3-1-2011

Improving the tracking and removal of retrievable inferior vena cava filters.

Anthony D Goei

Shellie C Josephs

Thomas B Kinney

Charles E Ray

David Sacks

Improving the Tracking and Removal of Retrievable Inferior Vena Cava Filters

Anthony D. Goei, M.D., F.A.C.S.,[1] Shellie C. Josephs, M.D.,[2] Thomas B. Kinney, M.D., F.S.I.R.,[3] Charles E. Ray, Jr, M.D., F.S.I.R.,[3] and David Sacks, M.D., F.S.I.R.[5]

ABSTRACT

Therapeutic and prophylactic inferior vena cava (IVC) filters should be placed based on currently accepted indications to prevent a fatal pulmonary embolism (PE). The protective effect of filters is offset by the potential for lower extremity deep venous thrombosis (DVT), caval thrombosis, and possible otherwise unnecessary life-long anticoagulation (AC). The duration of treatment for most DVTs or PEs is 3 to 6 months of AC/filter. Filters should be retrieved when duration of treatment for a DVT/PE has been met, the risk of a PE is no longer high, and/or there is no longer a contraindication to AC. An effective system that leads to improving the retrieval rate of filters must include education of the patient, a tracking system to minimize patient lost to follow-up, and dedicated personnel to oversee the process. If these goals are accomplished, interventionalists can help decrease the incidence of a fatal PE during the high-risk period, and also decrease the risk of a DVT or the use of otherwise unnecessary life-long AC in subsequent years. Currently, there is much room for improvement in the frequency that IVCF patients are systematically followed and filters are retrieved. The principles discussed in this report will be helpful in this process.

KEYWORDS: Retrievable inferior vena cava filters, tracking inferior vena cava filter patients, improving retrieval of inferior vena cava filters

CLINICAL VIGNETTE

A 23-year-old man was involved in a motor vehicle collision, and suffered multiple trauma including a severe closed head injury as well as complex pelvic and bilateral femur fractures. He remained comatose following a decompressive craniotomy for an expanding intracranial hemorrhage. The interventional radiology (IR) service was asked to place a prophylactic retrievable inferior vena cava filter because the patient was immobilized, was felt to be at high risk from a pulmonary embolism (PE), and could not be placed on low-dose heparin for prophylaxis against a deep venous thrombosis (DVT). The indications, conduct, and possible outcomes of the procedure (including the possible inability to retrieve the filter) were discussed with his wife who provided consent. A retrievable inferior vena cava filter (IVCF) was inserted

[1]Department of Radiology, Fort Sam Houston, Texas; [2]Department of Radiology, University of Texas Southwestern Medical School, Dallas, Texas; [3]Department of Clinical Radiology, University of California at San Diego, San Diego, California; [4]Department of Radiology, University of Colorado Denver, Aurora, Colorado; [5]Advanced Interventional Radiology, The Reading Hospital and Medical Center, West Reading, Pennsylvania.

Address for correspondence and reprint requests: Anthony D. Goei, M.D., F.A.C.S., Department of Radiology, 3851 Roger Brooke Drive, Fort Sam Houston, TX 78234 (e-mail: anthony.goei@amedd.army.mil; tkgoei@aim.com).

Thoracic Interventions; Guest Editor, Charles T. Burke, M.D.

Semin Intervent Radiol 2011;28:118–127.

DOI: http://dx.doi.org/10.1055/s-0031-1273946.
ISSN 0739-9529.

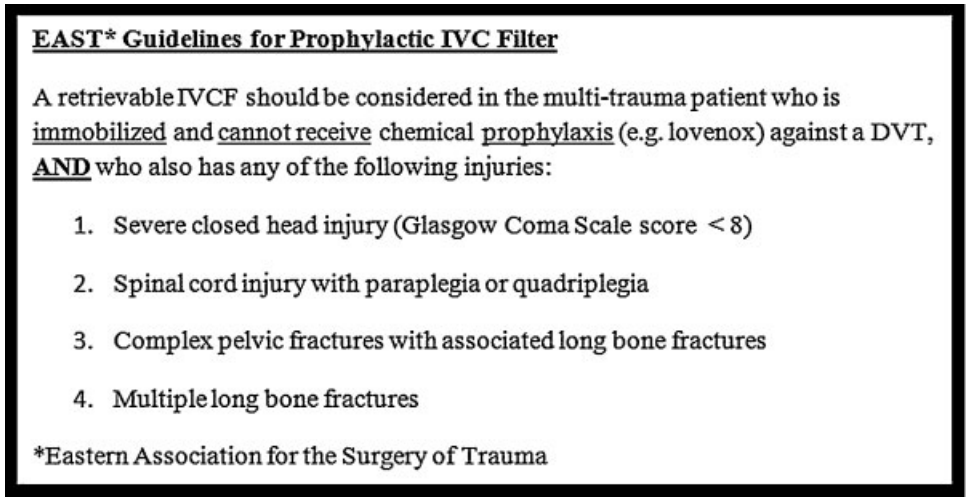

Figure 1 EAST Guidelines for a prophylactic inferior vena cava filter.

on hospital day 2. The patient recovered from his injuries, and was transferred to a rehabilitation facility one month later. He continued to make gradual progress, and 6 months later he was able to ambulate well with a cane. He returns to the IR clinic stating that since he is at risk for developing a DVT because of the filter, his primary care provider plans to initiate lifelong anticoagulation (AC) with Coumadin. He mentions that he heard about a recent (August 9, 2010) U.S. Food & Drug Administration (FDA) communication regarding IVC filters. He asks for your opinion regarding the safety and effectiveness of IVCF, and more importantly, how to proceed at this time.

THE PROBLEM

This is a former multitrauma patient who was at high risk for a DVT and PE in the immediate postinjury period and had a prophylactic retrievable inferior vena cava filter (PIVCF) inserted but was lost to follow-up. He now returns with the filter that is no longer necessary but is still in place. His primary care provider plans to start AC. What is the best course of action at this time given this clinical scenario?

DISCUSSION

Trauma patients are at risk for a DVT and PE; PE causes ~5% of deaths in the trauma patient who is hospitalized more than 48 hours.[1] The prophylactic insertion of a retrievable IVCF to decrease the incidence of a fatal PE in the high-risk trauma patient has gained increasing popularity over the last two decades.[1,2] In addition to the standard indications for an IVCF, indications for the use of a PIVCF have been established. The Eastern Association for the Surgery of Trauma (EAST) has published a clinical practice guideline that focuses on decreasing the incidence of venous thromboembolism (VTE) in high-risk trauma patients (http://www.slrsurgery.org/files/guidelines/Traum_DVT_study_J_of_T_2007.pdf).[3] Insertion of a PIVCF should be considered in trauma patients who cannot receive anticoagulation because of an increased bleeding risk, and have an injury pattern rendering them immobilized for a prolonged period. Appropriate PIVCF patients include those with (1) severe closed head injury (Glasgow Coma Scale score of eight or less), (2) spinal cord injury with paraplegia or quadriplegia, (3) complex pelvic fractures with associated long bone fractures, and (4) multiple long bone fractures (Fig. 1).[3]

Prospective venographic studies of trauma patients reveal that venous thromboembolism (i.e., DVT and PE) is common in these patients. VTE is estimated to be the third most common cause of in-hospital deaths in trauma patients.[4] Geerts et al documented that 201 (58%) of 349 trauma patients developed DVT, with proximal DVT occurring in 63 (18%) of patients.[5] Note that in this study no VTE prophylaxis was used, and only 3 of the 201 patients with DVT had clinical signs of the DVT. Seven (2%) of the patients had PE and in three of these the PE was fatal. The instances of DVT and PE are estimated to be even higher in the polytraumatized patients categorized in the EAST guideline. Operators placing filters should be familiar with the EAST indications for a PIVCF and their own local practice patterns or protocols, as well as have a system for tracking these patients so that each device can be removed when it is no longer needed. Failure to do so will result in many patients harboring a subsequently unnecessary IVCF when the benefit-to-risk ratio is no longer favorable.

The PRECIP trial performed by Decousus et al demonstrated that patients with IVC filters are at increased risk of developing a recurrent lower extremity DVT and/or clot within the filter (Table 1).[6] This randomized prospective study was designed to evaluate

Table 1 PREPIC Study: Clinical Results of Trial after 12 Days, 2 and 8 Years

Results @ 12 days Symptomatic and Asymptomatic Patients	AC & IVCF "Filter Group" ($n=200$)	AC Alone "No Filter Group" ($n=200$)	Statistics
Recurrent PE	2(1.1%)	9(4.8%)	$P=.03$
Recurrent PEs in patients presenting with PEs	(1.1%)	(8.6%)	
Mortality	5 (2.5%)	5 (2.5%)	$P=.99$
Results @ 2 yearsSymptomatic Patients Only			
Recurrent PEs	6 (3.4%)-1 fatal	12(6.3%)-5 fatal	$P=.16$
Recurrent DVTs	37 (20.8%)	21 (11.6%)	$P=.02$
IVC filter thromboses (Subset of recurrent DVTs)	16 (9%)		
Major bleeding	17 (8.8%)	22 (11.8%)	
Mortality	43 (21.6%)	40 (20.1%)	$P=.65$
Results @ 8 years Symptomatic Patients Only			
Recurrent PEs	9 (6.2%)-2 fatal	24(15,1%)-5 fatal	$P=.008$
Recurrent DVTs	57 (35.7%)	41 (27.5%)	$P=.042$
IVC filter thromboses (Subset of recurrent DVTs)	26 (16%)	2* (1.3%)	
Major bleeding	26 (15.4%)	31 (18.5%)	
Mortality	98 (48.1%)	103 (61.0%)	$P=.83$

*19 of the 200 patients in the AC alone cohort (''no filter group'') subsequently underwent filter insertion during the study period.
AC, anticoagulation; DVT, deep venous thrombosis; IVCF, inferior vena cava filter; PE, pulmonary embolism; PREPIC, Prevention du Risque d'Embolie Pulmonaire par Interruption Cave

the safety and effectiveness of permanent IVCF for general surgical and medical patients. Four-hundred patients with proximal DVT who were believed to be at high risk for PE were randomized to either receive AC plus an IVC filter ("filter group") versus AC alone ("no filter group"). They initially studied patients at 12 days following randomization for both symptomatic and asymptomatic PE, and at 2 years for symptomatic VTE. The authors concluded that in high-risk patients with proximal DVT, the initial benefit of IVCF for prevention of PE was counterbalanced by an excess of recurrent DVT, without any difference in mortality. Closer examination of the table reveals that although the rate of recurrent PE was not statistically different, if the authors had compared the rate of fatal PE it is possible to demonstrate the beneficial effect of filters at 2 years as well. The PREPIC (Prevention du Risque d'Embolie Pulmonaire par Interruption Cave) data has been extended for an 8-year follow-up demonstrating that a patient with a filter is significantly more likely to subsequently develop a recurrent lower extremity DVT compared with a patient without a filter (36% vs 28% over an 8-year follow-up, $P=.042$), albeit with a lower risk of developing a PE (6.2% vs 15.1%, $P=0.54$). The combined rate of symptomatic DVT and PE at 8 years was nearly identical in the two groups.[7]

All these data suggest that filters are effective in preventing fatal and nonfatal PE. After 8 years of study, the number of patients with lower extremity DVT in the filter group compared with the no filter group was 55 versus 41. This was not statistically significant. The number of patients with IVC thrombosis in the filter group compared with the no filter group was 26 versus 2 (19 patients in the no filter group crossed over and ended up with a filter and 2 of these patients experienced IVC thrombosis by 8 years). The number of patients with symptomatic PE in the filter group versus no filter group was 9 versus 24. Because many PEs are asymptomatic, if the ratio of PE between the two groups is the same for asymptomatic and for symptomatic, the decreased number of total PE is very similar to the increased number of IVC thrombosis in the filter group. The emphasis of the findings from the Decousus et al study should be that filters work, rather than that filters are thrombogenic.

Decousus et al concluded that at 8 years, IVCF reduced the risk of a PE but increased the risk of a DVT and had no effect on survival. The authors did NOT conclude that the mere presence of a filter mandates AC if it is subsequently no longer contraindicated. Although an alternative explanation of the same data are that IVCF reduced the ongoing risk of PE by effectively catching clot in the filter, the results of the Prevention du Risque d'Embolie Pulmonaire par Interruption Cave (PREPIC) trial have led many clinicians to consider placing a patient with an IVCF on lifelong AC to decrease the likelihood of developing a lower extremity DVT or IVC thrombosis.[8] It is possible, therefore, that a trauma patient with no history of a DVT or PE, who undergoes insertion of a PIVCF that subsequently is not removed, may ironically end up on lifelong AC. The downside is that AC is associated with well-known complications, to include bleeding, requirement for blood transfusions, and even death. The incidence of significant hemorrhage is estimated at ~5% per year of lifelong AC.[9] It is possible that the risk of harm to a patient is greater from the AC than from the filter.

Ray et al did a meta-analysis to study whether anticoagulation affects VTE rates in patients with fil-

ters.[10] This was a systemic review of the literature from 1963 to 2007, which included reports where (1) there was a clear identification if AC was used in a filter patient; (2) short- or long-term VTE outcomes were presented; (3) outcomes were specifically addressed after filter placement with and without AC; and (4) the trial was a randomized controlled, prospective cohort, retrospective cohort, or case-controlled study. One hundred thirty-five references were found and reviewed, with only nine total studies meeting inclusion criteria. Among the 1369 subjects included in the analysis, the VTE rate was 12.3% with IVCF plus AC versus 15.8% with IVCF but no AC (OR, 0.64%, 95% CI, 0.35–1.16, $P = .14$). The authors concluded that IVCF can be placed in patients who cannot receive concomitant AC without placing them at significantly higher risk of development of VTE. Despite this study, the role for AC following a filter insertion beyond the treatment period for a DVT/PE remains controversial. Therefore, to avoid the potential increased risks of VTE and lifelong AC in patients with filters, retrievable IVCF should be removed when the risk of a PE is no longer high and/or there is no contraindication to AC. This is important to do not only for devices that are implanted for standard therapeutic indications, but even more so for devices inserted for prophylaxis against fatal PE in the high-risk multitrauma patient.

The frequency of PIVCF removal has traditionally been very low; at the same time their use has increased.[1,2] Several recent reports demonstrate that the technical success rate of most filter retrieval is very high (range from 58–100% with mean of 93%) further exemplifying the importance of following up such patients.[11] It has also been shown when patients are followed very closely, it is possible to eventually retrieve as many as 50% or more of the filters that are inserted.[12–14] This very respectable retrieval rate, however, usually occurs only under study conditions. For most IR practices, particularly those that are not involved in clinical research on IVCF, the actual percentage of filters that are retrieved is much lower, and often may be less than 10%. Given the potential long-term consequences of an IVCF (i.e., DVT, caval thrombosis, possible otherwise unnecessary lifelong AC, filter migration or fracture), it is imperative that systems are established to improve education, track, and eventually remove each device when it is no longer needed. In 2006, the Society of Interventional Radiology published an excellent set of guidelines for the use of retrievable IVCF, which include both indications (presently the same as permanent filters) and algorithms for removal of retrievable IVCF (http://www.sirweb.org/misc/Guidelines_filters.pdf).[15] Operators placing filters who insert and retrieve IVCF should be familiar with the contents of this useful document.

On August 9, 2010, the FDA issued the following communication: "FDA recommends that implanting physicians and clinicians responsible for the ongoing care of patients with retrievable IVC filters consider removing the filter as soon as protection from PE is no longer needed."[16] In this communication, it was reported that since 2005 the FDA has received 921 adverse events involving IVCF on their MAUDE database (www.accessdata.fda.gov). This database relies on individual physicians to report problems with filters so there is an inherent bias with possible underreporting. Within this database, there were 328 reported instances of device migration, 146 instances of device embolizations (detachment of filter components), 70 instances of perforation of the IVC, and 56 instances of filter fracture. Although 921 adverse events seems significant, the reader must be cognizant of the many tens (or even hundreds) of thousands of these filters that have been placed during this timeframe. Some of the reported events occurred in patients who had clinically significant adverse outcomes. SIR has responded with the following statement: "The Society of Interventional Radiology strongly urges close communications between doctor and patient. Those individuals with IVC filters are encouraged to talk to their interventional radiologists and their other physicians about any concerns or questions. Patients with filters should always discuss with their doctors whether and when filter removal is an option."[17] Both the FDA and SIR statements emphasize the need for filter patients to undergo retrieval of their IVCF as soon as "protection from PE is no longer needed," suggesting that patients need to be followed closely and brought back for IVCF removal at the appropriate time.

To determine the optimal time for retrieval of the IVCF, it is important to be familiar with the guidelines for the treatment of DVT and PE in general. Current guidelines were published in 2008 by the American College of Chest Physicians (http://chestjournal.chestpubs.org/content/133/6_suppl/454S.full.pdf + html).[18] For anyone with a single episode of DVT or PE, the treatment includes AC for 3 or 6 months depending on the clinical scenario and the discretion of the treating physician. When the patient cannot be placed on AC, an IVCF is inserted and the duration of the treatment for protection from PE should still be a total of 3 or 6 months; this includes filter indwell time and anticoagulation time if the filter has already been removed. For this reason, patients with an IVCF can often have the filter removed after 3 or 6 months have elapsed since their index event. This fact can be very helpful in determining the timing for removal of an IVCF.

In the event that a patient who temporarily cannot receive AC undergoes a filter insertion, and later is able to start AC, it is important to initiate AC while the filter is still in place.[15,17] It is also reasonable at that

time to consider retrieval of the filter after the patient is therapeutic on AC to decrease the likelihood of filter complications. As suggested in the 2006 SIR guideline, it is neither necessary nor desirable to interrupt AC for the retrieval. Therapeutic AC does not increase the risk of bleeding complications from filter retrieval.[18,19] In one study, 62 IVCF removals were attempted in anticoagulated patients. There was no extravasation seen on cavography after filter removal, and no operative bleeding complications, hematomas, or contusions. Use of ultrasound to guide the puncture at the access site should minimize potential bleeding complications. Once the filter is retrieved, the patient can complete the 3- or 6-month course of treatment for the DVT or PE. In the event a patient remains unable to start AC, the filter should be left in place until the 3- or 6-month duration of treatment is completed. The filter should be removed when either the 3- or 6-month mark is reached, assuming the indication for filter placement no longer exists. One additional caveat should be considered in those patients in whom a prophylactic filter was placed. Because there was no known DVT or PE at the time of insertion, the timing of filter removal may be based on when the patient is either ambulating well or when he or she has reached a level of stability and no additional surgical procedure is planned. Prior to filter removal in these patients, based on local practice, ultrasound screening of the lower extremities may be performed to make sure that the patient has not developed a DVT during the period of immobility and illness.

A COMPREHENSIVE METHOD TO INCREASE IVC FILTER RETRIEVALS

To achieve the ultimate goal of retrieval of an IVCF that is no longer needed, an effective system must be established to facilitate the entire process. A successful retrieval system should have three essential components. These include (1) the education of health care providers, patients, and their families; (2) a method of tracking filter patients; and (3), an individual who is dedicated and responsible for the success of the entire process. Establishing only one or two of these processes is not sufficient, and many patients will become lost to follow up. However, if all three key components are effectively implemented, the goal of increasing filter retrieval will most likely be achieved.

Education

The patient, immediate family, and any significant friend should be thoroughly educated regarding the indications for filter insertion as well as the indications for filter retrieval. The key to adult learning is repetition; therefore, the process of obtaining informed consent and thoroughly familiarizing the patient and others regarding the entire process from start to finish will usually require several encounters. It begins with the initial preprocedure evaluation, is continued during the immediate periprocedure period, and should be reinforced during the week or so following filter insertion. Whenever possible, it is important to conduct another visit prior to the patient's discharge or transfer to another facility if the filter has not yet been removed to provide additional reinforcement. These visits can be performed by an IR physician, an IR nurse, trauma nurse, or any qualified individual (e.g., radiology practitioner assistant [RPA] or other midlevel provider) who has been appropriately trained. During each encounter, the patient and family should be given an opportunity to ask questions and receive information that can reinforce their understanding of the importance of follow-up and possible retrieval of the filter when it is no longer needed. It is important to ensure that both the patient and family know how to contact the tracking service once they leave the hospital. A successful retrieval system includes a patient who understands the importance of retrieval of an unnecessary filter. An informed family will also help increase the likelihood that appropriate follow-up is accomplished and the filter patient is not lost to follow-up.

Informational handouts that the patient and family can take with them on discharge from the hospital will go a long way to facilitate successful education. Manufacturers of IVCF often provide a patient booklet with each filter, which should be utilized whenever possible. Alternatively, sketches and diagrams that can be downloaded from the Internet allow for a better understanding of the basic processes of insertion and retrieval of the filter. Descriptions of the benefits and risks of an IVCF (both in the short- and long-term) will help to ensure that these important facts are discussed. The potential retrievability of various filters can be illustrated and the importance of appropriate follow-up and possible filter removal can be emphasized.

The education piece of any successful system also involves familiarizing other health care providers, including physicians, nurses, and therapists, about the importance of filter retrieval when it is no longer useful. Many health care workers today are not aware that it is possible to retrieve some IVCF. Many are also not aware of the potential long-term consequences of keeping a filter in place when it is no longer necessary, and are not likely to refer a patient for filter retrieval. It is especially important that primary care providers and any physician involved in the care of a filter patient understand the importance of filter retrieval. Nursing personnel as well as therapists can also play a role in identifying patients who should have a filter retrieved. If other members of the health care team are well informed, a filter patient is less likely to become lost in the system and not be referred back for filter retrieval.

Tracking System

A system must be established that will allow the accurate tracking of all patients with retrievable filters. In this manner, the clinical course of each patient can be closely followed, and appropriate follow-up and retrieval of an unnecessary filter be performed. This system can be as simple as an Excel spreadsheet with basic patient demographics, details of indications for insertion, and potential date of retrieval (Fig. 2). It is very important to obtain two or more phone numbers that can be used to contact the patient in the future. A specific individual should be assigned to manage the database to ensure timely and accurate entries during the entire spectrum of care, beginning with filter insertion and extending beyond filter retrieval (discussed below). A computerized medical record system will facilitate evaluation of the progress of the patient following filter insertion. Good communication between the service that is tracking the patient and individuals primarily responsible for the care of the patient will further the decision regarding the optimal timing for filter retrieval.

Some hospitals use techniques to identify patients with retrievable IVCF such as armbands and reminders in the medical records that denote the patient has a retrievable filter. This facilitates the dissemination of information when multiple teams of providers are caring for the patient or when a patient is transferred to another facility. The increasing availability of electronic medical records may help in the education of medical staff by sending alerts in both the inpatient and outpatient charts indicating the time since filter placement and information on how to schedule the patient for removal.

Although other tools can be used by patients to remind them of the indwelling filter and the potential for

Last	Date	Type	Indication/Contact Info	Retrieval	NOTE
		G2X	Hemorrhagic Stroke	Ms. Waggle xxxxxxxxxxxxxxxxx(566-xxxx/c 827-xxxx).	
		ne		1/14/2010 Retrieved	
		G2X	TBI with DVT/PE 210 653 202	Dr. xxxxxxxxxat the Live Oak VA clinic #590-xxxx.	
				5/24: see on PCM on 28, I suggest he speak to her about G2X	
				NEEDS TO BE CALLED	
		Optior	TBI No DVT/PE Prophylactic	2/13: Still In Rehab, f/u 3/3 with Cortez (513-xxxx)	
			Right UE PICC	3/8/2010 Large clot in IVCF	
				8/21/2010: Retrieved	
		G2X		1/19/2010: Retrieved	
		G2X	Bilat femoral DVT	3/3: lovenox for DVT prophylaxis	
				NEEDS TO BE CALLED	
		Optior	TBI No DVT/PE Prophylactic	2/22: Transferred to Rehab	
			(210)213-xxxx/415-xxxx	5/25: Message left with wife	
				10/2/2010 Retrieved	
		Optior	PE with GI bleed	He will f/u with GS at WHMC	
			(210) 490-xxxx	Dr. Gilxxxxxxx 930-xxxxxx	
			(210)594-2056 Gunst (WHM(	6/10: message left for pt to call me	
				NEEDS TO BE CALLED	
		G2X	Placed OSH	2/25/2010 Retrieved	
		G2X	Placed OSH	3/15/2010 Retrieved	
		Optior	PE	5/20/2010 Retrieved	
		G2X	DVT and GSW	Will need removal in 3 months	
				6/10: message left with Josie 214 xxxxxx	
				NEEDS TO BE CALLED AGAIN	
		Optior	DVT	Will need removal in 3-6 months	
			Home: 479-xxxx	10/5/2010 Retrieved	
		G2X	DVT	10/12/2010 Retrieved	
		G2X	DVT/PE with failure of AC	10/14/2010 Retrieved	
		Optior	DVT/PE with complication of	4/27/2010 Retrieved	
		Optior	Prophylactic	6/1/2010: Retrieved	
		Celec	Prophylactic	5/7/2010: Retrieved	

Figure 2 A simple spreadsheet used to track filter patients.

removal, nothing should attempt to replace consistent communication between the patient and family and the service that is tracking the patient. Only by identifying whether the indication for the filter still exists can one determine the appropriateness of filter retrieval; no other tool can replace the need for this constant communication. In this regard, the business card and dedicated personnel (discussed below) have proven to be invaluable assets.

At the time of the filter insertion, it is helpful to arrange for an appointment in the IR clinic or for a follow-up telephone call in 4 weeks. This will help to ensure that a future evaluation of the patient's progress is made. Decisions regarding management of the filter can be made during that follow-up encounter. Occasionally, in patients with a very clear window of need for the filter, it is possible to set up their appointment for filter retrieval before they leave the IR suite following filter placement. These patients should all receive a standard reminder call from the clerical staff the day before their next appointment. This can help to decrease the "no-show" rate.

Dedicated and Responsible Personnel

The most important aspect of a successful filter removal program is having dedicated personnel assigned to ensure the success of the entire process. A physician, physician assistant, nurse, or clerk who is charged with the responsibility of notifying providers and patients when a filter may be removed is very important. Standard letters, telephone calls, and reminders in the electronic medical records need to be available and utilized, but individual attention is necessary for all of these adjuncts to work. This responsible individual must be self-motivated, thorough, and committed to the task.

A policy of dedicated follow-up within a system designed to track and retrieve IVCF spearheaded by a nurse practitioner (NP) can achieve a high rate of filter removal. O'Keeffe et al studied trauma and nontrauma patients who had a retrievable IVCF placed at Parkland Medical Center in Dallas, Texas, in 2006.[20] This level one trauma center has three separate trauma services, and a NP is an integral member of each service. In 2005, the removal rate of retrievable filters was 13%, and a dedicated tracking system was not in place. The study was conducted between January 1 and December 31, 2006. During this period, a tracking protocol for trauma patients was utilized consisting of chart stickers, arm bracelets, and dedicated follow-up by the NP assigned to each trauma team. No protocol was utilized for tracking the nontrauma patients who had a filter inserted: these patients were not followed in a dedicated manner. One hundred sixty-seven retrievable filters were placed: 91 in trauma patients and 76 in nontrauma patients. Trauma patients were more likely to have their IVCF removed than nontrauma patients: 55% versus 19%, $P < .001$. There were differences between the three trauma teams, with removal rates of 44%, 42%, and 86%, respectively ($P < .05$). These investigators concluded that a policy of dedicated follow-up of patients with IVCF can achieve significantly higher rates of filter removal than have been previously reported.

The authors found that the key to a successful system was "identifying individuals who were responsible for the active outpatient follow-up of these patients, with access to the resources necessary for retrieval including duplex scanning, radiology scheduling, and attending surgeons who would review indications for removal in these patients." (In other systems, clinically oriented IR with knowledge of the SIR and ACCP guidelines can also serve a similar role to that of the attending surgeon.) As also stated in the report, the investigators "chose to use nurse practitioners, who provided continuity of care over the course of an entire year, were able to successfully maintain a database of these patients, and remain in contact with them to arrange follow-up and outpatient studies." It is noteworthy that among the three NPs there were significant differences in retrieval rate: 44%, 42%, and 86%. The

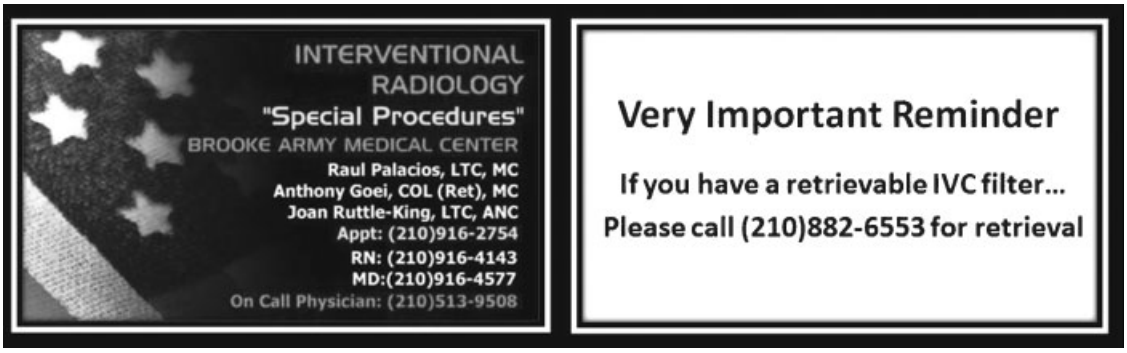

Figure 3 Brooke Army Medical Center Interventional Radiology business cards. In addition to various useful numbers listed on the front of the card, the back has a reminder for filter patients. It emphasizes the importance of filter retrieval and provides a cell phone number that can be answered after normal working hours to answer questions and arrange for follow-up appointments.

individual assigned to track filter patients may have other competing responsibilities, and must be given the resources necessary to be successful. Tracking trauma patients can be time and labor intensive. In some instances, having the time to achieve the task may be the most important resource that responsible individual will need. It also highlights the importance of identifying dedicated personnel who are assigned to perform close follow-up of filter patients.

Another excellent example of a successful tracking and retrieval system can be found at University Medical Center Brackenridge in Austin, Texas. In this level one trauma center, the cardiology and IR services share a series of catheterization suites ("cath lab"). There are two registered nurses who work in the cath lab and have the primary responsibility for ensuring that patients with retrievable filters are tracked, and as many filters as possible are removed when appropriate. These two individuals consult with the primary care physician to verify that the patients are on anticoagulation therapy and are eligible for removal. The IR attendings are consulted as needed.

Their successful process utilizes many helpful adjuncts besides a database. As soon as a filter is placed, the patient is scheduled for a filter repositioning or retrieval within a designated timeframe. Following filter

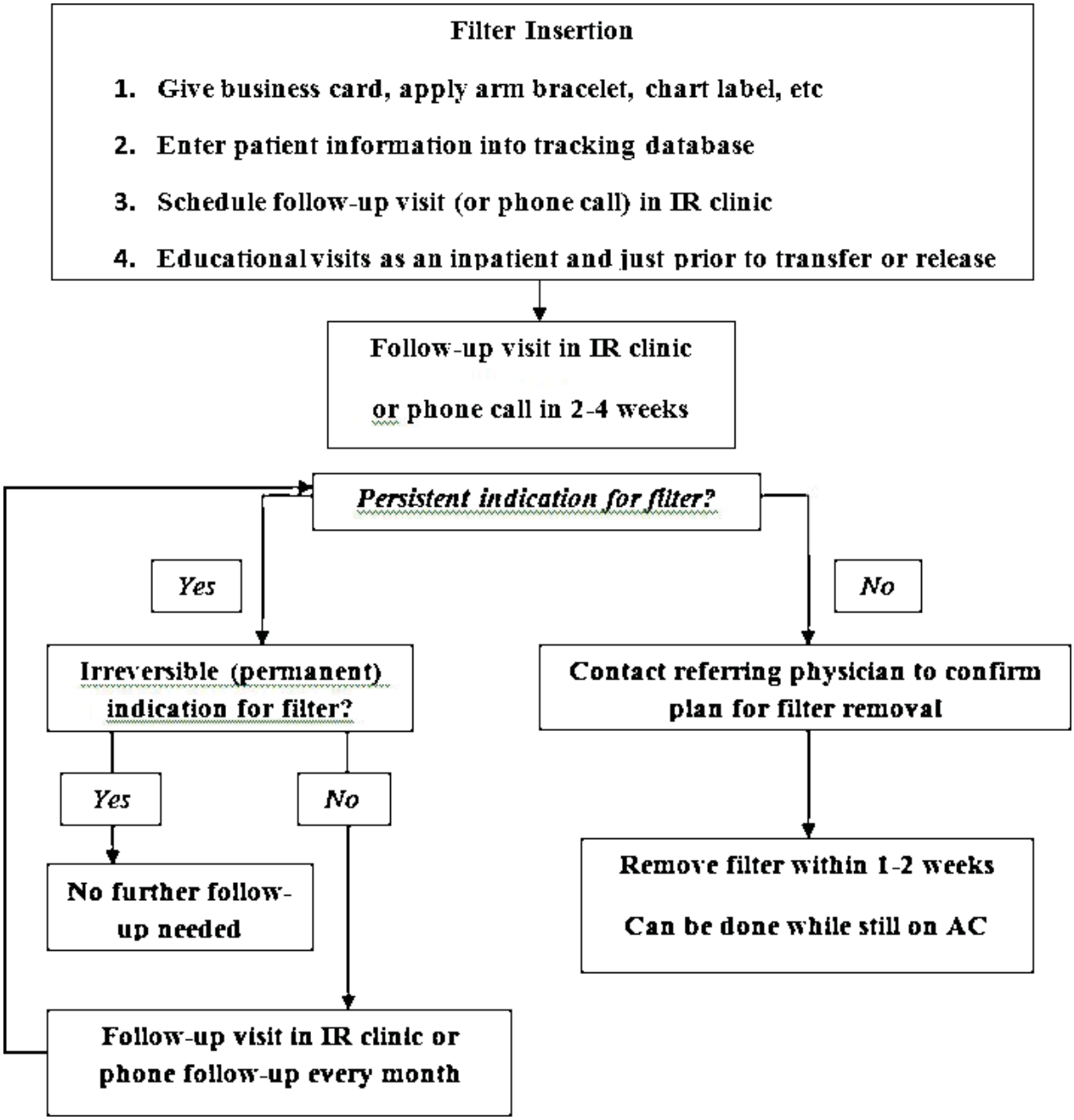

Figure 4 Flow diagram of process to track and remove retrievable inferior vena cava (IVC) filters.

insertion, an armband is placed to identify that the patient has a retrievable filter. The medical record is flagged with a sign placed on the front of the inpatient chart. Finally, a sign is also placed on the door to the patient's room noting the presence of a filter patient. In this manner, everyone involved in caring for this patient is made aware of his or her status and the need for good follow-up. Because of these efforts, this hospital is able to follow-up and evaluate 98% of patients who have received a retrievable filter, with ~50% of all filters eventually being removed—personal communication.

A business card with the name and means to contact the individual designated to track all filter patients should also be provided to both the patient and any significant family member or friend. The telephone number should be a direct line or even a cell phone that can be answered after normal work hours. This will greatly help to decrease loss to follow-up. At Brooke Army Medical Center, Fort Sam Houston, Texas, all patients in contact with the IR service are given a business card. In addition to the phone and pager numbers listed on the front, the business card has a back section specifically designed for patients with retrievable filters (Fig. 3). It emphasizes the importance of follow-up, and clearly states how patients can contact the IR service whenever there is a question or need to schedule an appointment. This has proven to be an easy and effective means by which patients, family members, and health care providers are able to contact the IR service for follow-up. This often translates to a successful retrieval of a filter that may otherwise have not been done. The business card is an inexpensive and effective adjunct that should be utilized.

THE CHALLENGE

Many barriers currently exist that may make it difficult to establish a successful tracking and retrieval system as described above. A prophylactic IVCF is most often inserted in the young multitrauma patient. It is well known that trauma patients are often difficult to track and are often lost to follow-up. Many of the trauma patients are from inner-city, low-socioeconomic groups and do not have a stable address or phone number. Interestingly, in some clinical settings, the most common reason for not retrieving a filter is patient refusal. It has been noted by some IR that many of the trauma patients do not want an additional procedure to remove the IVCF if they are asymptomatic. In other instances, patients undergo additional procedures for years to correct orthopedic injuries, and are worried about losing protection from a fatal PE if they undergo filter retrieval. Despite these challenges, every effort should be made to contact filter patients and arrange follow-up. The expectations for a high retrieval rate for all patients with IVCF should be tempered with the reality that for the trauma population it may not be as high as in other patient populations. However, the young trauma patient stands to gain the most whenever an IVCF that is no longer needed is removed. Any operator inserting retrievable filters has an obligation to ensure that there is a tracking system in place to follow the patient. In the event there is no such process currently in place, the principles and resources discussed here will be helpful in establishing such a system. An example of a simple process is summarized in Fig. 4.

CONCLUSION

Retrievable and prophylactic IVC filters should be placed based on currently accepted indications that are discussed in the guidelines from SIR and ACCP. The protective effect of filters is offset by the potential for DVT, IVC thrombosis, possible otherwise unnecessary lifelong AC, and filter migration or fracture. The standard duration of treatment for many VTE is 3 to 6 months of AC/filter. Filters should be retrieved as soon as the risk for a PE warrants their removal. This occurs when the duration of treatment for a DVT/PE has been met, the risk of a PE is no longer high, and/or there is no longer a contraindication to AC. An effective system that leads to improving the retrieval rate of an IVCF must include thorough education of the patient and the family, an accurate tracking system to minimize patient lost to follow-up, and dedicated personnel responsible for overseeing the entire process. If these goals are accomplished, interventionalists can help decrease the incidence of a fatal PE during the high-risk period, decrease the risk of a DVT, and the use of otherwise unnecessary lifelong AC in subsequent years. Currently, there is much room for improvement in the frequency that IVCF patients are systematically followed and filters are retrieved. The very informative and useful 2006 SIR guidelines for the use of retrievable IVCF should be implemented now. The principles discussed in this report will be helpful in this process.

ACKNOWLEDGMENTS

The authors would like to thank Michelle Sewell, RN, Tina Olivarez, RN, and Lauren Brandt, RN, for sharing information regarding their successful process for tracking IVCF patients at the University Medical Center Brackenridge in Austin, Texas. The assistance of Kathleen Goei, RN, MSN, PhD, in the preparation of this manuscript is also greatly appreciated.

NOTES

The opinions or assertions contained herein are the private views of the authors and are not to be construed

as reflecting the views of the Department of the Army or the Department of Defense.

REFERENCES

1. Shackford SR, Cook A, Rogers FB, Littenberg B, Osler T. The increasing use of vena cava filters in adult trauma victims: data from the American College of Surgeons National Trauma Data Bank. J Trauma 2007;63(4):764–769
2. Aryafar H, Kinney TB. Optional inferior vena cava filters in the trauma patient. Semin Intervent Radiol 2010;27(1): 68–80
3. Rogers FB, Cipolle MD, Velmahos G, Rozycki G, Luchette FA. Practice management guidelines for the prevention of venous thromboembolism in trauma patients: the EAST practice management guidelines work group. J Trauma 2002; 53(1):142–164
4. Knudson MM, Collins JA, Goodman SB, McCrory DW. Thromboembolism following multiple trauma. J Trauma 1992;32(1):2–11
5. Geerts WH, Code KI, Jay RM, Chen E, Szalai JP. A prospective study of venous thromboembolism after major trauma. N Engl J Med 1994;331(24):1601–1606
6. Decousus H, Leizorovicz A, Parent F, et al. A clinical trial of vena caval filters in the prevention of pulmonary embolism in patients with proximal deep-vein thrombosis. Prévention du Risque d'Embolie Pulmonaire par Interruption Cave Study Group. N Engl J Med 1998;338(7):409–415
7. PREPIC Study Group. Eight-year follow-up of patients with permanent vena cava filters in the prevention of pulmonary embolism: the PREPIC (Prevention du Risque d'Embolie Pulmonaire par Interruption Cave) randomized study. Circulation 2005;112(3):416–422
8. Brender E. Use of emboli-blocking filters increases, but rigorous data are lacking. JAMA 2006;295(9):989–990
9. Levine MN, Raskob G, Beyth RJ, Kearon C, Schulman S. Hemorrhagic complications of anticoagulant treatment: the Seventh ACCP Conference on Antithrombotic and Thrombolytic Therapy. Chest 2004;126(3, Suppl): 287S–310S
10. Ray CE Jr, Prochazka A. The need for anticoagulation following inferior vena cava filter placement: systematic review. Cardiovasc Intervent Radiol 2008;31(2):316–324
11. Ray CE Jr, Mitchell E, Zipser S, Kao EY, Brown CF, Moneta GL. Outcomes with retrievable inferior vena cava filters: a multicenter study. J Vasc Interv Radiol 2006;17(10): 1595–1604
12. Binkert CA, Drooz AT, Caridi JG, et al. Technical Success and safety of Rerieval of the G2 Filter in a prospective, Multicenter Study. J Vasc Interv Radiol 2009;20:1595–1604
13. Johnson MS, Nemcek AA Jr, Benenati JF, et al. The safety and effectiveness of the retrievable option inferior vena cava filter: a United States prospective multicenter clinical study. J Vasc Interv Radiol 2010;21(8):1173–1184
14. Kaufman JA, Kinney TB, Streiff MB, et al. Guidelines for the Use of Retrievable and Convertible Vena Cava Filters: Report from the Society of Interventional Radiology Multidisciplinary Consensus Conference. 2006;17:449–459
15. Removing Retrievable Inferior Vena Cava Filters. Initial Communication. FDA Communication dated August 9, 2010. Available at:http://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/ucm221676.htm 9/21/2010. Accessed February 16, 2011
16. SIR President James F. Benenati, MD, FSIR. Message from SIR President: Society of Interventional Radiology Responds to FDA Blood Clot Device (IVC Filter) Advisory. Available at: http://www.medpedia.com/news_analysis/356-Paul-J-Dorio-MD/entries/42409-IVC-Filters—Society-of-Interventional-Radiology-Advisory. Accessed February 16, 2011
17. Kearon C, Kahn SR, Agnelli G, Goldhaber S, Raskob GE, Comerota AJ; American College of Chest Physicians. Antithrombotic therapy for venous thromboembolic disease: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition). Chest 2008; 133(6, Suppl):454S–545S
18. Schmelzer TM, Christmas AB, Taylor DA, Heniford BT, Sing RF. Vena cava filter retrieval in therapeutically anticoagulated patients. Am J Surg 2008;196(6):944–946; discussion 946–947
19. Hoppe H, Kaufman JA, Barton RE, et al. Safety of inferior vena cava filter retrieval in anticoagulated patients. Chest 2007;132(1):31–36
20. O'Keeffe T, Thekkumel TJ, Friese S, Shafi S, Josephs SC. A policy of dedicated follow-up improves the rate of removal of retrievable inferior vena cava filters in trauma patients. Am Surg 2011. In press