pulmonary embolism are which of the following?

- a. unexplained shortness of breath
- b. tachycardia
- c. nervousness
- d. all of the above

9. Adverse reaction or reactions to heparin include which of the following?

- a. hematoma
- b. compartment syndrome
- c. thrombocytopenia
- d. all of the above

10. The prevalence of VTE is increasing due to which of the following?

- a. aging of the population
- b. more complicated surgeries
- c. longer survival of patients with predisposing conditions
- d. all of the above

Appendix B

Orthopaedic Course Selby Hospital

Angela Miller MSN, ONP-C, FNP-BC

Purpose/Goal

To provide an instructional course to orthopaedic nurses interested in completing the national orthopaedic certification exam. This course will help to improve orthopaedic nursing knowledge while encouraging the practice of critical thinking skills in the implementation of evidence-based practice.

Objectives

1. To complete the Orthopaedic Nurse Exam upon finishing this course. The ONC exam is based on an analysis of the practice of thousands of orthopaedic nurses across the United States. From that analysis, a test blueprint is constructed to determine what percentage of questions will cover each area of practice (content areas) and each nursing role (test objectives). The ONC examination contains 150 questions. Of these, 135 are scored; the remaining 15 questions are pilot items, and the candidate's performance on those questions will not be reflected in the exam score. A raw score of 97 is needed to pass the examination, equaling 72%
2. To encourage self study for the ONC exam. This includes identifying a list of topics needed to cover during the individual course of study. Encourage a collection of professional resources to use as study aids including the national association of nurses on line store.
3. To establish a basic foundation for the use of evidence-based practice (EBP) in nursing. EBP is a thoughtful integration of the best available evidence, coupled with clinical expertise that enables nurses to address healthcare questions with an evaluative and qualitative approach. EBP allows the nurse to assess current and past research, clinical guidelines, and other information resources in order to identify relevant literature while differentiating between high-quality and low-quality findings. To implement the understanding that EBP nursing consists of the following: formulating a well-built question; identifying articles and other evidence-based resources that answer the question; critically appraising the evidence to assess its validity; apply the evidence; and re-evaluate the application of evidence and areas for improvement.

Course Instruction

Week 1: Degenerative Joint Disease

2 hours

- Osteoarthritis
- Charcot joints

- Chondromalacia of the patella
- Posttraumatic arthritis
- Hallux valgus

Week 2: Test on Degenerative Joint Disease 30 minutes

Inflammatory Disease 30 minutes

- Rheumatoid arthritis
- Systemic lupus erythematosus
- Psoriatic arthritis
- Systemic sclerosis
- Ankylosing spondylitis
- Bursitis
- fibromyalgia

Metabolic Bone Disease 30 minutes

- Osteoporosis
- Paget's disease
- Gout
- Avascular necrosis

Neuromuscular /Pediatric/Congenital 30 minutes

- Osteogenesis imperfect
- Slipped capital femoral epiphysis
- Osgood-Schlatter disease
- Tibial torsion
- Spina bifida

Week 3: Test on Inflammatory Disease, Metabolic Bone Disease, and Neuromuscular/
Pediatric/Congenital 30 minutes

Oncology: Musculoskeletal Tumors 30 minutes

- Osteosarcoma
- Ewing's sarcoma
- Giant cell tumor of the bone

Orthopaedics in the operating room 30 minutes

- Total hip arthroplasty

- Total knee arthroplasty
- Total shoulder arthroplasty
- Thromboembolism- (pretest and posttest)

Sports Injuries

1 hour

- Shoulder injuries
- Elbow injuries
- Wrist injuries
- Hand injuries
- Hip injuries
- Knee injuries
- Ankle injuries
- Foot injuries

Week 4: Test Oncology/Orthopedic/Sports Injuries

30 minutes

Orthopaedic Trauma

1.5 hours

- Types of fractures
- Dislocations
- Emergency treatment
- Complications
- Nursing management

Week 5: Test Orthopedic Trauma

30 minutes

Question & Answers/Preparing for the Exam

30 minutes

Review

1 hour