Objective: To characterize the location, incidence, and timing of deep venous thrombosis (DVT) after general surgical procedures.

Design: Retrospective data review.

Setting: University hospital.

Patients: Of 2189 patients who underwent general surgical operation, 35 (1.6%) developed DVT afterward.

Main Outcome Measures: Main outcome measures included patient characteristics, location of DVT (lower vs upper), time of DVT diagnosis from the index operation (days), time of diagnosis according to discharge (inpatient vs outpatient), any associated pulmonary embolism, and mortality.

Results: There were 22 men and 13 women with a mean age of 58 years. The index general surgical operations included pancreatic surgery (n=10), esophagogastric surgery (n=8), intestinal/colorectal surgery (n=13), and other (n=5). Diagnosis of DVT was based on symptoms in 94.3% of cases and based on routine duplex screening in 5.7% of cases. Upper extremity DVTs occurred in 40%; lower extremity DVTs occurred in 45.7%; and combined upper and lower extremity DVTs occurred in 14.3% of patients. The mean time between diagnosis of DVT and the index operation was 8.6 days with 29 of 35 patients (83%) with DVT diagnosed as an inpatient and 17% diagnosed in the outpatient setting. Catheter-associated DVT occurred in 21 of 35 patients (60%); 19 patients had an upper extremity catheter and 2 patients had a femoral catheter. Twenty-two of 35 patients (62.9%) with postoperative DVT had other concomitant complications such as ventilator dependency, sepsis, renal failure, surgical site infection, and pneumonia. Deep venous thrombosis with concomitant pulmonary embolism occurred in 4 of 35 patients (11.4%), with 1 of these 4 patients having only upper extremity DVT. The 30-day mortality in this study cohort was 14.2%.

Conclusions: In the presence of prophylaxis, the incidence of DVT after general surgical operation is low, with more than 80% of cases diagnosed in the inpatient setting. Since more than half of the DVTs are catheter induced, efforts for DVT prevention should include more attention to the need for a central catheter, limiting the amount of time of a central catheter, and possibly the use of anticoagulation in the presence of a central catheter.


A S THE LEADING CAUSE OF OP-erative-related mortality, venous thromboembo-lism (VTE) and its prophylaxis in the surgical community is becoming increasingly important and prevalent.1 The most recent evidence suggests that more than 900 000 cases occur annually, with one-third of those ultimately having a fatal pulmonary embolus.2,3 Up to 40% of general surgery patients will develop deep venous thrombosis (DVT) in the absence of prophylaxis, with a 2-fold increase in incidence if the patient has a concurrent malignancy.4 Previous evidence suggested that one-quarter of patients undergoing high-risk abdominal surgeries received no VTE prophylaxis, while one-half received inadequate preventive measures.5 Surgeons have long resisted adoption of aggressive chemoprophylaxis methods because of bleeding concerns. However, more recent data suggest that bleeding complications in general surgical patients who received prophylaxis occur in less than 3% of cases, and these complications are reduced when lower-dose chemoprophylaxis is used.6 One of the best-studied populations comes from the Apollo Trial, which demonstrated nearly a 70% reduction in VTE when chemoprophylaxis was combined with mechanical methods and a low 1.6% rate of major bleeding.7
While the frequency and severity of DVT have been well documented in several surgical subspecialties, data regarding DVT development after general surgical operations is less compelling. Best current evidence would suggest that the risk of developing DVT after a general surgical operation without thromboprophylaxis ranges from 10% to 40%, with an associated 1% mortality risk. For this reason, the American College of Chest Physicians has published the eighth edition of their practice guidelines for prevention of VTE, which outlines appropriate indications for VTE thromboprophylaxis after general surgery operations. However, few data exist regarding the specifics of DVT formation when general surgical patients receive adequate prophylaxis. The purpose of this study was to further characterize the incidence, location, and timing of DVT formation in the setting of thromboprophylaxis after general surgical operations.

### METHODS

Retrospective data from the National Surgical Quality Improvement Program (NSQIP) database at a tertiary care university hospital were analyzed over a 2-year period from January 1, 2008, through December 31, 2009. Data at the University of California Irvine Medical Center are collected by 1 NSQIP-trained reviewer who reviews medical records of patients undergoing general and vascular surgery according to the method of collection established by NSQIP. Records are reviewed for all perioperative complications that occur within 30 days of the index operation. Patients are risk stratified using standardized and validated criteria, allowing uniform comparison of patients with varying perioperative risk for morbidity and mortality. Retrospective medical record review of patients who developed DVT in the perioperative period was performed. Index general surgical cases for these patients include pancreatic surgery, esophagogastric surgery, intestinal/colorectal surgery, and “other.” Deep venous thrombosis was defined as the presence of documented venous thrombosis within deep veins requiring either anticoagulation therapy or placement of a vena cava filter. Main outcome measures included patient characteristics, demographics, location of the DVT (lower vs upper extremity), the presence of a concomitant central catheter, time of DVT diagnosis from index operation (days), time of diagnosis with regard to inpatient vs outpatient status, the presence of any associated pulmonary embolism, and 30-day mortality.

### RESULTS

A total of 2189 general surgery operations in the NSQIP database were identified during the 2-year study period. Of those, 35 patients (1.6%) were identified with DVT in the perioperative period (Table). Twenty-two patients were male and 13 were female. Mean age of the study patients with DVT was 58 years. The index operations for these 35 patients included 10 patients who underwent pancreatic surgery, 8 patients who underwent esophagogastric surgery, 13 patients who had intestinal or colorectal surgery, and 5 patients who had a variety of “other” procedures. Diagnosis of DVT was made based on symptoms in 94.3% of cases and by routine duplex screening in 5.7% of cases. Of the 35 patients, upper extremity DVT accounted for 40% of cases, while lower extremity DVT accounted for 45.7% of cases. The remaining 14.3% of cases had combined upper and lower extremity DVT. The mean time between diagnosis of DVT and the index operation was 8.6 days. Of the 35 patients, 29 (83%) were diagnosed as inpatients while 6 patients (17%) were diagnosed in the outpatient setting. The majority of patients (21 of 35 patients [60%]) had an indwelling central or peripherally inserted central catheter, 19 patients had an upper extremity catheter, and 2 patients had a femoral catheter. Twenty-two of 35 patients (62.9%) with postoperative DVT had other associated morbidities, including ventilator dependency, sepsis, renal failure, surgical site infection, and pneumonia. The same number of patients had a concurrent malignancy. The incidence of DVT with concomitant pulmonary embolus was 11.4% (4 of 35 patients); 1 of these 4 patients had an isolated upper extremity DVT. The 30-day mortality of our cohort of patients was 14.2%. Compliance with DVT prophylaxis in accordance with Surgical Care Improvement Program criteria averaged 93% over the study period.

### COMMENT

Since the integration of the NSQIP database at our institution 3 years ago, significant progress has been made toward elucidating our outcomes and allowing resources to be put toward improving those outcomes. As expected, the vast majority of patients who developed DVT underwent surgery for malignant disease, underscoring the high-risk nature of this patient population. We found a high frequency of upper extremity DVT (40%) and association with a central venous catheter (CVC) (60%), which shed considerable light on the presence of central catheters as a risk factor for DVT in our institution. Nearly 63% of those patients diagnosed with DVT had other complications such as ventilator dependence, sep-
sis, infection, renal failure, and pneumonia, which suggests that complications beget complications. Postoperative complications can be an inciting factor for a hypercoagulable state that leads to DVT development. Severe ill patients with postoperative complications are patients who require the highest level of chemoprophylaxis. Overall mortality of this cohort approached 15% because of the extremely ill nature of this patient population and risks for postoperative complications.

Overall rates of DVT formation differ widely because of variability in study populations, as well as variable detection methods used for DVT diagnosis. Leonardi et al. performed a meta-analysis on 55 randomized controlled trials of nonorthopedic surgical patients. In that study, the overall incidences of DVT ranged from 6% to 12% without chemoprophylaxis to 2% to 5% with prophylaxis. A similar incidence of 0.6% to 1.6% was reported in a large Cochrane database study when maximal prevention included both mechanical and chemical prophylaxis. Other studies of bariatric patients reveal more progress in prevention, with rates as low as 0.06% for gastric bypass patients, while a separate group of patients randomized to laparoscopic vs open cholecystectomy had rates of DVT of 7% and 16%, respectively. Taken as a whole, our DVT incidence of 1.6% appears favorable compared with that of similar general surgical operations elsewhere. Most other trials also use routine surveillance duplex scanning to detect the presence of DVT, although the earlier-mentioned bariatric study identified patients solely based on symptoms. This difference in active surveillance vs symptomatic identification of DVT alone explains the relatively low incidence among those high-risk bariatric patients. In our study, 5.7% of patients were identified through surveillance alone; however, we were unable to obtain the total number of patients who underwent DVT screening during the same period, precluding us to calculate the true incidence of DVT based on screening.

Other studies have examined the value of posthospital chemoprophylaxis in high-risk patients. Our data found 83% of DVT diagnoses were made in the inpatient setting, with only 17% occurring in the outpatient setting. A recent Cochrane review found the overall incidence of VTE decreased from 14.3% to 6.1% in those patients treated for 30 days postoperatively and that symptomatic VTE fell from 1.7% to 0.2%. All patients in the Cochrane review were surveilled postoperatively, whereas those in our series underwent surveillance duplex scanning randomly and only while in the hospital, explaining the disproportionate number of patients screening positive for DVT. Our hospitalwide compliance with routine DVT prophylaxis in accordance with Surgical Care Improvement Program criteria averaged 93% over the study period.

The role of a CVC as a risk factor in development of DVT is well established. The incidence of clinically overt DVT related to CVC in nonsurgical patients with cancer ranges from 0.3% to 28%. However, in studies that included routine surveillance via duplex scanning of the upper extremities, rates of detection in asymptomatic patients rose to 30%. In our study, 60% of patients who developed DVT had associated central catheters. All of the CVCs used in this patient population were placed for either total parenteral nutrition or venous access, with the former composing the minority. Unfortunately, we were not able to determine the true incidence of CVC-associated DVT because of the lack of data regarding the number of patients in our cohort who received CVC during the study period. A recent Cochrane review analyzed the use of chemoprophylaxis in patients with cancer with CVC and showed a trend toward reduction in symptomatic DVT but failed to show decreased mortality. The combination of cancer and CVC in the presence of a general surgical operation may warrant further study to determine the benefit, if any, of more aggressive or higher-dose chemoprophylaxis in this particular patient population. The results of our study also stress paying attention to the need for CVC use and limiting the time of its use.

This analysis has several shortcomings. First, it is a retrospective review, which does not permit comparison of different patient groups to analyze a difference in DVT prevention among various patient populations. Use of the NSQIP database also has inherent limitations in that most institutions use index cases and typically do not capture all surgical cases performed in that hospital. This permits sampling error to take place within the data. The data on the number of patients who underwent surveillance duplex scanning for DVT are not available. Therefore, the true incidence of DVT based on screening cannot be determined. Similarly, the data on the number of patients who had associated CVC are not available; hence, we were unable to determine the true incidence of CVC-associated DVT. Finally, other studies confirm that screening for DVT yields higher rates so an ideal study should institute screening for DVT.

The incidence of DVT after general surgical operations is low, with most cases diagnosed as inpatients. With more than half of DVTs being caused by central catheters, efforts toward DVT prevention should include closer scrutiny to the need for central catheters, including limiting the duration of central catheters, and consideration of the added use or perhaps higher dose of anticoagulation when central catheters are present.

Accepted for Publication: May 16, 2011.
Published Online: August 15, 2011. doi:10.1001/archsurg.2011.204
Correspondence: Ninh T. Nguyen, MD, Division of Gastrointestinal Surgery, University of California, Irvine Medical Center, 333 City Blvd West, Ste 850, Orange, CA 92868 (ninhn@uci.edu).

Author Contributions: Study concept and design: Smith, Diniz, Stamos, and Nguyen. Acquisition of data: Smith, Diniz, and Nguyen. Analysis and interpretation of data: Smith, Stamos, and Nguyen. Drafting of the manuscript: Smith, Diniz, and Nguyen. Critical revision of the manuscript for important intellectual content: Stamos and Nguyen. Statistical analysis: Nguyen. Administrative, technical, and material support: Smith, Diniz, Stamos, and Nguyen. Study supervision: Stamos and Nguyen.

Financial Disclosure: None reported.
Previous Presentation: This study was presented at the 82nd Annual Meeting of the Pacific Coast Surgical Association; February 21, 2011; Scottsdale, Arizona.
REFERENCES