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ORIGINAL RESEARCH

Asymptomatic Deep Vein Thrombosis in Patients Undergoing Screening Duplex Ultrasonography

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BACKGROUND: Because of concerns for propagating clots into pulmonary emboli by the placement of pneumatic compression boots (PCBs), the standard of care at our institution was to perform a duplex Doppler ultrasound with compression (DUSC) before applying PCBs. We sought to determine the rate of asymptomatic preexisting deep vein thrombosis (DVT) in hospitalized patients who underwent DUSC before PCB.

METHODS: We evaluated consecutive patients who underwent lower extremity DUSC within 48 hours of admission. All patients were assessed for DVT risk factors using the American College of Chest Physicians' criteria (American College of Chest Physicians Conference on Antithrombotic/Thrombolytic Therapy: Evidence-Based Guidelines, 9th Edition). A *t* test, Wilcoxon rank sum test, and χ^2 or Fisher exact test were used to compare patients characteristics according to DVT status. Logistic regression was used to determine the importance of each risk factor on the risk of DVT.

RESULTS: DUSC was performed during 1136 hospitalizations; 1071 patients were included in the dataset. Of those, 19 patients (1.8%) had asymptomatic DVT and had at least 1 risk factor; 16 (84.2%) had more than 1 risk factor. The only risk factors that were statistically significant were ambulatory dysfunction and thromboembolic disease history.

CONCLUSION: Few patients have asymptomatic DVT upon admission; all of these patients have at least 1 predisposing risk factor. There appears to be no need for DUSC prior to initiation of PCBs. DUSC evaluation for DVT may be of value if there is a history of previous DVT, ambulatory dysfunction, or more than 3 risk factors, as the information may change therapeutic approaches. *Journal of Hospital Medicine* 2014;9:19–22. © 2013 Society of Hospital Medicine

Hospital-acquired venous thrombus embolism (VTE) is a pressing patient health and safety issue and has been identified as a causal factor in preventable deaths in the hospital setting.[1,2] More than 540,000 hospitalizations with VTE occur each year among adults in the United States.[3] The number of adults with VTE is anticipated to increase from 0.95 million in 2006 to 1.82 million in 2050.[4] The Institute of Medicine has defined failure to provide adequate thromboprophylaxis to hospitalized, at-risk patients as a medical error.[2,5] The American College of Chest Physicians guidelines state that thromboprophylaxis is highly effective at preventing deep vein thrombosis (DVT) and proximal DVT, highly effective at preventing symptomatic VTE and fatal pulmonary emboli (PE), and that the prevention of DVT also prevents PE.[6] Where anticoagulation is contraindicated, mechanical methods of thromboprophylaxis are recommended as preferable to no thromboprophylaxis, with careful attention directed toward ensuring the proper use of, and optimal adherence with, mechanical prophylaxis.[7,8] In our institution, concerns about the existence of asymptomatic clots being propagated into PEs by the placement of pneumatic compression boots (PCBs), led to routine performance of duplex Doppler ultrasound with compression (DUSC) before applying PCBs to those patients who were admitted and who were deemed to have a contraindication to anticoagulation prophylaxis. The recently released (April 2012) American College of Radiology Choosing Wisely list of practices specifically recommends forgoing imaging for DVT and PE in the absence of risk factors.[9] The recommendations do not specifically address screening for DVT prior to the initiation of prophylaxis. The goal of this prospective observational study, conducted prior to the Choosing Wisely campaign, was to verify our hypothesis that the prevalence of asymptomatic DVTs was very low, and provide our clinicians with evidence to allay concerns about placement of PCBs without imaging, allowing a practice pattern that would reduce costs without impacting patient safety.

METHODS

Study Population

We collected the records of all 1136 consecutive patients who underwent lower extremity DUSC within

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48 hours of admission to the hospital, prior to PCB placement, between October 2005 and November 2006. The decision as to what type of prophylaxis was appropriate for each patient and if a DUSC was necessary prior to PCB placement was up to the individual attending physician. The study patient population included elective and emergent admissions from the medical, surgical, and obstetrical services.

Data Source

Study patients were identified at the time of the screening duplex study and entered into the database. A test was considered positive if a clot was detected at the level of the popliteal vein, or higher, in either leg. Patients' charts were reviewed for identification of DVT, defined as a positive (same criteria) DUSC during the hospitalization. Pulmonary emboli were defined as a positive computed tomography angiogram or high-probability lung scan plus positive risk factors for DVT. A manual chart review (performed by J.U.), thoroughly examining all 1136 inpatient records, was completed to identify diagnoses and risk factors, which are defined as follows:

- Age >60 years.
- Cancer at time of admission or within 6 months of admission.
- Ambulatory dysfunction defined as diagnosis of ambulatory dysfunction stated in the electronic medical record (EMR), bedridden >3 days prior to admission, lower extremity cast or splinting, or major surgery (intra-abdominal, neurosurgery, cardiac surgery, or orthopedic surgery requiring admission) within 8 weeks of admission.
- Obesity defined as diagnosis of obesity in EMR or body mass index (BMI) >30.
- Acute stroke (cerebrovascular accident) or transient ischemic attack.
- Acute myocardial infarction or acute coronary syndrome.
- Previous DVT/PE documented in EMR.
- Genetic predisposition defined as documented as history of, but not limited to, factor V Leiden syndrome, antithrombin III deficiency, protein C deficiency, protein S deficiency, hyperhomocysteinemia, or prothrombin 20210 mutation.
- Hormone replacement/birth control pills defined as hormone replacement therapy, birth control pills, including Nuva Ring and Ortho Evra, pregnancy, or <6 weeks postpartum.

Sociodemographic data (age, gender, race, weight, height, and status of healthcare insurance) and time from arrival at the emergency room to ultrasound (US) examination were extracted from the EMR database.

The study was conducted with the approval of the Christiana Care Health Services institutional review board, and procedures were conducted in accordance with institutional guidelines.

Statistical Analysis

A t test or Wilcoxon rank sum test for continuous variables, and χ^2 or Fisher exact test for categorical variables, were used to compare demographic and clinical data according to the presence or absence of DVT. Logistic regression was used to determine the relative importance of each risk factor on the risk of DVT. Because the variable "time to US" was not normally distributed, we transformed it into a categorical variable using the median as the cut point. All the tests were 2-sided, and P values <0.05 were considered significant. We used Current Procedural Terminology (CPT) code 93970 and the associated 2012 Medicare National Average reimbursement of $261.07 to estimate the cost of DUSC that could be avoided. Data were analyzed using the Statistical Analysis System version 9.2 (SAS Institute, Cary, NC).

RESULTS

A total of 1136 consecutive records were examined; 4 records were excluded from the analysis because they had a diagnosed PE prior to US, and 35 records were excluded because the US was performed beyond 48 hours after admission. The final dataset included 1097 hospital admissions for 1071 patients. Of the 1097 admissions, 759 (69.2%) originated from the emergency department (ED). It is important to note that 70,161 hospital admissions occurred during the same time period, of which 36,363 (51.8%) were admissions that started in the ED. The proportion of patients requiring mechanical DVT prophylaxis is therefore very small (<5%), assuming that a large number of the patients with unplanned admissions would require DVT prophylaxis.

Of the 1071 patients in the final analytical dataset, 544 (50.8%) were male, the mean age was 65.5 years, the mean BMI was 28.7 (median, 27.0) (Table 1), and the majority of the patients were white. US was performed within 24 hours in 712 (66.5%) patients, and 665 (62.1%) had Medicare. An asymptomatic DVT was detected by DUSC in 19 patients (1.8%). None of the clinical and demographic characteristics were statistically different between those with DVT and without (Table 1).

Patients with DVT had at least 1 risk factor; 16 (84.2%) of them had 2 or more risk factors. In addition, the presence of 2 or more risk factors was much more frequent among those with DVT than among those without (84.2% [16/19] vs 58.4% [614/1052], $P = 0.03$).

As shown in Table 2, a history of DVT or PE and ambulatory dysfunction are the only risk factors associated with DVT at admission. In addition, the prevalence of DVT increases as the number of risk factors increases (Table 3). The prevalence is much higher in those who had 4 or more risk factors than among those with fewer than 4 risk factors (12.2% [6/49] vs 1.3% [13/1022], $P = 0.0001$).

TABLE 1. Demographic and Clinical Characteristics According to DVT Discovered at Admission

	Total, n = 1071	DVT, n = 19	Non-DVT, n = 1052	*P*
Male (%)	544 (50.8)	6 (31.6)	538 (51.1)	0.11
Age, y, mean ± SD	65.5 ± 16.3	71.4 ± 15.3	65.4 ± 16.3	0.11
BMI, kg/m^2, mean ± SD	28.7 ± 7.6	30.1 ± 12.9	28.7 ± 7.5	0.52
Time to US test from admission, h, median	19.9	21.3	19.8	0.72
Race				0.74
White (%)	802 (74.9)	15 (78.9)	787 (74.8)	
Black (%)	221 (20.6)	3 (15.8)	218 (20.7)	
Other (%)	48 (4.5)	1 (5.3)	47 (4.5)	
Duplex US test <24 hours (%)	712 (66.5)	12 (63.2)	700 (66.5)	0.81
DVT during admission (%)	2 (0.19)	0	2 (0.19)	1.0
PE during admission (%)	2 (0.19)	0	2 (0.19)	1.0
Medical insurance (%)				0.79
Self-pay	35 (3.3)	0 (0.0)	35 (3.3)	
Medicare	665 (62.1)	15 (78.9)	650 (61.8)	
Medicaid	44 (4.1)	1 (5.3)	43 (4.1)	
HMO	49 (4.6)	0 (0.0)	49 (4.7)	
Blue Cross	136 (12.7)	2 (10.5)	134 (12.7)	
Other	142 (13.3)	1 (5.3)	141 (13.4)	

NOTE: Abbreviations: BMI, body mass index; DVT, deep vein thrombosis; HMO, health maintenance organization; PE, pulmonary embolism; SD, standard deviation; US, ultrasonography.

TABLE 2. Risk Factors According to DVT Discovered at Admission

	Total, n = 1071	DVT, n = 19	Non-DVT, n = 1052	*P*
Age ≥60 years	702 (65.6)	15 (79.0)	687 (65.3)	0.33
Previous DVT or PE	80 (7.5)	9 (47.4)	71 (6.8)	<0.0001
Ambulatory dysfunction	228 (21.3)	9 (47.4)	219 (20.8)	0.01
Obesity	372 (34.7)	6 (31.6)	366 (34.8)	1.00
Heart failure	164 (15.3)	4 (21.1)	160 (15.2)	0.52
Stroke/TIA	75 (7.0)	3 (15.8)	72 (6.8)	0.14
Acute coronary syndrome	99 (9.2)	1 (5.3)	98 (9.3)	1.00
Active cancer	124 (11.6)	4 (21.1)	120 (11.4)	0.26
Hormone	30 (2.8)	0	30 (2.9)	1.00
Genetic	4 (0.4)	0	4 (0.4)	1.00

NOTE: Data are presented as number (%). Abbreviations: DVT, deep vein thrombosis; PE, pulmonary embolism; TIA, transient ischemic attack.

Results of the logistic regression, similar to those of the nonadjusted analysis, showed that the only risk factors independently associated with the discovery of a DVT upon DUSC were the presence of ambulatory dysfunction (odds ratio [OR]: 2.99, 95% confidence interval [CI]: 1.13-7.90) and a history of DVT or PE (OR: 10.51, 95% CI: 3.90-28.31) (Table 4).

We estimated a savings for Medicare of approximately $266,000 to $280,000 ($261.07 × 1071 DUSC or $261.07 × 1022 [after excluding the patients with 4 or more risk factors]) over 13 months had the DUSC not being conducted.

DISCUSSION

This study shows that discovering an asymptomatic DVT is relatively rare (<2%) in patients arriving at the hospital for all causes of admission, even taking into account multiple risk factors that increase the risk for DVTs. The study strongly supports the practice of placing compression devices as soon as possible for those patients who have a contraindication to anticoagulant prophylaxis. Along with reducing the delay to placement while awaiting the test, there is significant cost reduction to the healthcare system by not doing DUSC. There appears to be no need for diagnostic studies prior to the placement of these devices unless the patient has more than 3 risk factors or there is a history of previous DVT or ambulatory dysfunction. This study strongly supports the premise that patients are not arriving with DVTs, but are developing them in the hospital.[1,2,10] The 1.8% prevalence of asymptomatic DVT in this study is somewhat lower than that found in other studies. The Prophylaxis for Thromboembolism in Critical Care Trial (PROTECT) tested dalteparin vs unfractionated heparin on 3764 patients in the intensive care unit. Initial screening done to rule out DVT found that 3.5% of patients receiving dalteparin and 3.4% receiving unfractionated heparin had proximal DVTs.[8] Other Investigators used venous compression ultrasound examinations of the lower limbs to determine that 5.5% of patients hospitalized in a medical unit have an asymptomatic DVT of the lower limbs on admission.[5] A limitation of that study is the inclusion of all

TABLE 3. Prevalence of DVT According to the Number of Risk Factors

No. of Risk Factors	Total, n = 1071	DVT, n = 19 (1.8%)
0	100	0
1	341	3 (0.9%)
2	412	7 (1.7%)
3	169	3 (1.8%)
4	39	5 (12.8%)
5	10	1 (10.0%)

NOTE: The percentages in the DVT column represent the proportion of patients with DVT at each level of risk factors. For example, among the patients with 4 risk factors, 5 patients out of 39 (12.8%) had DVT. Abbreviations: DVT, deep vein thrombosis.

TABLE 4. Risk Factors Associated With DVT*

	OR†	95% CI	*P*
Age ≥60 years	1.76	0.53–5.84	0.353
Active cancer	2.12	0.63–7.17	0.227
Ambulatory dysfunction	2.99	1.13–7.90	0.027
Obesity	0.76	0.27–2.21	0.619
Heart failure	1.33	0.39–4.49	0.646
Stroke/TIA	3.00	0.77–11.70	0.113
Acute coronary syndrome	1.06	0.13–8.66	0.957
Previous DVT or PE	10.51	3.90–28.31	<0.0001
Time to duplex US (≥19.9 hours)‡	1.94	0.72–5.22	0.188

NOTE: Abbreviations: CI, confidence interval; DVT, deep vein thrombosis; OR, odds ratio; TIA, transient ischemic attack; PE, pulmonary embolism; US, ultrasonography.

*n = 1071.

†Adjusted OR.

‡19.9 hours is the median for the variable "time to duplex US."

thrombo emboli, specifically those found in the calf (19 out of 21, or 90%). However, if one eliminates the calf venous thrombi, not considered risk factors for PE, the prevalence of DVT (0.85%) is about half that of our observed 1.8%.

In common with previous studies, a history of previous thromboembolic disease was clearly the most significant of many evaluated risk factors for DVT.[5,6,10] Ambulatory dysfunction was also a statistically significant risk factor that was likely underreported here because of the inexact documentation in many of the medical records. Interestingly, a history of active malignancy did not prove to be a significant risk factor, contrary to other study reports.[5,6,10]

The frequency of asymptomatic DVT appears to increase with the accumulation of risk factors. An asymptomatic DVT existed in 1.3% of the patients with 3 or fewer risk factors, compared with 12.2% of those with 4 or 5 risk factors. It is possible that a higher number of risk factors for DVT would be an indication for obtaining a DUSC prior to the placement of PCBs, although the small number of patients with more than 3 risk factors in our study population may limit the strength of this observation.

Limitations

As commented above, the number of patients in whom ambulatory dysfunction is present may be higher than is captured, due to insufficient recognition and poor documentation. Other studies have found a wide variety of risk factors associated with admission and the development of DVTs.[2,5,6, 10] Our study was not designed to establish an all-inclusive list and/or prevalence of risk factors for thromboembolic disease. Another limitation is that only those patients who could not receive heparin prophylaxis received the DUSC evaluation. It is unclear if this could introduce bias inadvertently.

CONCLUSION

Our data strongly suggest, in alignment with recent recommendations, that there is no need to perform screening DUSC prior to the placement of prophylactic compression devices among hospital admissions who have contraindications to anticoagulation. Rather, efforts should be focused on implementing systems to ensure rapid placement of these compression devices at the time of admission for those patients who cannot receive anticoagulation prophylaxis. Evaluation for DVT may be of value if there is a history of previous DVT or PE, ambulatory dysfunction, or more than 3 risk factors, as the information may change the therapeutic approach. Current guidelines recommend the measurement of D-dimers as a screening tool for DVT.[11]

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