Clinical Science

Line-associated thrombosis as the major cause of hospital-acquired deep vein thromboses: an analysis from National Surgical Quality Improvement Program data and a call to reassess prophylaxis strategies

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Abstract

BACKGROUND: Quality improvement has mitigated the occurrence of postoperative deep vein thromboses (DVTs); however, despite adherence to protocols, they continue to occur. This study aimed to characterize their rate and distribution at our institution, and appropriate use of thromboprophylaxis.

METHODS: Local American College of Surgeons National Surgical Quality Improvement Program data were queried for general surgery cases complicated by DVT from 2009 to 2011. Medical records were evaluated to ascertain the following: classify DVTs by site, ascertain if appropriate prophylactic measures were instituted, evaluate treatment instituted, evaluate the occurrence of a PE if the DVT was line-associated, and if so, the indication for the central line.

RESULTS: Of 1,857 patients, 39 had postoperative DVTs (2.1%). Fourteen lower-extremity (35.9%) DVTs, 4 central (10%) DVTs, and 21 upper-extremity (53.8%) DVTs (UEDVTs) were captured. All but 2 had appropriate thromboprophylaxis. All but one UEDVT was line-associated. Diagnoses were prompted by symptoms in 72% of the patients. Pulmonary emboli developed in 3 of 39 patients.

CONCLUSIONS: An unexpected finding was that line-associated UEDVTs comprised over half of all DVTs, mostly in patients without cancer. This analysis highlights the need for more selective central-line use; choosing peripheral access may reduce DVT rates further. Improved pharmacoprophylaxis protocols would likely benefit this population.

Deep vein thrombosis (DVT) is a significant complication of the inpatients and especially postoperative populations, resulting in serious morbidity and mortality. In the past, it was the leading cause of operative-related mortality with an estimated 900,000 cases reported each year, of which approximately 300,000 died from fatal pulmonary emboli (PEs).1,2 As such, the DVT rate has been the target of a number of quality improvement measures aimed at...
Reducing this burden. Routine use of antithrombin-3 inhibitors and vitamin K antagonists, in addition to early ambulation and mechanical prophylaxis, has reduced the rate of DVTs significantly and has even further dropped the mortality from a rate of 30% if untreated to 5% to 1.5% with treatment.3 At our institution, we were initially noted to be higher than average with regard to our postoperative DVT rate before rigorous institution of pharmacologic and mechanical prophylaxis. According to the American College of Surgeons National Surgical Quality Improvement Program Participant Use Data File (ACS-NSQIP PUF), national DVT rates average .7%, while the rate at our institution reached 2.1%. The objectives of this study were to examine the current rate of postoperative DVTs in postsurgical patients at our institution, whether or not appropriate anticoagulation measures were being utilized, and the specific site and cause of DVT.

Methods

After approval by the Institutional Review Board of the Cleveland Clinic Foundation, retrospective data from the NSQIP PUF was extracted for our tertiary care hospital from the ACS-NSQIP PUF between January 2009 and June 2011. The ACS-NSQIP PUF is a Health Insurance Portability and Accountability Act – compliant, multi-institutional data source available to researchers affiliated with ACS-NSQIP hospitals.4 The PUF contains aggregate data submitted by participating hospitals with associated patient-level information. Data are collected by trained chart reviewers and compiled by the ACS-NSQIP. The use of this database has been well-described elsewhere in the literature.5,6 Once patients were identified, a review of their Electronic Medical Records was undertaken to classify them by DVT site; ascertain whether or not appropriate prophylactic anticoagulative measures were instituted before surgery; what treatment regimen was instituted once a DVT occurred, if a concomitant PE resulted; whether or not the DVT was the result of a central venous catheter (CVC), and if so, the indication for the CVC. Appropriate prophylaxis complied with the C.H.E.S.T. 9th edition guidelines, and is delineated in Fig. 1.

General surgery patients were chosen as the study population because historically this cohort has the highest DVT rate, thus quality improvement initiatives would have the largest opportunity for improvement.

The primary outcome measure was the occurrence of a postoperative venous thromboembolism (VTE), defined as either a DVT or a PE, within 30 days of the primary procedure. Deep venous thrombosis is defined as the identification of a new blood clot or thrombus within the systemic venous system. This diagnosis is confirmed by duplex ultrasonography, venogram, or computed tomography (CT) in the case of visceral DVTs. ACS-NSQIP defines a PE as a lodging of blood clot in the pulmonary arterial system with subsequent obstruction of blood supply to the lung parenchyma. A PE was considered to have occurred if the patient had a ventilation–perfusion scan interpreted as “high probability” of PE, a positive pulmonary arteriogram, or a positive spiral CT examination or angiogram.

Results

Of 461,231 general surgery patients in NSQIP between 2009 and 2011, 2,943 developed a DVT (.7%). Of this general population, a total of 1,857 postoperative patients were captured in the NSQIP database from our institution, of whom 44 had developed a VTE complication (2.1%). When risk adjustment was performed, the expected rate at our institution was 1.6%. Five individuals were recorded as having a DVT in the NSQIP PUF, but on review of electronic medical records they either had no documentation of such and no confirmatory scans or had been diagnosed previously at an outside hospital, thus these were excluded from the
database. Mean age was 53 years with an average body mass index of 30.5. Index cases included 6 hepatobiliary, 16 colorectal, 5 ventral hernia, 5 small bowel or abdominal, and 2 others. Twelve were cancer operations. Current smokers comprised 17.2% with diabetics 16.1%. Approximately 80% had 2 or fewer comorbidities. Twenty-one of the 39 DVTs were found in the upper extremity (53.8%). All but one of these (an internal jugular DVT) were line-associated.

Fourteen of the 39 DVTs were in the lower extremity (35.9%), none of which were line-associated, and 4 (10%) were central DVTs in the mesenteric or innominate vessels (Fig. 2). Ultrasound was used in the detection of all extremity DVTs, CT was used to diagnose central DVTs and PEs. Patients were symptomatic in 76.9% with the remainder being detected because of routine screening by intensive care unit protocols. Pulmonary embolism occurred in 3 lower-extremity DVTs (7.7%) with no subsequent fatalities after appropriate anticoagulant therapy. All but 2 patients received appropriate thromboprophylaxis via subcutaneous antithrombin-3 inhibitors or compression stockings based on the complexity of the index procedure, for a compliance rate of 94.9% (Fig. 3).

Figure 2  Distribution of DVTs found in general surgery patients. Upper-extremity DVTs comprised greater than half of all DVTs, which increased further if central thromboses are not considered.

Conclusions

Despite aggressive measures, venous thromboemboli remain a source of medical burden in the surgical patient population. Further evaluation of our data will be needed to discern what effect such measures have had on our overall rate as well as its distribution; however, literature has shown that appropriate use of thromboprophylaxis has significantly

tunneled catheters (Fig. 4). Indications for placement of lines included total parenteral nutrition (TPN) administration in 11 cases because of postoperative ileus, malabsorption, or preoperative correction of nutritional state, long-term intravenous antibiotics in 3 cases, need for central access for administration of fluids and medications in 4 cases, and dialysis in 1 patient (Fig. 5).

Figure 3  Fourteen of the 39 DVT cases occurred in the lower extremities (3 iliac, 5 femoral, and 6 calf). All had appropriate antithrombotic prophylaxis. Pharmacologic prophylaxis was held in 3 cases because of elevated bleeding risk. Twenty-one of 39 DVT cases occurred in the upper extremities (9 subclavian and 12 internal jugular). All but one (an internal jugular DVT) were line-associated. All lower-extremity DVT patients received appropriate prophylaxis. A total of 2 of the 21 upper-extremity DVT patients did not receive appropriate prophylaxis in that they had compression devices only, when subcutaneous heparin was warranted.

Figure 4  Of the 20 line-associated DVTs captured in the database, 10 were peripherally inserted, 7 were non-tunneled, and 3 were tunneled.
reduced the DVT rate and subsequent morbidity and mortality of PEs. At this time, the rate of lower-extremity DVTs in our general surgery population has fallen to <1%, to the point that over half of all surgical DVTs are now in upper-extremity locations. In fact, this value is likely underreported, considering that when surveillance screening is performed on hospitalized patients, the UEDVT rate has been recorded at as high as 40% in patients with CVCs. According to the recent literature, the most significant risk factors for UEDVTs are the presence of CVC with an odds ratio of 9.7 (CI 7.8 to 12.2), followed by cancer, and major surgery within 30 days. This held true in our study population, since nearly all of our UEDVTs were line-associated; however, only 19% of these patients had cancer. In addition, a significant number of these were found in patients who had received PICC lines, indicating that while these peripherally inserted catheters may be beneficial from an infectious disease standpoint, they still pose a significant risk with regard to thrombosis. In addition, the NSQIP database only samples post-surgical patients, meaning that the true incidence of UEDVTs is likely higher in the overall hospital population considering that PICC lines are used in a greater proportion of non-surgical patients.

Although UEDVTs have a much lower incidence of PE progression, they nonetheless carry a risk of post-thrombotic syndrome (PTS). The PTS, caused by venous hypertension secondary to outflow obstruction and valvular injury, varies from mild edema with little discomfort to significant arm swelling, heaviness, and fatigue with exertion, along with dilation of the superficial veins of the upper arm and chest wall, dependent dusky cyanosis of the arm, and occasionally neuropathy of the distal aspect of the affected extremity. These symptoms can result in permanent morbidity. Current literature cites the rate of PTS at approximately 20% of patients in the 2 years following DVT, of whom 10% may develop severe PTS involving persistent edema, and neuropathic pain and paresthesias. In addition, the loss of central access by DVT formation and the rare occurrences of superior vena cava syndrome or PE all justify the need for improved prevention of CVC-related DVTs.

Current quality improvement measures typically focus on the pathophysiology that predisposes to the formation of the de novo thrombi classically found in lower extremities. To date, no QI measures have been focused on the reduction of UEDVTs at our institution, and no literature exists currently regarding a system-wide implementation of protocols aimed at reducing this burden in a surgical population. Although surgical patients all receive prophylactic anticoagulation pre- and postoperatively, central-line placement is not currently an indication for such treatment. Furthermore, patients who are discharged with PICC lines receive no thromboprophylaxis whatsoever according to our homecare protocols, and there is little in the literature to indicate that this has been widely investigated. On the other hand, pharmacoprophylaxis for cancer patients with CVCs is well-described in the literature. Surveillance studies have noted as high as a 48% rate of catheter-related-thrombosis in this patient population. Monreal et al noted efficacy of subcutaneous heparin in the prevention of catheter-related DVTs with a 57% reduction in the rate of UEDVT in cancer patients who had long-term central access placed. Nonetheless, very few studies have broadened this concept beyond the cancer population. A recent abstract in the Journal of Hospital Medicine evaluated the use of standard pharmacoprophylaxis on Internal Medicine patients with central lines and found a decreased incidence of UEDVT from 5.2 per 1,000 to 2.9 per 1,000.

Such studies define the need for expansion of such interventions to the surgical patient population. The general surgical population historically is at higher risk for VTE than the Internal Medicine population, suggesting that the use of pharmacoprophylaxis in that population would likely be warranted in the higher risk group. In addition, considering that 81% of our UEDVTs were not cancer related, this indicates that the presence of a CVC is a highly significant risk factor for DVT by itself, even in the absence of other contributing factors such as cancer, in the surgical population. When evaluating our lower-extremity DVT rates, it is clear that our institution is well within the acceptable range. It may be said at this point that compliance to protocols which have been classically focused on the inhibition of de novo thrombus formation have essentially reached their maximum. In fact, a recent study from Johns Hopkins University noted that nearly all colorectal surgical patients who developed VTE were on current best practice prophylaxis, yet their rate remained high at 4.1%. Similarly, nearly all of our patients received appropriate prophylaxis (Fig. 3). As such, considering our DVT distribution, it appears that improved reduction of morbidity and mortality needs more than just the standard protocols focused on lower-extremity DVTs and would include the development
of standard treatment and prevention protocols for line-associated DVTs. Although the C.H.E.S.T guidelines extensively discuss the protocols for prevention and treatment of de novo VTE, they have very little that addresses prevention of catheter-related disease. In fact, they note specifically in their conclusion that the appropriate approach to UEDVTs, both in terms of treatment options and duration of care, is a question that needs to be answered with new research.18

In summary, our findings illustrate the need for measures that aim to reduce the overuse of CVCs both in terms of placement and in duration of use. Heightened recognition of this issue is warranted, with institutional protocols that address continued assessment of indication and duration for central access. We recommend that CVCs should not be placed if any alternative is available, such as midline or peripheral intravenous. Placement solely for the sake of access should be avoided if at all possible. When central access is specifically required, daily assessment as to its continued need should occur. Given current best evidence, when an UEDVT occurs, anticoagulation with a vitamin K antagonist should be performed for a period of 3 months. Finally, given the high proportion of our DVT which occurred with PICC lines after discharge, we are also currently in the process of evaluating potential benefits of pharmacoprophylaxis at home in these patients, as literature is currently conflicted regarding this practice.19–21 Ultimately, our findings illustrate the need for further studies that broaden the evaluation of chemoprophylaxis for the presence of CVCs to the entire surgical population, not just those with cancer, to determine if the presence of a CVC is an indication for pharmaceutical prophylaxis in and of itself.

References