

| Area under the curve | |
|----------------------|-------------------------|
| F1 + 2 | 0.78 (95% CI 0.72-0.85) |
| D-dimer | 0.87 (95% CI 0.81-0.94) |
| ETP | 0.55 (95% CI 0.46-0.65) |
| F1 + 2 / ETP | 0.76 (95% CI 0.69-0.83) |
| D-dimer / ETP | 0.87 (95% CI 0.81-0.94) |

F1 + 2, prothrombin fragment 1 + 2; ETP, endogenous thrombin potential; CI, confidence interval.

Fig. Levels of the measured parameters in the deep venous thrombosis (DVT) negative and positive groups.

available enzyme-linked immunosorbent assay. The ETP was measured by the calibrated automated thrombogram assay. Differences between DVT-negative and DVT-positive patients were assessed with the Mann-Whitney *U* test. The area under the receiver operating characteristic curve was used to determine the overall performance of the measured parameters.

Results: The median age of the 253 patients (111 male) was 54 (range, 18-93) years. The DVT was confirmed by imaging in 51 (20%) patients. There was no significant age difference between the DVT-negative and DVT-positive groups ($P = .810$). The DVT-positive group had more men ($P < .001$). Levels of the measured parameters in the DVT-negative and DVT-positive groups are shown in the Fig.

Conclusions: A cohort without comorbidities or taking anticoagulants was selected in an attempt to show the isolated impact of lower extremity thrombosis on thrombin generation measured both in vivo and ex vivo. Levels of in vivo thrombin generation were increased in patients diagnosed with DVT vs those without. However, ex vivo ETP levels did not differ. Increased ETP levels are associated with increased risk of venous thromboembolism. Our observed discrepancy between in vivo and ex vivo parameters might be explained by a consumption of potential to generate thrombin ex vivo after an event that generates thrombin in vivo. Patients with high levels of in vivo thrombin generation parameters should thus have lower levels of ETP. A ratio of the in vivo biomarkers and ETP was therefore expected to have higher overall performance to diagnose DVT than F1+2 and D-dimer alone, which was not observed. The DVT increased the levels of F1+2 and D-dimer, but levels of ex vivo thrombin generation measured by ETP were not different from those without DVT.

Author Disclosures: E. Kalodiki: Nothing to disclose; F. Wexels: Nothing to disclose; O. Dahl: Nothing to disclose; J. Walenga: Nothing to disclose; W. Jeske: Nothing to disclose; O. Iqbal: Nothing to disclose; D. Hoppensteadt: Nothing to disclose; J. Fareed: Nothing to disclose.

Overuse of Lower Extremity Venous Duplex by the Emergency Department for Detection of DVT: Pilot Study to Evaluate Use of D-Dimers as a Screening Tool in Low-Risk Patients



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Objective: As the cost of health care remains a major concern for patients, providers, and payers, it has become increasingly important to evaluate resource utilization behaviors. The purpose of this study was to evaluate the utilization patterns of the emergency department in the ordering of lower extremity venous duplex ultrasound examinations for detection of acute deep venous thrombosis (DVT) and the use of D-dimer as a screening test in low-risk (by Wells criteria) patients. Estimated cost

at our institution is \$15 for the D-dimer test and \$300 for the venous duplex ultrasound scan.

Methods: All venous duplex ultrasound examinations that were ordered by the emergency department during the course of 10 days were evaluated. After-hours duplex ultrasound examinations were those ordered between the hours of 9 PM and 7 AM on weekdays and between the hours of 4 PM and 7 AM on weekends. Studies were evaluated for the patient's presenting complaint, indication for duplex ultrasound as documented in the provider's notes, results of the duplex ultrasound examination (positive vs negative for DVT), D-dimer studies, and Wells criteria scores.

Results: During this 10-day period, 68 lower extremity venous duplex ultrasound examinations were performed for emergency department patients, 28% of which were performed after hours ($n = 19$). Only 13% ($n = 9$) of these patients received concomitant D-dimer serum tests, of which 56% (5/9) of results were positive; 26 studies were bilateral, and only 5 studies were positive for acute DVT in one ($n = 4$) or both ($n = 1$) legs. Of 42 unilateral studies, only 9% ($n = 4$) were positive for acute DVT.

Among patients with Wells criteria score <2 , only 5 of 63 (8%) had a D-dimer sample sent. Among these, one had a positive duplex ultrasound scan. Five (8%) other positive duplex ultrasound scans occurring in the low-risk population did not have concomitant D-dimer samples sent. No patients with negative D-dimer results had acute DVT on duplex ultrasound examination.

Conclusions: Based on the preliminary results of our pilot study, it appears there is significant overutilization of venous duplex ultrasound imaging by the emergency department for DVT screening with underutilization of D-dimer in low-risk patients. Use of D-dimer tests instead of duplex ultrasound scan in low-risk (Wells criteria score <2) patients would have potentially saved \$16,359 during a 10-day period, which would be approximately \$597,104 per annum. Larger studies are recommended to examine the overuse of duplex ultrasound in the emergency department setting.

Author Disclosures: V. Lee: Nothing to disclose; C. Rockman: Nothing to disclose; M. Sadek: Nothing to disclose; G. Jacobowitz: Nothing to disclose.

Reference Data from the Vascular Laboratory and Application to Chronic Venous Disease Treatment



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Objective: Several population studies have described the incidence and prevalence of chronic venous disease (CVD). This prospective study was designed to determine in detail the distribution of reflux and obstruction in all lower limb veins to provide reference data for the management of CVD patients.

Methods: Consecutive patients presenting to a university vascular clinic and undergoing a duplex ultrasound examination were included in the study. Patients with C2 CVD class or higher regardless of symptoms or cosmetic concerns were evaluated. Every patient received a detailed history and physical examination by a vascular surgeon including all demographic information. All patients then had a bilateral lower extremity venous ultrasound examination for reflux and obstruction. The examination was performed in the standing position with the exception of iliac veins and inferior vena cava, which were assessed in the supine position. Location and extent of reflux, vein diameters, and presence of obstruction were recorded. Obstruction was characterized as partial or complete for each venous segment. History of objectively documented venous thrombosis and findings on ultrasound examination indicating previous thrombosis were noted.

Results: There were 491 patients who presented for evaluation. Excluded were 241 patients, of whom 49 had undergone previous treatment and 192 had only C0 or C1 disease bilaterally. The remaining 250 patients were 32.8% male and 67.2% female. The mean body mass index was 28.3 kg/m² (range, 19.2-44 kg/m²); 55.2% identified as white, 11.2% as black/African American, 23.6% as Hispanic/Latino/Spanish origin, and 0.8% as American Indian/Alaska Native. Asymptomatic patients accounted for 17% of the cohort and symptomatic patients for 83%. Clinical, Etiology, Anatomy, and Pathophysiology (CEAP) class was distributed as 43% C2, 28.8% C3, 15.2% C4, 7.6% C5, and 4.8% C6.

In the superficial veins, 70.4% of patients had only unilateral disease; 29.6% had bilateral disease. Axial reflux was found in one vein 53.2% of

the time; two veins, 27.6%; three veins, 4.8%; four veins, 4%; five veins, 0.8%; and six veins, 0.4%. Calculation of potential ablations was performed, excluding superficial reflux in 2.6% of limbs with small diameter, 5.6% with segmental reflux, 4.4% with tributary reflux, and 6.0% with non-saphenous reflux that would receive adjunct procedures including microphlebectomy or ultrasound-guided foam sclerotherapy. These adjunct procedures would account for 18.6% of therapy, whereas 64.0% would be ablative therapy. Past deep venous thrombosis was found in 7.2%; 2.8% had concurrent superficial and deep venous thrombosis.

Conclusions: From these data, we can assume that the average patient presenting with venous complaints would have symptomatic disease with great saphenous vein reflux and would require one or two ablations based on the prevalence of saphenous reflux in the population. Patients who had at least one saphenous vein with reflux would have an average of 1.6 ablations/patient.

Author Disclosures: **J. Crawford:** Nothing to disclose; **A. Gasparis:** Nothing to disclose; **N. Labropoulos:** Nothing to disclose.

Continuous Aspiration Thrombectomy of Acute Inferior Vena Cava and Inferior Vena Cava Filter Occlusions—Does It Work and Is It Safe?



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Objective: Acute thrombosis of the inferior vena cava (IVC) and IVC filters has significant morbidity. Traditional endovascular management is pharmacomechanical with varying amounts of thrombolytics. Hemorrhagic complications from thrombolytics can be life-threatening. Rheolytic thrombectomy is effective, but complications include blood loss and renal insufficiency. Continuous aspiration thrombectomy (CAT) has recently emerged as a viable option for patients with deep venous thrombosis. Early results suggest that CAT may minimize blood loss, hemorrhagic complications, and renal insufficiency. This study evaluated the safety and efficacy of CAT in treating acute IVC thrombus and acutely occluded IVC filters.

Methods: This is a single-center, retrospective study conducted to analyze patients with acute IVC thrombus and acutely occluded IVC filters undergoing CAT. Patients were treated between December 2015 and September 2018. All patients underwent CAT. The primary end point was the periprocedural success, defined as an antegrade flow after CAT. Secondary end points were total lytic dose, hemorrhagic complications, and blood loss.

Results: A total of 156 vacuum-assisted thrombectomy procedures were performed. Of these, 21 procedures were performed on patients with acute DVT, 8 of whom presented with thrombus in the IVC or had an acute IVC filter occlusion. Antegrade flow was established after vacuum-assisted closure in seven of these patients. The mean preoperative and postoperative blood loss was 12.3/36.6 and 9.8/29.5, respectively. Access site hematomas were reported in two patients. No other complications, such as perforation, intracranial hemorrhage, or retroperitoneal bleeds, were reported. The range of lytic dose was 0 to 35 mg, with an average of 20.5 mg.

Conclusions: CAT is an emerging technology for arterial and venous thromboembolism. This is the first study analyzing CAT for acute IVC thrombus and occluded IVC filters. The study results suggest that CAT is safe and promising for the treatment of acute IVC thrombosis and acutely occluded IVC filters. Further investigation is necessary to establish a protocol for CAT in patients with IVC disease.

Author Disclosures: **M. Broering:** Nothing to disclose; **B. Robertson:** Nothing to disclose; **A. Kulwicki:** Nothing to disclose; **B. Kuhn:** Nothing to disclose; **M. Recht:** honorarium Penumbra; **P. Muck:** honorarium, stock holder Penumbra.

Vein Surgery Practice Patterns Differ Between Vascular Surgeons and Other Physicians



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Objective: A dramatic increase in utilization of venous procedures has occurred during the past decade. Significant variation in practice pattern

among physicians has become apparent. Given the destructive nature of these procedures, this variation has the potential to lead to large disparities in the quality of care delivered to patients with venous disease. The aim of this study was to determine the variation in vein surgery practice patterns between vascular surgeons and other physicians.

Methods: A retrospective review of a health insurance procedure claims database for the years 2014 to 2016 was conducted. All ablation, sclerotherapy, and phlebectomy procedures were included. Physicians were classified as vascular surgeon or other physician based on American Board of Surgery vascular surgery board eligibility. Indications for each procedure were classified as “neither symptoms nor complications,” “symptoms only,” “complications only,” or “both symptoms and complications” based on the diagnosis codes associated with each procedure. Procedures performed on the same date were assumed to be part of the same case. The number of procedures and cases per patient was calculated. Distribution of indications for procedure and average procedures and cases per patient were compared between vascular surgeons and other physicians by χ^2 test and Welch t-test, respectively.

Results: A total of 368 procedures performed for 219 cases on 135 patients by 6 vascular surgeons and 11 other physicians were analyzed. The distribution of indication for procedures for vascular surgeons (neither symptoms nor complications, 0; symptoms only, 27; complications only, 97; both symptoms and complications, 71) was significantly different from that for other physicians (neither symptoms nor complications, 10; symptoms only, 81; complications only, 61; both symptoms and complications, 21; $P < .0001$; Fig 1). Vascular surgeons performed the

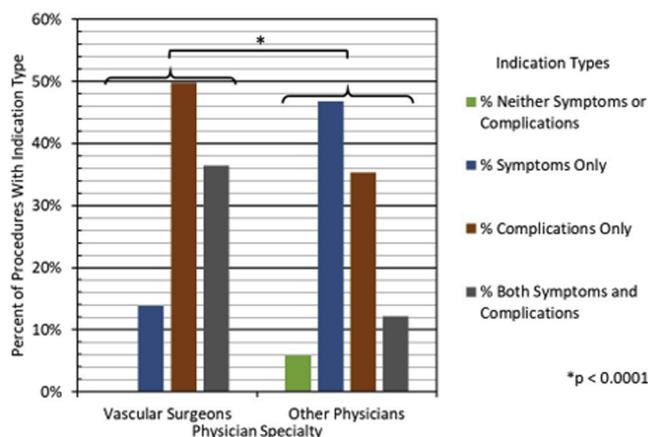


Fig 1. Indications for procedure by specialty.

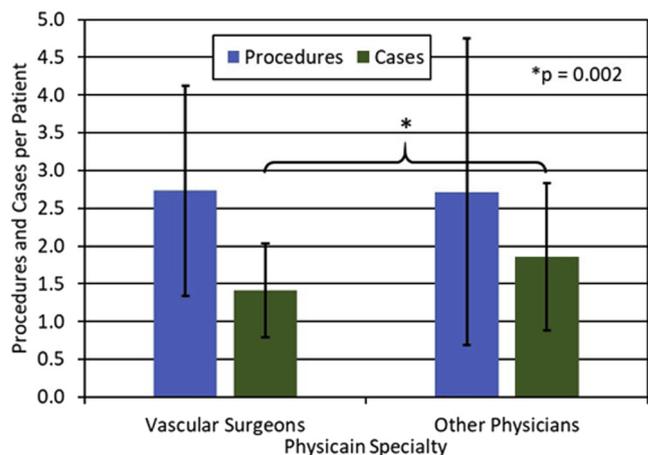


Fig 2. Procedures and cases per patient.