Does Timing of Inferior Vena Cava Filter Retrieval Planning Impact Retrieval Rates? A Comparison of Planning Before or After Hospital Discharge

Benjamin Parsons, DO; Peter J. Polewski, MD; Angela L. Smith, MA; Andrew J. Borgert, PhD; Ezana Azene, MD; Kurt Ziegelbein, MD; Mason Fisher, MD; Andrew Horstman, PA-C; Shannon Brozak, PA-C; Paul J. Escher, BA

ABSTRACT

Introduction: Indwelling inferior vena cava (IVC) filters are associated with complications, and the US Food and Drug Administration recommends their prompt removal when no longer indicated. Therefore, assessing strategies for increasing retrieval rates is warranted.

Objective: To analyze the variability of IVC filter retrieval rates within our institution based on 2 separate, pre-existing processes in which IVC retrieval is planned for before or after hospital discharge.

Methods: Retrospective chart review was completed for all IVC filters placed in adults between January 2005 and March 2015. Demographics and clinical data related to filter placement and retrieval were abstracted. Patients were classified into 2 groups: patients who had a trauma consultation trauma and nontrauma medical and surgical patients medical. The trauma group patients were subject to a 2-layer tracking process, in which retrieval planning was done before discharge, versus the medical group with a single-layer tracking process and retrieval planning done after discharge.

Results: Of the 588 filter placements analyzed, 236 were placed in trauma patients and 352 were placed for medical reasons. The retrieval rate of the entire cohort was 45% (262/588), with the rate among trauma patients more than double that of medical patients (155/236, 66% and 107/352, 30%; respectively, $P < 0.0001$).

Conclusion: IVC filter retrieval rate was increased when filter removal was included in discharge planning versus postdischarge tracking. A systematic, multidisciplinary strategic approach to IVC filter management has great potential to improve filter utilization, resource allocation, patient safety, and filter retrieval.

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Author Affiliations: Gundersen Health System, La Crosse, Wis (Parsons, Polewski, Azene, Ziegelbein, Fisher, Horstman, Brozak); Gundersen Medical Foundation, La Crosse, Wis (Smith, Borgert, Escher).

Corresponding Author: Benjamin Parsons, DO, Mail Stop EB2-001, 1900 South Ave, La Crosse, WI 54601; phone 608.775.5768; email bmparson@gundersenhealth.org.

INTRODUCTION

Venous thromboembolism events (VTE), which include deep vein thrombosis (DVT) and pulmonary embolism (PE), are a common problem affecting an estimated 422/100,000 people in the United States per year.[1] Anticoagulation is currently the standard of treatment to manage DVT and PE.[2] For those patients who have a contraindication to or proven failure of anticoagulation, placement of an inferior vena cava (IVC) filter is an effective mode of PE prevention.[3] Filter placement consensus guidelines have been published by the American College of Chest Physicians and the Society of Interventional Radiology, among others. Despite the implication of consensus, the differences that remain have led to varied practice patterns. Indications for placement are predominantly categorized as absolute, relative, or prophylactic.[3-5] However, over the last decade, the ease of use and retrievability of modern IVC filters has, in effect, lowered the threshold for device insertion in many clinical settings, rapidly expanding relative and prophylactic indications.[6]

Periprocedural complication rates are low with IVC filter placement, consisting mainly of insertion site DVT and, rarely, bleeding or vascular injury. However, increasing attention is being paid to long-term complications associated with indwelling filters. Filter fracture, embolization from IVC filter thrombi, IVC thrombosis, increase in subsequent DVTs, and migrations of the filter are among the reported complications.[7-17] These

complications and postmarketing reports prompted the US Food and Drug Administration (FDA) to release a statement in 2010 recommending filter removal as soon as PE protection is no longer warranted.[18]

Retrievable IVC filters should be removed from patients with a documented DVT/PE when tolerance of a therapeutic dose of anticoagulation has been reached, yet retrieval rates have been generally low. A single-center study review of retrieval rates between 2001 and 2006 found only 30.4% of patients had a documented plan for IVC filter removal. Of those without plans, 21.6% did not have contraindications to removal.[19] Ko and colleagues demonstrated that a specific institutional process that monitors insertion and removal of IVC filters significantly increased filter retrieval rates.[20] One member of their trauma service was tasked with compiling a database to coordinate timely removal of all filters placed. The database also was used to generate an email to the admitting provider of any patient who had a filter placed as a reminder to plan for retrieval. These results guided adoption of specific retrieval program protocols across the nation, leading to improved trends for retrieval.[21-23]

Institutional practices surrounding retrieval planning varies. At our institution, the interventional radiology (IR) department performs all IVC filter placement and removal procedures. The IR Department documents all IVC filter placements (medical and trauma patients) in a database that is reviewed quarterly to identify patients who need filter retrieval. Those patients identified are called to arrange for IVC filter removal. In addition, all patients with IVC filters placed by the trauma team are entered into a separate database maintained by the trauma team. This discrete trauma database is used to schedule retrieval prior to discharge. Thus, patients treated by the trauma service who require an IVC filter have an additional layer of retrieval planning prior to discharge. Because of this 2-layer tracking process, we sought to evaluate the variability of IVC filter retrieval rates within our institution.

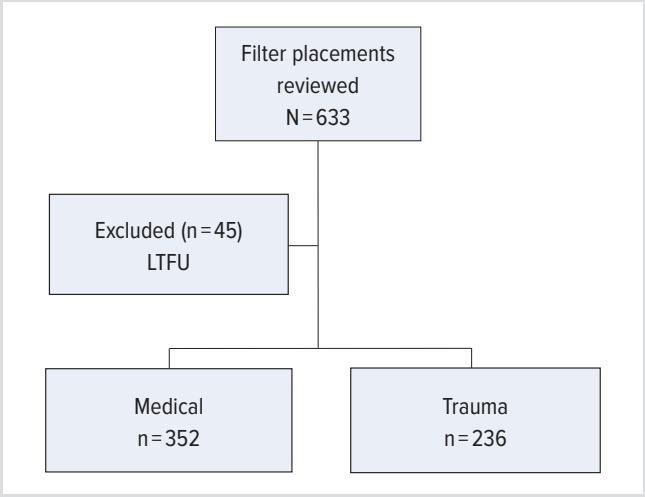
METHODS

Our single-center cohort study consisted of patients with an IVC filter implanted between January 2005 and March 2015 who were 18 years or older at the time of placement. The study protocol was reviewed and approved by the institutional review board. No informed consent was required due to the retrospective study design. Patients were identified using a query of electronic medical records.

Institution IVC Filter Placement Databases

The IR Department maintains a database, independent of the electronic medical record, of all implanted IVC filters. The database is populated using a radiology program that identifies all IVC filter placements over a specified time frame. Chart review is performed quarterly for patients in this database to determine if the filter has been removed, needs to be retrieved, or if the patient has died. If indicated, patients are contacted to arrange filter retrieval.

Figure. Study Population



Abbreviation: LTFU, Lost to follow-up.

To plan filter removal prior to discharge, our trauma service implemented a protocol of entering into a database patients who received a trauma consultation and had an IVC filter placed. Similar to the IR Department's, this trauma database also is separate from the electronic medical record. Most patients recorded in this database will have filter removal scheduled with IR prior to discharge. The independent process of chart review in the IR Department serves as an additional layer to capture those trauma patients who were either missed or were unable to keep the planned follow-up appointment, and phone calls are placed to schedule removal.

Study Subjects and Measurements

Patients 18 years and older with an IVC filter were identified using a query of electronic medical records. Patients were divided into 2 groups: patients who had a trauma consultation trauma and nontrauma medical and surgical patients medical. Medical patients were defined as those requiring a filter for medical indications. The trauma group patients were subject to a 2-layer retrieval plan tracking process in which retrieval planning was done prior to discharge. Retrieval planning for the medical group was tracked by a single process in which retrieval is planned after hospital discharge. Patients with no medical record data subsequent to their filter placement were deemed lost to follow-up and excluded from analysis. See the Figure for a study population flow diagram.

Electronic medical records were reviewed and data were abstracted for predetermined variables, including patient characteristics (age, sex, body mass, smoking history), comorbid conditions, and filter placement and retrieval dates. To determine overall survival for patients included in analysis, the date of last contact and vital status also were abstracted.

Table 1. Patient Demographics and Clinical Characteristics

Variable	Medical Group n = 352	Trauma Group n = 236	*P*-value
Age (years, median ± SD)	65 ± 15.8	43 ± 19.7	< 0.0001
Gender			< 0.0001
Male	179 (51)	172 (73)	
Female	173 (49)	64 (27)	
Body Mass Index*			0.0003
< 30	170 (49)	141 (67)	
30-34	85 (25)	42 (20)	
35-39	41 (12)	18 (9)	
40-49	30 (9)	7 (3)	
≥ 50	19 (5)	3 (1)	
Smoking status			< 0.0001
Current	37 (11)	62 (26)	
Former	145 (41)	50 (21)	
Never	158 (45)	94 (40)	
Never assessed	12 (3)	30 (13)	
Comorbidities			
Congestive Heart Failure	47 (13)	9 (4)	< 0.0001
Nephrotic syndrome	114 (32)	13 (6)	< 0.0001
Hypertension	172 (49)	52 (22)	< 0.0001
Diabetes Mellitus	85 (24)	21 (9)	< 0.0001
History of stroke	36 (10)	4 (2)	< 0.0001
History of Myocardial Infarction	24 (7)	5 (2)	0.0099
Coronary Artery Disease	52 (15)	8 (3)	< 0.0001
Chronic Lung Disease	50 (14)	14 (6)	0.0016
Venous Thromboembolism (at the time of filter placement)	236 (67)	13 (7)	< 0.0001

Note: Data are presented as frequency (%), unless indicated otherwise. Missing BMI data for 7 patients in the Medical Group, and 25 patients in the Trauma Group.

Table 2. Clinical Indications for Inferior Vena Cava Placement in the Medical Group

Clinical Indication	n = 352	(%)
Prep for surgery with a clot history	84	(24)
Pulmonary embolism with large clot burden	56	(16)
Bleeding on anticoagulation	57	(16)
Active or prior gastrointestinal bleed	43	(12)
Active bleed with deep vein thrombosis/ pulmonary embolism	28	(8)
Hemorrhagic cerebrovascular accident	21	(6)
Other	18	(5)
Malignancy	12	(3)
Failure of anticoagulation therapy	11	(3)
Inability to anticoagulate and surgery	9	(3)
Not an anticoagulation candidate	9	(3)
Severe cardiopulmonary disease	3	(1)
Fall risk	1	(0.3)

Note: Data are presented as frequency (%).

Statistical Analysis

Categorical variables were compared using the chi-square or Fisher's exact tests. Continuous variables were evaluated with Wilcoxon rank sum tests. To control for differences in demographic and clinical features between the trauma and medical groups, a multivariate logistic regression model of successful filter removal was developed via a stepwise variable selection process, with $P < 0.25$ required for initial inclusion of a candidate explanatory variable into the model, and P-value < 0.10 required for the candidate variable to remain in the model over subsequent model building steps. All statistical analysis was completed with SAS 9.3. A P-value of < 0.05 was defined as significant.

RESULTS

There were 633 IVC filter placements at our institution during the 10-year study period; 45 patients were lost to follow-up, leaving a sample size of 588 for final analysis. Of those analyzed, 30 of the placed filters were deemed permanent at the time of placement, and 68 patients died within 30 days. Nearly all (n = 28) of the permanent filters were found in the medical group. We found that 60% of the filters placed during the study period were for medical indications, and the medical population had a higher percentage of comorbid conditions. The medical group was older, with a mean age of 65.4 years compared to 43.2 years in the trauma group ($P < 0.0001$). The medical group had a lower proportion of male subjects ($P < 0.0001$) and a higher percentage of comorbid conditions. See Table 1 for complete demographic and clinical characteristics.

The IR Department placed all of the filters included in our study. The most common type of filters inserted among both groups was Cook Medical® Celect™ (n = 381, 65%), followed by the G2® Bard® (n = 116, 20%), and Bard® Recovery™ (n = 51, 9%). Very few filters inserted were by Crux® or Günther-Tulip® (n = 26, 4%; and n = 13, 2%, respectively) and there was only 1 Bird's Nest® filter placed during our study period. Overall, 178 filters (30%) were placed for absolute indications and 72 (12%) for relative indications; 320 (54%) were placed with prophylactic indications and 18 (3%) for indications outside the Society of Interventional Radiology's guideline.[3] Some patients categorized in the trauma group (prophylactic indication) may have had absolute indications not noted in the data. The 3 most prevalent clinical indications for filter placement in the medical group were to prep for surgery with a clot history (n = 84, 24%), pulmonary embolism with large clot burden (n = 56, 16%), and bleeding on anticoagulation (n = 57, 16%). See Table 2 for a complete listing of clinical indications for filter placement.

Of the 588 filters implanted, the overall retrieval rate was 45% (262/588). The retrieval rate among trauma patients was more than double that of patients with an IVC filter placed for medical reasons (155/236, 66%, and 107/352, 30%; respectively, $P < 0.0001$), and the median time to removal was 63 days (range 8-820) for the trauma cohort versus 80.5 days (range 2-877) in the medical group ($P = 0.016$). Out of 285 attempts, there were 262 successful retrievals (92%). Of the 324 nonpermanent medical cases, 33% (n = 107) of IVC filters were removed, while 66% (155/234) of filters in the nonpermanent trauma cases were removed ($P < 0.0001$). The association between filter placement for trauma indications and successful retrieval remained significant after controlling for relevant demo-

graphic and clinical factors via multivariate logistic regression (Table 3). In this model, filter placement for trauma indications, body mass index > 35 kg/m^2, and temporary anticoagulation after filter placement (vs no anticoagulation after placement) were independently associated with increased probability of successful filter removal, while advanced age (> 75 years), an active cancer diagnosis, congestive heart failure, and hypertension were associated with a decreased probability of filter removal. We found that retrieval was not attempted for 66% (234/352) of the filters inserted in the medical cohort versus 29% (69/236) in the trauma group.

Table 3. Logistic regression

Variable	Odds Ratio	Odds Ratio Confidence Interval	*P*-value
Trauma case	2.74	1.69 - 4.46	< 0.0001
Age > 75 yrs	0.25	0.14 - 0.45	< 0.0001
Body Mass Index > 35	1.66	1.02 - 2.71	0.042
Active cancer	0.35	0.20 - 0.63	0.0003
Congestive Heart Failure	0.31	0.13 - 0.70	0.005
Hypertension	0.65	0.42 - 1.01	0.05
Lifelong Anticoagulation [a]	1.23	0.64 - 2.24	0.53
Temporary Anticoagulation [a]	2.12	1.34 - 3.36	0.003

[a] Reference = Never Anticoagulation.

DISCUSSION

Reported rates of IVC filter retrieval historically have been variable, ranging from 10% to 50%.[6] Adverse events, including caval perforation, strut fracture, IVC occlusion, and filter migration have been associated with long-dwelling retrievable filters.[7,10,12,16] In response to low retrieval rates and risks, the FDA issued a Safety Communication recommending that implanting physicians and clinicians be responsible for following up with patients with retrieval IVC filters and to remove them as soon as clinically indicated.[18]

The optimal strategy for IVC filter retrieval remains challenging and subject to individual institution processes. Our analysis of a 2-layer tracking system for trauma patients and a single-layer system for medical and surgical patients resulted in significantly greater retrieval rates for the 2-layer system. At our institution, the trauma service and IR Department have independent processes to track implanted IVC filters that need removal, with some overlap. The primary difference in the processes is the time when formal retrieval planning occurs–before or after discharge. The IR Department plans retrieval after discharge for all IVC filters placed (including trauma, medical, and surgical patients), whereas the trauma service plans for retrieval prior to discharge. Thus, trauma patients are afforded an additional layer of tracking to ensure a plan for retrieval. We found that filters placed in trauma patients (2-layer tracking system) are being removed 2 times (66%) more often than those placed for medical indications (30%).

The long-term complications associated with frequent lack of follow-up and failure to remove retrievable IVC filters has emerged as a major health issue. Several dedicated programs have been proposed to improve the rate of IVC filter retrievals. Databases and/or registries, dedicated filter retrieval clinics, and dedicated personnel to track and arrange retrieval all have been used as a means to retrieve filters in a timely manner.[23-26] Lynch tracked patients for follow-up through a database and yielded an improved retrieval rate from 24% to 59%, and a University of British Columbia study found that a hematology consult was a significant predictor of retrieval attempts.[24] By establishing a dedicated filter retrieval clinic, Minocha et al saw an increase in filter retrieval from 29% to 60%.[23] Leeper and colleagues demonstrated an approximately 40% greater retrieval rate within their trauma patients versus nontrauma patients with a single trauma nurse practitioner following filter patients and coordinating outpatient visits for retrieval prior to discharge.[27] The CIRSE Retrievable IVC Filter Registry has shown an increased trend to remove IVC filters in recent years, which could reflect institutional efforts at implementing programs focused on tracking and retrieving implanted filters; however, room for improvement remains.[25] Future efforts focusing on leveraging electronic medical records to improve IVC filter retrieval rates are warranted.

Given the retrospective nature of this study, a limitation is the inherent vulnerability of the data source and confounding variables. Our data collection was reliant upon the quality of documentation in the electronic medical record, and omissions, misclassification, and misreporting may have contributed to incomplete information. Given the retrospective nature of the study, we were not able to assess intent of filter permanence, patient preference for filter retrieval, reasons for failure to attempt filter retrieval, and other relevant data points that were not recoverable on chart review.

Despite these limitations, our results support the concept of planning for IVC filter retrieval before patients are discharged. Despite the challenges associated with varied health care system models, a systematic, multidisciplinary strategic approach to IVC filters has great potential to improve filter utilization, resource allocation and patient safety, and to increase filter retrieval rates. We encourage each institution to implement programs to assist in IVC filter retrieval. Based on the data we observed, our institution has now implemented a systemwide protocol of arranging IVC filter retrieval prior to discharge for all patients. We believe other institutions should give strong consideration to such a program.

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