High Variation Between Hospitals in Vena Cava Filter Use for Venous Thromboembolism

Richard H. White, MD; Estella Marie Geraghty, MD, MS, MPH; Ann Brunson, MS; Susan Murin, MD, MSc; Ted Wun, MD; Fred Spencer, MD; Patrick S. Romano, MD, MPH

Background: The extent to which vena cava filter (VCF) use varies between hospitals in the management of acute venous thromboembolism (VTE) is not clear.

Methods: We conducted a retrospective observational study that compared the frequency of VCF use among California hospitals from January 1, 2006, through December 31, 2010. Using administrative hospital discharge data, we followed explicit criteria to identify non-trauma patients with acute VTE, and determined the frequency of VCF placement in each of the hospitals that admitted more than 55 VTE patients. Multivariable hierarchical regression models to predict VCF use included important clinical and demographic variables as fixed effects and hospital as a random effect.

Results: Among the 263 hospitals included, 130,643 acute VTE hospitalizations occurred with the placement of 19,537 VCFs (14.95%). Variation in the percentage of acute VTE hospitalizations that included VCF placement was very high, from 0% to 38.96% (interquartile range, 6.23%-18.14%), with 18.49% of the observed variation due to differences among the hospitals that provided care. Significant clinical predictors of VCF use included acute bleeding at the time of admission (odds ratio, 3.4 [95% CI, 3.2-3.6]), a major operation after admission for VTE (3.4 [3.3-3.5]), presence of metastatic cancer (1.7 [1.6-1.8]), and extreme severity of illness (2.5 [2.3-2.7] vs mild). Insertion of VCFs occurred more frequently than expected in 109 hospitals and less frequently in 59. Hospital characteristics associated with VCF use included a small number of beds (odds ratio, 0.2 [95% CI, 0.2-0.4], <100 vs >400 beds), a rural location (0.4 [0.2-0.5]), and other private vs Kaiser hospitals (1.5 [1.1-2.0]). Use of VCFs varied widely even in geographically proximate areas.

Conclusions: The frequency of VCF use in patients with acute VTE varied widely and depended on which hospital provided the care, even after adjusting for clinical and socioeconomic factors. Further research is needed to determine whether this variation is associated with local cultural differences between hospitals or with differences in the availability of interventional radiologists or specialists, or whether it reflects the absence of high-quality evidence that VCFs are effective.


The decision to use or not to use a vena cava filter (VCF) in a hospitalized patient with acute venous thromboembolism (VTE) is difficult. If anticoagulation treatment cannot be given, placement of a VCF may be the only treatment option available. In this situation, inserting a VCF likely provides ordering physicians with some comfort because a filter might benefit their patient by sieving the blood and preventing the migration of thrombi into the lungs. However, VCF use is associated with a higher incidence of lower extremity thrombosis, and there is no evidence that inserting a VCF improves survival. Moreover, recent reports indicate a high rate of fracture of some permanent and retrievable filters.3 Despite uncertainty about the relative benefits vs risks of VCFs, the use of VCFs continues to increase rapidly.4 The recent availability of retrievable VCFs has not reduced physician uncertainty about the effectiveness of VCFs. The Society of Interventional Radiology concluded that the quality of literature that pertains to VCFs is insufficient to support evidence-based recommendations.5,6 In a study of trauma patients throughout the United States, prophylactic use of VCFs varied dramatically between centers.7 The American College of Chest Physicians 2012 guidelines for antithrombotic treatment of VTE highlighted doubts about the benefits of VCFs in patients with acute VTE and recommended against using a VCF unless anticoagulant therapy is not possible because

See also pages 493 and 513

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of the risk for bleeding.8 In a recent population-based study of VCF use, 13% of hospitalized patients with acute VTE received a filter, but consensus remained among 3 experts that the use of a VCF was appropriate in only 50% of the patients.9

Variation in the provision of health care services may be the result of differences in the prevalence of disease, differences in access to care or the inclination to receive care, and local variation in physicians’ opinions about the risks and benefits of a treatment.10 The extent of variation in the use of VCFs between hospitals in the management of acute VTE has not been carefully studied. To explore this variation, we compared the frequency of VCF use in California hospitals in a 5-year period, focusing on patients diagnosed as having acute VTE.

METHODS

We designed this retrospective observational study to compare the frequency of VCF use among nonfederal hospitals in California from January 1, 2006, through December 31, 2010. To compare VCF use across hospitals, we restricted the analysis to hospitalizations that included a diagnosis of acute VTE without major trauma. Trauma cases were excluded because of the high rate of elective prophylactic VCF use in this population.7 This study was approved by the California Health and Welfare Agency Committee for the Protection of Human Subjects, and the University of California, Davis, institutional review board.

DATABASE

The California Patient Discharge Database contains information about all hospitalizations in the state, and serial records from a single person can be linked using an encrypted form of the Social Security number called the record linkage number.11,12 All Patient Discharge Database records include demographic information, a principal medical diagnosis, as many as 24 additional secondary diagnoses, a principal procedure, and as many as 20 secondary procedures coded using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM). Since 1996, all medical diagnoses in the Patient Discharge Database required a present-on-admission (POA) indicator. The database also includes a hospital identifier (with links to hospital category [eg, public, academic, and for-profit] and location [rural vs urban]) and each patient’s insurance status (eg, self-pay, Medicare, or private insurance).

ASSEMBLY OF ACUTE VTE COHORT

Trauma hospitalizations were identified and then excluded according to the presence of 1 major injury diagnosis code (listed in the eAppendix; http://www.jamainternalmed.com) or 2 or more injury ICD-9-CM codes (800.x-880.x). Hospitalizations for trauma that included a diagnosis of acute VTE were classified as trauma. Remaining hospitalizations were categorized in a hierarchical fashion based on the presence of a potential indication for VCF use as acute VTE, VTE of uncertain acuity, and all other hospitalizations. Within each linked record, if a VCF was inserted, all subsequent hospitalizations were censored.

Acute VTE

Hospitalizations were classified as acute VTE if the principal diagnosis was acute deep vein thrombosis (DVT) or acute pulmonary embolism (PE) (the ICD-9-CM codes are given in the eAppendix). Cases diagnosed as having hospital-acquired acute VTE were identified by the presence of a secondary diagnosis code for acute VTE coupled with a POA indicator of no (POA=N). Venous thromboembolism events were classified as acute PE with or without acute DVT or as acute DVT alone.

VTE of Uncertain Acuity

Hospitalizations that had at least 1 secondary ICD-9-CM code for VTE that was flagged with a POA indicator of yes (POA=Y) or coded as V12.31 (personal history of DVT) were categorized as VTE of uncertain acuity. This category was created because before October 1, 2009, secondary ICD-9-CM codes flagged POA=Y lacked specificity13 and could reflect a prior VTE, a recent (subacute) VTE, an upper extremity DVT, or a chronic DVT.

VCF Use

Placement of a VCF was identified by procedure code 38.7 (interruption of the vena cava). Although this procedure code is also used for vena cava plication, ligation, or other interruption, these other procedures are rarely performed.4-14 The frequency of VCF use was calculated as the number of VCFs inserted during each category of hospitalization divided by the corresponding total number of hospitalizations. Thus, each case could have contributed more than 1 hospitalization, each representing an opportunity for VCF placement. All acute VTE cases transferred to another acute-care hospital with VCF placement within 3 days were identified.

COMORBIDITY AND SEVERITY OF ILLNESS

Comorbid conditions (n=26) were defined using the Elixhauser comorbidity software (eAppendix).15,16 Cases with cancer were classified as having metastatic cancer (ICD-9-CM codes 196.0-199.9) or nonmetastatic cancer (ICD-9-CM codes 140.0-195.9 and 200.0-209.9). Bleeding was ascertained using a specific set of ICD-9-CM codes.17,18 Proprietary software (APR-DRG grouper software, version 24; 3M) was applied to every record to determine the severity of illness at the time of admission, which was classified as mild, moderate, major, or extreme.19

STATISTICAL ANALYSIS

The frequency of VCF use was compared among hospitals that had a minimum of 55 or more acute VTE hospitalizations during the 5-year study period. This number was selected to ensure that the 95% confidence intervals were no wider than 10% for hospitals that inserted an average percentage of VCFs (approximately 13%).

Measures of variation in VCF use included the range, interquartile range,10 coefficient of variation,20 and intraclass correlation coefficient (ICC).21 The ICC is the ratio of between-hospital variance to the sum of between-hospital and within-hospital variance, which is calculated as part of multivariable hierarchical regression modeling. Three multivariable logistic regression models and corresponding hierarchical models that predicted VCF use were constructed. Potential risk factors were entered as fixed-effect variables, with hospital added as a random effect in the hierarchical models. Model 1 included age, sex, and clinical characteristics potentially associated with VCF use; model 2 added race/ethnicity and insurance status as socioeconomic factors (recognizing that hospitals might be more likely to perform a procedure when they expect to receive fee-for-service payment); model 3 added hospital-specific characteristics (size, location, and type). We compared Kaiser hospitals with other private hospitals because they
uniquely reflect the care provided by a health maintenance organization. The first hierarchical model was applied to the cohort to calculate the ratio of the number of observed VCFs placed to the expected number for each hospital.

Geographic mapping was performed using commercially available software (ArcMap, version 10.0; ESRI). Hospital locations were geocoded to their street address with a 100% match rate. Three categories of VCF use (upper third, middle third, and lower third) were plotted on the basis of the risk-adjusted rate. Three categories of VCF use (upper third, middle third, and lower third) were plotted on the basis of the risk-adjusted rate. Three categories of VCF use (upper third, middle third, and lower third) were plotted on the basis of the risk-adjusted rate.

Categorical data were analyzed using χ² testing. Analyses were performed using statistical software (SAS; SAS Institute Inc), and a 2-sided P < .05 was considered statistically significant.

Figure 1 shows the total number of VCFs placed annually in California from 2006 to 2010. During the period analyzed, 130 643 hospitalizations for acute VTE and 399 899 hospitalizations for VTE of uncertain acuity occurred. In 2006, a VCF was placed during 13.82% of all acute VTE hospitalizations. This rate increased to 16.08% in 2009, but was slightly lower in 2010, at 15.12%.

Table 1 shows the bivariate frequency of clinical, demographic, socioeconomic, and hospital characteristics and the frequency of VCF use during the hospitalizations for acute VTE and VTE of uncertain acuity. A VCF was inserted during 19 537 acute VTE hospitalizations (14.95%). There were only 55 instances (0.28%) when a patient with acute VTE was transferred to a different hospital followed by VCF insertion within 3 days. Among the acute VTE hospitalizations, 78.54% were admitted for acute VTE and 21.46% had hospital-acquired VTE; 17.34% had cancer; 8.38% had acute bleeding; 13.62% underwent a major operation; and 42.08% were classified as having major or extreme severity of illness at the time of admission. The frequency of VCF placement was higher in patients with bleeding, cancer, a surgical procedure, and greater severity of illness. The frequency of VCF use was higher in larger hospitals: 16.64% in the hospitals with more than 200 licensed beds (n=167), 10.80% in hospitals with 100 to 199 beds (n=101), and 3.76% in hospitals with fewer than 99 beds (n=68). Among hospitals with more than 100 beds, the frequency of VCF placement for acute VTE was 15.23% in non-Kaiser private hospitals, 16.21% in academic medical centers or their affiliated hospitals (n=14), and 11.71% in Kaiser-Permanente hospitals.

Figure 2 shows the frequency distribution of VCF use in the 263 hospitals that had at least 55 acute VTE hospitalizations during the study period, displayed in rank order from the highest rate of use to the lowest. The range of the frequency of VCF use varied widely, from 0% to 38.96%, with an interquartile range of 16.23% to 18.14% and a coefficient of variation of 0.65. Even among the 23 Kaiser hospitals, variation was appreciable (7.73%-19.89%), with an interquartile range of 8.64% to 15.83% and a coefficient of variation of 0.43.

The multivariable model to predict VCF use is shown in Table 2. In the primary logistic model, the strongest clinical predictors of VCF use were bleeding at the time of admission (odds ratio [OR], 3.4 [95% CI, 3.2-3.6]), bleeding during the hospitalization (2.7 [2.4-2.9]), major severity of illness (2.0 [1.9-2.2]), extreme severity of illness (2.5 [2.3-2.7]), and metastatic cancer (1.7 [1.6-1.8]). After risk adjustment, hospital-acquired acute VTE was not a significant predictor of VCF use. This logistic model had a C statistic of 0.706.

In the primary hierarchical model, which included hospital as a random effect, the ICC for hospitals was 18.49%. Using this model to calculate the odds ratio for the observed number of VCFs placed to the expected (mean) use, 109 hospitals used VCFs significantly more frequently than expected and 59 hospitals used VCFs significantly less frequently than expected.

When the socioeconomic terms of race/ethnicity and insurance status were added to create model 2, these variables were not significant predictors of VCF use, and they had no effect on the variable estimates for the clinical characteristics.

In model 3, hospital characteristics were added and the discrimination of the logistic model improved significantly (C statistic, 0.720 [P < .001]), but these characteristics had no meaningful effect on the variable estimates for the clinical characteristics.

The hospital characteristics that were significant predictors of VCF placement were a hospital size of fewer than 100 licensed beds (OR, 0.2 [95% CI, 0.2-0.4]), 100 to 199 licensed beds (0.7 [0.5-0.8]), and classification as a rural location vs urban (0.4 [0.2-0.5]). Adding these hospital characteristics lowered the ICC for hospitals to 12.66%. We found no significant difference in the odds of VCF use when academic hospitals (n=14) were compared with Kaiser hospitals, but non-Kaiser private hospitals had significantly greater odds of using a VCF compared with Kaiser hospitals. We found no significant difference in the odds of VCF use when we compared profit and not-for-profit hospitals.

Figure 3 shows a map of the hospitals in California in the upper, middle, and lower tertiles of risk-adjusted VCF use based on the hierarchical model that included clinical risk and socioeconomic risk factors. Even in simi-
lar geographic regions, we found wide variation in the use of VCFs.

**COMMENT**

The major finding of this study was an exceptionally wide range in the frequency of VCF use between hospitals, from 0% to 38.96% of all acute VTE hospitalizations. To provide some perspective, the coefficient of variation for VCF use was 0.65, which places it among surgical procedures with the greatest variation in geographic studies in the United States.22 Similarly, the range in the risk-adjusted odds of VCF use was even greater than the range observed for the surgical procedure (prostatectomy) that, in one study, had the highest variation across hospital referral regions in the United States.23 The overall mean frequency of VCF placement we observed, 14.95%, was similar to the rate reported in Worcester, Massachusetts (13.1%).9 Because variation among hospitals in the use of VCFs may reflect variation in case mix, we adjusted for important factors that might influence the decision to use a VCF, such as bleeding, undergoing a surgical pro-

### Table 1. Characteristics of VTE Hospitalizations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total No.</th>
<th>Acute VTE (%)</th>
<th>VTE of Uncertain Acuity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>130,643</td>
<td>19,537 (14.95)</td>
<td>399,889 (14.46)</td>
</tr>
<tr>
<td>Age, y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;40</td>
<td>12,953</td>
<td>1,119 (8.64)</td>
<td>30,633 (1.86)</td>
</tr>
<tr>
<td>40-64</td>
<td>47,789</td>
<td>4,643 (13.44)</td>
<td>136,075 (3.26)</td>
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<tr>
<td>≥65</td>
<td>69,901</td>
<td>11,995 (17.16)</td>
<td>233,181 (4.06)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>61,450</td>
<td>9,489 (15.44)</td>
<td>176,087 (3.90)</td>
</tr>
<tr>
<td>Women</td>
<td>69,193</td>
<td>10,046 (14.52)</td>
<td>223,020 (3.39)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>87,525</td>
<td>13,198 (15.08)</td>
<td>263,356 (3.54)</td>
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<tr>
<td>African American</td>
<td>14,520</td>
<td>19,29 (13.29)</td>
<td>49,721 (3.17)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>19,509</td>
<td>2,943 (15.09)</td>
<td>59,560 (3.89)</td>
</tr>
<tr>
<td>Asian/Pacific Islander</td>
<td>5,223</td>
<td>862 (16.50)</td>
<td>16,567 (4.70)</td>
</tr>
<tr>
<td>Other, mixed, or unknown</td>
<td>3,666</td>
<td>605 (15.65)</td>
<td>10,685 (4.48)</td>
</tr>
<tr>
<td>Time of acute VTE event</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present on admission</td>
<td>102,601</td>
<td>12,965 (12.64)</td>
<td>360,947 (11.56)</td>
</tr>
<tr>
<td>Hospital acquired</td>
<td>28,042</td>
<td>6,572 (23.44)</td>
<td>80,042 (3.05)</td>
</tr>
<tr>
<td>VTE type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DVT alone</td>
<td>62,691</td>
<td>10,563 (16.85)</td>
<td>369,417 (2.96)</td>
</tr>
<tr>
<td>PE with DVT</td>
<td>67,952</td>
<td>8,974 (13.21)</td>
<td>30,472 (11.60)</td>
</tr>
<tr>
<td>Cancer</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Nonmetastatic</td>
<td>11,103</td>
<td>2,295 (20.67)</td>
<td>37,698 (4.99)</td>
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<tr>
<td>Metastatic</td>
<td>11,553</td>
<td>2,709 (23.45)</td>
<td>38,498 (7.02)</td>
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<tr>
<td>None</td>
<td>107,987</td>
<td>14,533 (13.46)</td>
<td>323,693 (3.86)</td>
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<tr>
<td>Bleeding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present on admission</td>
<td>7,002</td>
<td>2,673 (38.17)</td>
<td>36,089 (11.43)</td>
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<tr>
<td>Hospital acquired</td>
<td>39,484</td>
<td>15,04 (38.10)</td>
<td>357,845 (2.68)</td>
</tr>
<tr>
<td>None</td>
<td>119,693</td>
<td>15,360 (12.83)</td>
<td>96,060 (2.68)</td>
</tr>
<tr>
<td>Major surgical procedure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>17,799</td>
<td>5,121 (28.77)</td>
<td>83,165 (5.48)</td>
</tr>
<tr>
<td>No</td>
<td>112,844</td>
<td>14,416 (12.78)</td>
<td>316,724 (3.13)</td>
</tr>
<tr>
<td>No. of chronic comorbidities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>14,356</td>
<td>1,067 (7.43)</td>
<td>23,190 (1.96)</td>
</tr>
<tr>
<td>1</td>
<td>23,084</td>
<td>2,437 (10.56)</td>
<td>50,814 (2.79)</td>
</tr>
<tr>
<td>≥2</td>
<td>93,203</td>
<td>16,033 (17.20)</td>
<td>325,865 (3.86)</td>
</tr>
<tr>
<td>Severity of illness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>24,514</td>
<td>1,811 (7.39)</td>
<td>37,845 (0.98)</td>
</tr>
<tr>
<td>Moderate</td>
<td>51,151</td>
<td>6,169 (12.06)</td>
<td>124,249 (1.69)</td>
</tr>
<tr>
<td>Major</td>
<td>43,535</td>
<td>8,602 (19.76)</td>
<td>173,999 (3.95)</td>
</tr>
<tr>
<td>Extreme</td>
<td>11,443</td>
<td>2,955 (25.82)</td>
<td>63,796 (8.01)</td>
</tr>
</tbody>
</table>

Abbreviations: DVT, deep venous thrombosis; PE, pulmonary embolism; VCF, vena cava filter; VTE, venous thromboembolism.

a Acute VTE indicates hospitalization with a principal diagnosis of lower extremity DVT or PE, or hospital-acquired acute lower extremity DVT or PE that was not present on admission; VTE of uncertain acuity, hospitalization with a secondary code for a venous thrombotic event that could have been prior (code V12.51 [personal history of DVT] from the International Classification of Diseases, Ninth Revision, Clinical Modification), subacute, or chronic or did not involve the deep veins of the lower extremity.

b Among acute VTE cases, 17.34% had cancer.

c Among acute VTE cases, 8.38% had acute bleeding.

d Among acute VTE cases, 13.62% underwent a major surgical procedure (defined by the Center for Medicare and Medicaid Services; http://www.cms.gov /icd10manual/fullcode_cms/P0033.html).
procedure, the presence of cancer, the severity of illness at the time of admission, the number of chronic comorbidities, and the occurrence of acute PE (vs DVT alone). Even after adjusting for these variables, the effect of which hospital a patient was in represented a significant source of variation. Specifically, in a hierarchical model that included clinical risk factors alone, 18.49% of the residual variation in VCF use could be attributed to between-hospital variation. Using this model to calculate the odds ratio of the number of observed VCFs placed to the expected (mean) number, 109 hospitals used VCFs significantly more frequently and 59 hospitals used VCFs significantly less frequently than expected.

The risk factors most strongly associated with VCF placement were bleeding, undergoing a major operation, the presence of malignant disease, extreme severity of illness at the time of admission, and older age. These findings are not surprising and support the view that the use of VCFs is largely driven by concerns regarding bleeding or the potential risk for bleeding during anticoagulant therapy. A diagnosis of PE was associated with statistically significant lower odds of receiving a VCF, perhaps reflecting the American College of Chest Physicians guidelines that recommend not receiving anticoagulant therapy.7

We analyzed hospital characteristics that could potentially be associated with VCF use and found, not unexpectedly, that small and rural hospitals were far less likely to use a VCF, presumably reflecting the absence or paucity of trained interventional radiologists or vascular surgeons.24 In the risk-adjusted model, non-Kaiser private hospitals were approximately 50% more likely to insert a VCF than Kaiser hospitals, but we found no significant difference between for-profit and not-for-profit hospitals, suggesting that the wide variation in VCF use is not likely explained by exploitation of the fiscal benefits of VCF placement by for-profit private hospitals. Indeed, even within Kaiser hospitals, which are tightly affiliated with a health-care maintenance organization, we found appreciable variation of VCF use between hospitals, from a low of 0.77% to a high of 19.89%. The enthusiasm of specific physician-leaders within each hospital who advocate for or against the use of VCFs probably plays a central role in explaining the variation in VCF use across hospitals.25

Finally, socioeconomic terms were not significant predictors of VCF use when they were added to a model that included only clinical risk factors. When we performed geographic mapping, we found that geographically proxi-

![Figure 2. Rank order of frequency of vena cava filter (VCF) placement during hospitalizations for acute venous thromboembolism (VTE), 2006 to 2010. Hospitals include the 263 with at least 55 hospitalizations for acute VTE.](imageURL)
mate hospitals in the more densely populated San Francisco Bay Area and Los Angeles Basin showed wide variation in the use of VCFs, suggesting that broad regional differences do not explain the variation in use.

Together these findings suggest that an important factor affecting the use of VCFs is the local culture and practice pattern within each hospital. Although we could not gather reliable data regarding the number of interventional radiologists or vascular surgeons who work at each hospital, 1 possible explanation for the higher frequency of VCF use in larger private hospitals is the availability of specialists who are skilled in inserting these devices.

The database allowed the identification of more than 95% of patients hospitalized in nonfederal hospitals in California. All the patients who received a VCF probably were coded as having this procedure, because coding the insertion of a VCF increases the diagnosis-related group charge by $16,200 (CMS-DRG grouper software, version 29.0; CMS).

Although it is clear that using a VCF is associated with an appreciable risk of a mechanical or thrombotic complication,3,26 these risks may be discounted by physicians who order the deployment of a retrievable filter because they assume that the VCF is temporary and will be retrieved in a few days to weeks. Current literature suggests, however, that only a small proportion of VCFs are retrieved.24,27 Unfortunately, we could not determine reliably the frequency and timing of VCFs retrieval because pilot data indicated that only about 50% of the VCFs that were retrieved were coded as being removed using the available databases. Thus, we acknowledge that hospitals that insert VCFs in a large proportion of patients with acute VTE might be removing the VCFs within a short period.

A number of other limitations to this observational study exist. We could not identify the specific clinical indication for deployment of each VCF, such as nonuse or a contraindication to anticoagulation therapy. However, we took into consideration risk factors strongly as-

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**Figure 3.** Map of California showing the location, hospital size, rural vs urban status, and risk-adjusted odds of having a vena cava filter (VCF) inserted (in tertiles). When interpreting the map legend, note that the level of grayscale shading indicates the odds of VCF insertion, the symbol shape represents the hospital size, and the inclusion of a dot denotes a hospital in a rural area.
associated with VCF use, such as bleeding and undergoing surgery during the hospitalization. We did not have any data that allowed identification of the specific attending physicians or their specialty. Indeed, there may be as much between-physician variation in VCF use within each hospital as variation between hospitals. Thus, the observed degree of variation in VCF use between hospitals likely underestimates even larger variations among physician groups within and between hospitals.

In conclusion, we observed a striking variation between hospitals in the frequency of VCF use in patients diagnosed as having acute VTE, even after adjusting for potential indications for VCF placement. Taken together with the results of another recent study that reported no clear indication for VCF use in approximately 50% of patients who received a VCF, the findings suggest that use of VCFs is based substantially on the local hospital culture and practice patterns. The absence of reliable data indicating a clear benefit (or clear harm) associated with VCF use likely contributes to the wide variation in use that we observed.

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REFERENCES