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Kyle Andrew Munch

Dated: 30 April, 2014

IMPACT OF AN ELECTRONIC HEALTH RECORD (EHR) IMPLEMENTATION ON HOSPITAL-ACQUIRED VENOUS THROMBOEMBOLISM (VTE) RATES AND APPROPRIATENESS OF PROPHYLAXIS THERAPY

By

Kyle Andrew Munch

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Impact of an electronic health record (EHR) implementation on hospital-acquired venous thromboembolism (VTE) rates and appropriateness of prophylaxis therapy

To the Faculty of the University of Houston, College of Pharmacy:

The members of the committee appointed to examine the project of Kyle Munch find it satisfactory and recommend that it be accepted on 30 April, 2014.

signature on file

Committee Chair, Kevin Garey, PharmD, MS

signature on file

Committee Member, Maryam Bayat, PharmD, BCPS

signature on file

Committee Member, Kimberly Putney, PharmD

signature on file

Committee Member, Divya Varkey, PharmD, MS

signature on file

Dean, F. Lamar Pritchard, BS, PhD

ABSTRACT

Impact of an electronic health record (EHR) implementation on hospital-acquired venous thromboembolism (VTE) rates and appropriateness of prophylaxis therapy

PURPOSE: Hospital-acquired VTE is a very serious health complication for hospitalized patients leading to increased medical costs and death. VTE is preventable and therefore is not reimbursed by payers. The impact of an integrated EHR on VTE prophylaxis strategies and the incidence of hospital-acquired VTE is unknown. The purpose of this project is to determine the incidence of hospital-acquired VTE and assess the appropriateness of prophylaxis therapy provided pre- and post-implementation of an integrated EHR.

METHODS: Using data retrospectively collected from University HealthSystem Consortium (UHC), investigators compared incidence of hospital-acquired VTE as well as the appropriateness of pharmacologic and non-pharmacologic therapies provided for a time period of six months prior versus six months after implementation of an integrated EHR.

RESULTS: There were 158 cases of hospital-acquired VTE out of 13,685 patient discharges during the pre-EHR time period of July 1st, 2012 through December 31st, 2012. A total of 114 cases of hospital-acquired VTE out of 12,876 patient discharges during the post-EHR time period of July 1st, 2013 through December 31st, 2013 resulted in a statistically significant decline in the incidence of hospital-acquired VTE ($p = 0.0294$). Appropriateness of pharmacologic and non-pharmacologic prophylaxis therapy provided to sample groups ($N = 75$) of both populations, determined as the average length of stay (LOS) during which time appropriate risk-stratified prophylaxis was provided, was not significantly different ($p = 0.9679$). There was also

no statistical difference in appropriateness of prophylaxis provided to sample groups (N = 75) of all discharged patients post-EHR and patients with confirmed VTE post-EHR (p = 0.2141).

CONCLUSIONS: Implementation of an integrated EHR may have a significant impact in reducing the rates of hospital-acquired VTE.

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INTRODUCTION

Venous thromboembolism (VTE), including deep venous thrombosis (DVT) and pulmonary embolism (PE), is a serious health risk for hospitalized patients and is associated with recurrent complications, increased medical costs and death. It is estimated that 800,000 patients develop VTE each year, of which 25% die from PE before medical intervention is initiated.[1,2] The economic burden associated with treatment of DVT and PE is estimated to be $10,000 and $20,000 per treatment, respectively. Post thrombotic syndrome (PTS) is a chronic complication of VTE that occurs in 20-70% of patients with symptomatic DVT and is associated with annual healthcare costs of $200 million. VTE is considered the most common preventable cause of hospital death, resulting in an estimated 100,000 to 180,000 deaths annually. Therefore, the American College of Chest Physicians (ACCP) guidelines for VTE prevention recommend pharmacologic prophylaxis for at risk hospitalized patients including patients undergoing total hip or knee replacement as well as cardiac surgery patients with non-hemorrhagic complications.[3,4]

Compliance with recommendations for VTE risk assessment and prophylaxis is variable and many patients that may find benefit from prophylactic therapy do not receive it.[5] In a registry of 5,125 patients with ultra-sound confirmed DVT; only 1,147 (42%) of 2,726 patients received appropriate prophylaxis prior to diagnosis.[6] Some of the challenges associated with VTE prevention among hospitalized patients include varying VTE and bleeding risks within patient populations as well as changes in VTE and bleeding risks for individual patients as they progress through their hospital stay.[7] In addition, changes in medications or patient specific factors such

as weight, age, renal function, and recent invasive interventions may also affect decisions about VTE prevention strategies. Transitions across care providers and locations also pose a challenge.

Guidelines for VTE prevention recommend early risk assessment using a standardized model within 24 hours of hospitalization. Prior to EHR implementation, VTE risk assessment and ordering of prophylactic agents at Baylor St. Luke's Medical Center (BSLMC) was done through the use of a paper based physician order form. The order form, which utilizes the Caprini[8, 9] scoring method for VTE risk assessment and incorporates CHEST guideline recommendations for VTE prophylaxis is included here in Appendix 1. Post-EHR, VTE prophylaxis is built into many commonly used order sets to prompt prescribers. Further, a best practice advisory (BPA) is activated within the EHR for any patient greater than eighteen years of age who has been admitted to BSLMC for at least four hours. Patients excluded from this BPA include those with documented reasoning for no prophylaxis, patients with any current pharmacologic prophylaxis or anticoagulant order or those with any current mechanical prophylaxis order. A screenshot of the BPA is included here in Appendix 2.

VTE prevention is frequently incorporated into public reporting and national quality improvement initiatives.[10] Notably, VTE prevention is listed as a core performance measure for the Surgical Care Improvement Project as well as for the Centers for Medicaid and Medicare Value Based Purchasing program. Furthermore, VTE is classified as a hospital-acquired condition (HAC). As such VTE is considered to be preventable and therefore is not reimbursed by payers. Improved performance with this initiative is imperative. The use of clinical decision support has been suggested as a viable means to increase risk assessment, documentation, and

appropriate use of prophylactic agents for VTE prevention.[11] At BLSMC past efforts to increase compliance with these measures have resulted in limited success primarily due to a lack of efficient processes and clinical decision support to promote timely risk assessments and appropriate selection of prophylactic agents. This study acts a preliminary analysis of our institutional compliance level with measures for VTE prevention and its effect on hospital-acquired VTE incidence. As evidence suggests VTE prevention strategies may be enhanced with the use of advanced technologies and an EHR, study investigators seek to determine how prophylactic compliance is impacted by the implementation of an integrated EHR.

OBJECTIVES

In this study we propose to assess the incidence of hospital-acquired VTE pre and post-implementation of an integrated EHR. This project is intended to guide efforts to improve VTE prevention at our institution as well as to better direct the use of our EHR towards these ends. Specific aims include:

1. To compare the incidence of hospital-acquired VTE in the six month time period before and after implementation of a hospital-wide EHR.
2. To assess the proportion of patients given appropriate pharmacologic and non-pharmacologic VTE prophylaxis in the six month time period before and after implementation of a hospital-wide EHR.

HYPOTHESIS

The null hypothesis is that there is no difference in the rate of hospital-acquired VTE or the appropriateness of prophylaxis therapy provided before and after EHR implementation. The alternative hypothesis is that there is a difference in the rate of hospital-acquired VTE or the appropriateness of prophylaxis therapy provided before and after EHR implementation.

METHODS

An initial search of the UHC clinical database for patients with new onset VTE was conducted for the time periods of July 1st, 2012 through December 31st, 2012 and July 1st, 2013 through December 31st, 2013. VTE reports were generated for disease related groups (DRGs) specifically associated with acute DVT or PE. DRGs included were 4151, 41511-41513, 41519, 449, 452, 453, 4531-4534, 45340-45342, 4538, 45382-45389, 4539 and 4376. Reports were designed to only include VTEs that were not present on admission. In total, 158 cases of hospital-acquired VTE were identified from this search in the July-December, 2012 timeframe while 114 cases of hospital-acquired VTE were identified from the July-December, 2013 timeframe. The incidence of hospital-acquired VTE at the study institution was determined from these cases.

Efforts to determine the appropriateness of prophylactic therapy provided were determined by the degree of prescriber compliance associated with pharmacologic and non-pharmacologic measures for VTE prevention at BSLMC. In particular, patient regimens were assessed to determine whether patients received appropriate prophylactic therapy as stipulated by the BSLMC Venous Thromboembolism (both DVT and PE) Risk Assessment and Prophylaxis Physician Order Form. Patient inclusion and exclusion criteria are listed in Table 1. Prescriber

compliance with this risk assessment and stratification was evaluated through retrospective chart review of 75 randomly selected patients within the July-December, 2012 pre-EHR timeframe and compared with 75 randomly selected patients discharged within the July-December, 2013 post-EHR timeframe. A third group of 75 randomly selected patients discharged within July-December, 2013 with confirmed hospital-acquired VTE was compared with the sample of all discharged patients from the same timeframe in order to determine if appropriateness of prophylaxis therapy provided was decreased for patients who had developed a VTE while inpatient.

Table 1: Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
• **Patients discharged from BSLMC between July 1st, 2012 and December 31st, 2012 or between July 1st, 2013 and December 31st, 2013** • **Patients 18 years or older** • **Patients determined to have hospital-acquired VTE as identified through UHC database search and lacking a POA flag**	• **Patients < 18 years old**

The following data was collected on all patients: patient demographics including age, sex, height, weight, serum creatinine on admission, creatinine clearance on admission, anticoagulants used prior to admission, past medical history and past surgical history. Other information collected included the date of VTE diagnosis, non-pharmacologic and pharmacologic agents used for VTE prevention, indication for thromboprophylaxis, timeliness of thromboprophylaxis, presence of risk assessment documentation, record of early ambulation, documentation of adverse effects, and imaging or diagnostic tests. Questions answered included whether or not VTE prophylaxis was initiated prior to diagnostic testing order date,

whether or not VTE prophylaxis was initiated the day of or day after admission, whether or not there was a break in the patient's VTE prophylaxis therapy and the percent length of stay (LOS) prior to VTE diagnosis that appropriate prophylaxis, determined by the patient's risk category, was provided.

RESULTS

From the pre-EHR timeframe a total of 158 cases of hospital-acquired VTE were identified from 13,685 patient discharges. This resulted in an incidence rate of 1.155%. From the post-EHR timeframe a total of 114 cases of hospital-acquired VTE were identified from 12,876 patient discharges. This yielded an incident rate of 0.885%. The between group difference in incidence rates showed a statistically significant decline in hospital-acquired VTE after EHR implementation ($p = 0.0294$). As shown in Table 2, population demographics, including an estimate for overall severity of illness, for these two groups were very similar.

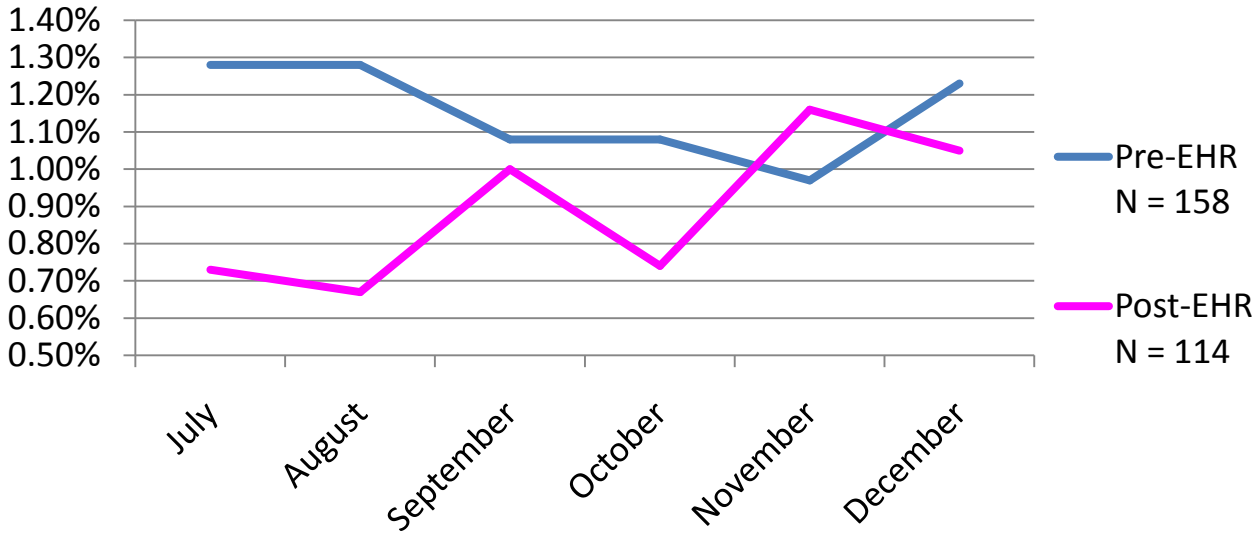
Table 2: VTE Incidence – Population Characteristics

	Pre-EHR (July 1st – December 31st, 2012)	Post-EHR (July 1st – December 31st, 2013)
Total Discharges	13,685	12,876
Confirmed VTE (%)	158 (1.155)	114 (0.885)
Case Mix Index (CMI)	1.9844	1.9911
Length of stay, average (days)	6.52	6.64
% ICU Cases	31.01	30.60

A closer look at the monthly incidence rates of hospital-acquired VTE between these two populations revealed an interesting finding, shown in Figure 1. While rates of hospital-acquired

VTE for the pre-EHR group largely remained the same, rates for the post-EHR group had a trend towards increased incidence as time progressed from EHR implementation.

Figure 1: Monthly Incidence of Confirmed VTE



The VTE-1 measure, as reported to the Centers for Medicare and Medicaid Services (CMS), looks at whether or not patients received VTE prophylaxis the day of or day after hospital admission or the day of or day after surgery end date. Compliance with this measure is noted if the patient has received mechanical or pharmacological prophylaxis or if there is a documented reason as to why the patient has not received mechanical and pharmacological prophylaxis. Authors noted a minor improvement in compliance with this measure when looking at the samples of patients discharged post-EHR implementation versus pre-EHR implementation. 78.7% of sampled patients discharged pre-EHR were found compliant with VTE-1, whereas 84% of sampled patients discharged post-EHR were found compliant. This post-EHR finding by study authors was consistent with what was actually reported to CMS by the study institution during that time period.

Appropriateness of prophylactic therapy provided was similar between the samples of patients from all discharges prior to EHR implementation versus post EHR implementation. On average, patients from the pre-EHR group received appropriate pharmacologic and non-pharmacologic VTE prophylaxis, stratified by risk, 63.87% of their total length of hospital stay. Patients from the post-EHR group received appropriate prophylaxis 66.61% of their total length of hospital stay, on average. This difference was not statistically different ($p = 0.9679$). There were no statistically significant differences in the population characteristics between these two groups, as shown in Table 3.

Table 3: Appropriateness of Prophylaxis – Population Characteristics

	Pre-EHR N = 75	Post-EHR N = 75
LOS appropriate prophylaxis provided, avg	63.87%	66.61%
Female (%)	39 (52)	45 (60)
Age, average (years)	71.0	76.6
Length of stay, average (days)	6.44	5.96
Surgical patients (%)	30 (40)	30 (40)
Risk Category, Highest (%)	44 (58.7)	36 (48)
Risk Category, High (%)	27 (36)	36 (48)

Appropriateness of prophylaxis was also compared for a sample of patients found to have hospital-acquired VTE in the post-EHR group. Patients discharged from the confirmed VTE group received appropriate prophylaxis an average of 70.52% of their length of stay prior to VTE confirmation. When compared to the sample of all patients discharged post-EHR, there was no significant difference in appropriateness of prophylaxis provided ($p = 0.2141$). However,

there was a statistically significant difference between these two groups in the proportion of females included (p = 0.0222), the average age of discharged patients (p = 0.0381), the percentage of patients who fell into the Highest VTE risk category (p = 0.0206) and the percentage of patients who fell into the High VTE risk category (p = 0.0006), shown in Table 4.

Table 4: Confirmed VTE Appropriateness of Prophylaxis – Population Characteristics

	Post-EHR (July 1st – December 31st, 2013)	
	All Patients N = 75	Confirmed VTE N = 75
LOS appropriate prophylaxis provided, avg	66.61%	70.52%
Female (%)	45 (60)	30 (40)
Age, average (years)	76.6	68.9
Length of stay, median (IQR)	4.0 (3.0-6.0)	15.0* (12.0-28.0)
Surgical patients (%)	30 (40)	36 (48)
Risk Category, Highest (%)	36 (48)	51 (68)
Risk Category, High (%)	36 (48)	15 (20)

*Two patients having a LOS > 100 days were included

DISCUSSION

With regards to overall baseline incidence of hospital-acquired VTE at BLSMC, this study suggests a lower annual incidence after implementing an integrated EHR. This increased quality of care results in approximately one hospital-acquired VTE prevented per 370 patients discharged. Using an estimate of 26,000 patient discharges over a 12 month timeframe would result in an estimated 70 patients saved from acquiring a VTE while inpatient at the study institution. Taking the mean total cost of a patient with hospital-acquired VTE at our institution ($85,245), subtracting the mean total cost of all patients discharged ($18,160) and multiplying

by 70 patients would yield a potential cost avoidance of $4,695,950 annually post-EHR implementation. Authors of this study recognize that this estimated cost avoidance is higher than costs attributed to inpatient VTE from previous literature, which largely estimates $20,000 per VTE treatment.

In order to address the incidence of hospital-acquired VTE at the study institution, efforts should be made to streamline care processes and enhance documentation. BPA logic within the EHR can be improved to activate on all patients who are not meeting risk-stratified prophylaxis recommendations. Given that sampled patients were not receiving appropriate prophylaxis for nearly one-third of their hospital length of stay, on average, a great need to reinforce VTE prevention strategies within the hospital is apparent.

LIMITATIONS

This study was retrospective in nature and relied on the accuracy of the authors to extract data elements through patient chart review. Further, the abstraction of medical charts and designation of VTE as not present on admission relies of the accuracy of medical records coders. Though the seasonal variability of VTE has been evidenced through several studies, the authors of this study accounted for these changes through use of the same six month time period prior to EHR implementation as after. Finally, the shortened time frame and small sample sizes allow for only inferences as to the appropriateness of prophylactic therapy provided to all patients at the study institution.

CONCLUSIONS

Most hospitalized patients have one or more risk factors for VTE. In order to prevent patients from acquiring this condition, enhancement of the current EHR at BSLMC, including optimization of BPAs, is needed. Appropriate use of EHRs may help reduce the incidence of hospital-acquired VTE through increased prescriber awareness and an improvement in the overall use of VTE prophylactic agents.

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Appendix 1: BSLMC VTE Risk Assessment and Prophylaxis Physician Order Form

ST. LUKE'S

DT0004

Venous Thromboembolism (Both DVT and PE) Risk Assessment and Prophylaxis Physician Order Form

CONTRAINDICATIONS TO PROPHYLACTIC ANTICOAGULANT THERAPY:

Absolute Pharmacologic Contraindications:	Relative Pharmacologic Contraindications:
☐ Concurrent **therapeutic** anticoagulation	☐ Cirrhosis
☐ Active GI Bleed / Active Peptic Ulcer	☐ Coagulopathy
☐ Active hemorrhage	☐ Pregnancy
☐ Documented or suspected HIT *(Consider fondaparinux (Arixtra®))*	☐ Previous history of cerebral hemorrhage
☐ Hypersensitivity to beef, pork, or heparin products	☐ Recurrent Falls
☐ Malignant hypertension	☐ Thrombocytopenia (Platelet count < 70,000/mm^3)
☐ Recent intraocular surgery	☐ Other: _____
☐ Spinal tap or epidural anesthesia (≤ 12 hours)	
☐ Other: _____	

If Pharmacologic therapy contraindicated or significant risk of bleeding, choose NON-pharmacologic prophylactic therapy below, then sign, date and time order:

☐ Intermittent Pneumatic Compression (IPC)
☐ Graduated Compression Stockings (TED hose):
☐ Thigh ☐ Knee

MUST STATE REASON FOR CONTRAINDICATION TO NON-PHARMACOLOGIC PROPHYLAXIS: _____

Risk Category	Incidence of DVT	Prophylactic Therapy
Low Risk (Total = 0 – 1 Point)	< 10%	☐ Early and aggressive ambulation
Moderate Risk (Total = 2 Points) Early ambulation + Pharmacologic **OR** Mechanical	10 – 20%	☐ Heparin 5000 units subcutaneously Q 12 hours ☐ Enoxaparin 40mg subcutaneously once daily[β] ☐ Graduated Compression Stockings (TED hose): ☐ Thigh ☐ Knee ☐ IPC (Bilateral, calf-length) ☐ Other: _____ Reason: _____
High Risk (Total = 3 – 4 Points) Early ambulation + Pharmacologic **OR** Mechanical	20 – 40%	☐ Heparin 5000 units subcutaneously Q 8 hours ☐ Enoxaparin 40mg subcutaneously once daily[β] ☐ Graduated Compression Stockings (TED hose): ☐ Thigh ☐ Knee ☐ IPC (Bilateral, calf-length) ☐ Other: _____ Reason: _____
Highest Risk (Total = 5 or more Points) Early ambulation + Pharmacologic **AND** Mechanical	40 – 80%	☐ Enoxaparin 40mg subcutaneously once daily[β] ☐ Enoxaparin 30mg subcutaneously Q 12 hours for **TKR, THR, hip fracture, SCI, and trauma patients only** ☐ Graduated Compression Stockings (TED hose): ☐ Thigh ☐ Knee **AND** IPC (Bilateral, calf-length) ☐ Other: _____ Reason: _____

KEY: [α] Select only one surgery type. Surgery patients must be evaluated for risk within 24 hours after surgery.
[β] If CrCl < 30mL/min, pharmacist may adjust to 30mg subcutaneously once daily and if BMI > 50, use 40mg subcutaneously BID.
HIT: Heparin Induced Thrombocytopenia, **TKR**=Total Knee Replacement, **THR**=Total Hip Replacement, **SCI**= Spinal Cord Injury, **BMI**=Body Mass Index

MONITORING:
☑ **CBC (with platelet + hemogram) at the initiation of therapy and every 3 days while on heparin or enoxaparin.**

ORDERS:
☐ **Consult Clinical Pharmacist Coordinator for alternatives.**

Physician Signature: _____ **Date:** _____ **Time:** _____

Risk Factors (RF):
If you reach total of ≥ 5 Points, stop and order HIGHEST RISK Prophylactic Therapy!

Each Risk Factor Represents 5 Points
☐ Acute spinal cord injury (paralysis) (< 1 month)
☐ Elective major lower extremity arthroplasty
☐ Hip, pelvis or leg fracture (< 1 month)
☐ Major surgery lasting over 3 hours[α]
☐ Multiple trauma (< 1 month)
☐ Stroke (< 1 month)
☐ Other: _____

5 Point Subtotal: **Total RF:** ___ x 5 = _____

Each Risk Factor Represents 3 Points
☐ Age 75 years or more
☐ BMI > 50 (venous stasis syndrome)
☐ Personal History of DVT/PE
☐ Family History of DVT/PE
☐ Positive Lupus anticoagulant
☐ Congenital or acquired thrombophilia
☐ Antithrombin III deficiency
☐ Positive antiphospholipid antibodies
☐ Major surgery lasting 2 -3 hours[α]
☐ Other: _____

3 Point Subtotal: **Total RF:** ___ x 3 = _____

Each Risk Factor Represents 2 Points
☐ Age 60 – 74 years
☐ BMI 41 - 50
☐ Major/arthroscopic/laparoscopic surgery lasting 45 minutes – 2 hours[α]
☐ Present cancer or chemotherapy
☐ Central venous access
☐ Other: _____

2 Point Subtotal: **Total RF:** ___ x 2 = _____

Each Risk Factor Represents 1 Point
☐ Age 41 – 59 years
☐ BMI: 25 – 40
☐ Abnormal pulmonary function (COPD)
☐ Acute myocardial infarction
☐ Congestive heart failure
☐ History of inflammatory bowel disease
☐ History of prior major surgery (< 1 month)
☐ History of unexplained stillborn infant, recurrent spontaneous abortion (≥ 3), premature birth with toxemia or growth-restricted infant
☐ Leg plaster cast or brace
☐ Medical patient currently at bed rest
☐ Minor surgery planned[α]
☐ Oral contraceptive or hormone replacement therapy (i.e. estrogen)
☐ Pregnancy or postpartum (< 1 month)
☐ Sepsis (less than 1 month)
☐ Serious lung disease including pneumonia (< 1 month)
☐ Swollen legs (current)
☐ Varicose Veins
☐ Other: _____

1 Point Subtotal: **Total RF:** ___ x 1 = _____

TOTAL RISK FACTORS SCORE:		☐ ≥ 5 Points

03/06/2013
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APPENDIX 2: BSLMC VTE BPA