Identifying Patient and Hospital Characteristics Resulting in Higher Use of Inferior Vena Cava Filters among Inpatients with Venous Thromboembolic Disease: Analysis of the 2014 Nationwide Inpatient Sample

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Editor:

After 3 decades of increasing use, inferior vena cava (IVC) filter placement rates have recently started declining, possibly secondary to the 2010 Food and Drug Administration safety communication, declining reimbursement, and increasing litigation (1,2). Previous studies have demonstrated geographic heterogeneity in IVC filter use, unexplained by disease prevalence (3). However, the patient and hospital characteristics conferring increased or decreased probability of filter placement remain poorly understood. The purpose of this study was to use a national database to identify predictors of IVC filter placement in patients in the United States with venous thromboembolism (VTE).

The 2014 Nationwide Inpatient Sample (NIS) was used for this study, which is the largest all-payer inpatient database in the United States. Patients admitted with VTE disease, defined by a diagnosis of pulmonary embolism (PE) and/or deep vein thrombosis (DVT), were identified using International Classification of Diseases (ICD)-9 diagnosis codes (**Table E1** [available online at *www.jvir.org*]). Only patients older than 18 years were included, and no other clinical or demographic exclusion criteria were applied. The outcome of interest was placement of an IVC filter during the admission, which was identified using the ICD-9 procedure code 38.7 (interruption of the vena cava), which has been used in previous studies to identify filter placements (1,2,4). A multivariate logistic regression model was used to determine the predictors of filter placement. Covariates included in the regression model were all Elixhauser Comorbidities, age, race, sex, and hospital characteristics. Two-sided *P*-values less than .05 were considered statistically significant.

In 2014, 616,915 patients (48.6% men, 51.4% women; mean age 64.3 years, age range 18–90 years) were admitted with the diagnosis of VTE; of these, 77,060 patients (12.5%) underwent IVC filter placement. Filter placement volumes by age were as follows: 18–44 years: 13.6%; 45–64 years: 32.8%; 65–79 years: 32.5%; and over 80 years: 21.1%. Results of the regression analysis are presented in the **Table**. IVC filters were significantly more likely to be placed in patients in older age groups compared to patients in younger age groups ($P < .001$). Teaching hospitals, urban location, and larger bed size were also associated with an increased incidence of filter placement ($P < .001$). Hospitals located in the Midwest and Western regions were significantly less likely to place filters compared to hospitals in the Northeast region ($P < .001$), with the Southern region demonstrating no difference. Filter placement rates computed for US census divisions are depicted in the **Figure**. Of the comorbidities, patients with anemia, coagulopathies, chronic liver disease, paralysis, and cancer were significantly more likely to receive filters. Patients with DVT had a higher adjusted odds ratio compared to patients with PE (**Table**).

The present study demonstrated a considerable heterogeneity in factors predicting IVC filter placement in the United States. Elderly patients are more likely to receive filters compared to younger patients, with patients older than 80 years almost twice as likely. Stein et al showed that IVC filter placement may confer a mortality benefit in elderly patients (4). Also, compliance with anticoagulation is challenging in the elderly age group (5), which may be another contributor to increased filter placement in this cohort. Teaching hospitals, urban location, and larger bed size were associated with significantly increased probability of filter placement. This variability of filter use was also demonstrated by White et al in their study of California hospitals, showing that the frequency of filter placement depended on the hospital providing care, after adjusting for clinical and socioeconomic factors (6). The present study also demonstrated that Northeast hospitals are more likely to place filters compared to hospitals in the Midwest and Western regions. This finding is concurrent with the study by Meltzer et al (3), who also showed greater use of filters in states on the East Coast, and greater use of filters per

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Table E1 is available online at *www.jvir.org*.

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Table 1. Results of the Cox Proportional Hazard Regression for Main Analysis Demonstrating the HR and 95% CI for Various Patient and Hospital Characteristics

PATIENT CHARACTERISTICS	HR	95% CI, Lower Limit	95% CI, Upper Limit	*P* Value
Age				
Age 18–44 years	Referent			
Age 45–64 years	1.3	1.261	1.339	< .001
Age 65–79 years	1.573	1.519	1.629	< .001
Age ≥ 80 years	1.868	1.8	1.94	< .001
Sex				
Women	Referent			
Men	1.008	0.992	1.025	.318
Primary Insurance				
Private insurance	Referent			
Medicare	0.907	0.885	0.93	< .001
Medicaid	0.862	0.836	0.889	< .001
Other	0.923	0.889	0.958	<0.001
AHRQ Comorbidity Measure (Based on Elixhauser Comorbidity Index)				
AIDS	0.992	0.851	1.157	.92
Alcohol abuse	1.266	1.215	1.319	< .001
Deficiency anemia	1.053	1.034	1.072	< .001
Arthritis	0.991	0.952	1.032	.67
Blood loss	2.829	2.709	2.956	< .001
Congestive heart failure	0.872	0.851	0.894	< .001
Chronic pulmonary disease	0.954	0.936	0.973	< .001
Coagulopathy	1.561	1.525	1.597	< .001
Depression	0.919	0.896	0.942	< .001
Diabetes mellitus without complications	0.994	0.975	1.014	.565
Diabetes mellitus with complications	0.877	0.844	0.91	< .001
Drug abuse	0.8	0.758	0.843	< .001
Hypertension	1.007	0.99	1.025	.396
Hypothyroidism	1.003	0.98	1.027	.785
Liver disease	1.142	1.095	1.192	< .001
Lymphoma	1.018	0.961	1.079	.536
Fluid and electrolyte disorders	1.345	1.323	1.368	< .001
Metastatic cancer	1.65	1.609	1.692	< .001
Other neurologic disorders	1.105	1.077	1.133	< .001
Obesity	1.052	1.029	1.074	< .001
Paralysis	1.911	1.851	1.973	< .001
Peripheral vascular disease	1.284	1.248	1.322	< .001
Psychoses	0.951	0.915	0.988	.01
Pulmonary circulation diseases	0.893	0.874	0.912	< .001
Chronic renal failure	0.991	0.969	1.013	.423
Solid tumor without metastasis	1.509	1.462	1.556	< .001
Peptic ulcer disease excluding bleeding	3.997	2.982	5.357	< .001
Valvular disease	0.916	0.883	0.95	< .001
Weight loss	1.392	1.36	1.425	< .001
HOSPITAL CHARACTERISTICS				
Hospital Bed Size				
Small bed size	Referent			
Medium bed size	1.26	1.228	1.292	< .001
Large bed size	1.378	1.346	1.41	< .001

continued