



Society of Interventional Radiology Clinical Practice Guideline for Inferior Vena Cava Filters in the Treatment of Patients with Venous Thromboembolic Disease

Developed in collaboration with the American College of Cardiology, American College of Chest Physicians, American College of Surgeons Committee on Trauma, American Heart Association, Society for Vascular Surgery, and Society for Vascular Medicine

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ABSTRACT

Purpose: To provide evidence-based recommendations on the use of inferior vena cava (IVC) filters in the treatment of patients with or at substantial risk of venous thromboembolic disease.

Materials and Methods: A multidisciplinary expert panel developed key questions to address in the guideline, and a systematic review of the literature was conducted. Evidence was graded based on a standard methodology, which was used to inform the development of recommendations.

Results: The systematic review identified a total of 34 studies that provided the evidence base for the guideline. The expert panel agreed on 18 recommendations.

Conclusions: Although the evidence on the use of IVC filters in patients with or at risk of venous thromboembolic disease varies in strength and quality, the panel provides recommendations for the use of IVC filters in a variety of clinical scenarios. Additional research is needed to optimize care for this patient population.

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The American Society of Hematology affirmed that these guidelines have value for hematologists

Please see [Appendix A](#) (available online on the article's [Supplemental Material](#) page at www.jvir.org) for all author conflicts of interest and disclosures.

[Appendices A–D](#) can be found by accessing the online version of this article on www.jvir.org and clicking on the [Supplemental Material](#) tab.

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ABBREVIATIONS

AAOS = American Academy of Orthopedic Surgeons, CI = confidence interval, COI = conflict of interest, DVT = deep vein thrombosis, IVC = inferior vena cava, OR = odds ratio, PE = pulmonary embolism, PICO = patient, intervention, control/comparator, outcome, PREPIC = Prevention du Risque d'Embolie Pulmonaire par Interruption Cave [study], RR = relative risk, VTE = venous thromboembolism

SUMMARY OF RECOMMENDATIONS

Acute PE

1. In patients with acute PE with a contraindication to anticoagulation therapy, we suggest an IVC filter be considered based on various clinical risk factors, as outlined in the rationale.

Strength of recommendation: Limited ★★☆☆

Acute DVT

2. In patients with acute DVT without PE and with a contraindication to anticoagulation therapy, we suggest that an IVC filter be considered based on various clinical risk factors, as outlined in the rationale.

Strength of recommendation: Consensus ★☆☆☆

Anticoagulation for VTE

- 3a. In patients undergoing anticoagulation for acute VTE (DVT, PE) in whom a contraindication to anticoagulation develops, we suggest that an IVC filter be considered in the setting of ongoing significant clinical risk for PE.

Strength of recommendation: Consensus ★☆☆☆

- 3b. In patients undergoing extended anticoagulation for VTE (DVT, PE) and have completed the acute phase of treatment in whom a contraindication to anticoagulation develops, we suggest that an IVC filter not be placed, with rare exceptions.

Strength of recommendation: Consensus ★☆☆☆

Recurrent VTE

4. In patients who are receiving therapeutic anticoagulation for VTE (DVT, PE) who experience a recurrent VTE, we suggest that a filter not be placed, with few exceptions. Reasons for anticoagulation failure should always be addressed.

Strength of recommendation: Consensus ★☆☆☆

Routine IVC Filter Placement

5. In patients with acute VTE (DVT, PE) who are being treated with therapeutic anticoagulation, we recommend against routine placement of an IVC filter.

Strength of recommendation: Moderate ★★★☆

PE with Advanced Therapies

6. In patients with acute PE who are undergoing advanced therapies, we suggest considering the placement of IVC filters only in select patients, as outlined in the rationale.

Strength of recommendation: Limited ★★☆☆

DVT with Advanced Therapies

7. In patients with DVT who are undergoing advanced therapies, we suggest considering the placement of IVC filters only in select patients, as outlined in the rationale.

Strength of recommendation: Limited ★★☆☆

Trauma Patients without Known VTE

8. In trauma patients without known acute VTE, we recommend against the routine placement of IVC filters for primary VTE prophylaxis.

Strength of recommendation: Moderate ★★★☆

Major Surgery Patients without Known VTE

9. In patients without known acute VTE who are undergoing major surgery, we suggest against routine placement of IVC filters.

Strength of recommendation: Consensus ★☆☆☆

Indwelling IVC Filters with No Anticoagulation Indication

10. In patients who have indwelling IVC filters with no other indication for anticoagulation, we cannot recommend for or against anticoagulation.

Strength of recommendation: Consensus ★☆☆☆

Indwelling IVC Filters with Mitigated PE Risk

- 11a. In patients with indwelling retrievable/convertible IVC filters whose risk of PE has been mitigated or who are no longer at risk for PE, we suggest filters be routinely removed/converted unless risk outweighs benefit.

Strength of recommendation: Consensus ★☆☆☆

- 11b. In patients with indwelling permanent IVC filters whose risk of PE has been mitigated or who are no longer at risk for PE, we suggest against routine removal of filters.

Strength of recommendation: Consensus ★☆☆☆

Complications and Indwelling IVC Filters

12. In patients with complications attributed to indwelling IVC filters, we suggest filter removal be considered after weighing filter- versus procedure-related risks and the likelihood that filter removal will alleviate the complications.

Strength of recommendation: Consensus ★☆☆☆

Structured Follow-up

13. In patients who have an IVC filter, we recommend the use of a structured follow-up program to increase retrieval rates and detect complications.

Strength of recommendation: Limited ★★☆☆

Planned Filter Removal

14. In patients in whom IVC filter removal is planned, we suggest against routine preprocedural imaging of the filter and the use of laboratory studies except in select situations, as outlined in the rationale.

Strength of recommendation: Consensus ★☆☆☆

Filter Removal without Standard Snare Techniques

15. In patients undergoing filter retrieval whose filter could not be removed by using standard techniques, we suggest attempted removal with advanced techniques, if appropriate and if the expertise is available, after reevaluation of risks and benefits.

Strength of recommendation: Consensus ★☆☆☆

Filter Placement Technique

16. In patients undergoing IVC filter placement, we cannot recommend for or against any specific placement technique.

Strength of recommendation: Consensus ★☆☆☆

INTRODUCTION

This clinical practice guideline is based on a systematic review of published studies on the use of inferior vena cava (IVC) filters in the treatment of patients with or at substantial risk of venous thromboembolic disease. In addition to providing recommendations to guide clinical decision-making, this guideline also emphasizes gaps in the literature and areas that would benefit from additional research.

The intended audience for this guideline is all appropriately trained and qualified clinicians involved in the management of patients with venous thromboembolic disease, administrators, and policy makers. Venous thromboembolism (VTE) care is delivered by many different medical specialties, including those that focus on medical management and those that provide interventions such as inferior vena cava (IVC) filter placement and removal, catheter-directed thrombolysis, or surgical thrombectomy. This guideline was created with multidisciplinary input in an effort to improve the quality of care for patients with or at risk for VTE who may require an IVC filter.

VTE, including deep vein thrombosis (DVT) and pulmonary embolism (PE), is a significant cause of morbidity and mortality (1). The mainstay of treatment for patients with VTE is anticoagulation (2). Nonetheless, caval interruption (surgical ligation) to prevent PE was first performed by Trendelenburg in the early 1900s (3). Since the 1960s, caval interruption with the placement of an IVC filter has been the preferred option for patients with acute VTE and a contraindication to anticoagulation. Technologic advances in IVC filter design, particularly the availability of filters that are designed to be retrieved or converted, have caused a shift in practice, with greater vigilance toward removing or converting these devices when this risk of PE has abated (4). However, these advances may have contributed to the increased placement of filters in patients without VTE but who are considered at risk for PE. Administrative data indicate that IVC filters are widely used in the United States, with approximately 96,000 placement procedures in 2014 (5). Although the use of IVC filters in various clinical scenarios has been variably supported by professional societies such as the American College of Chest Physicians

(2), American Heart Association (6), Society of Interventional Radiology (SIR) (7,8), and American College of Radiology, there are unanswered questions regarding their efficacy and lack of multiple high-quality trials demonstrating clear benefit (9). In addition, as more filters have been placed, complications of these devices have become more widely recognized (10). In the present clinical practice guideline, the authors provide evidence-based recommendations balancing the benefits and harms associated with the use, placement, and removal/conversion of IVC filters in the treatment of VTE and prevention of PE.

MATERIALS AND METHODS

The methods used to perform the systematic review supporting the guideline recommendations were employed to minimize bias and enhance transparency in the selection, appraisal, and analysis of the available evidence.

SIR partnered with the American Academy of Orthopedic Surgeons (AAOS) Clinical Quality and Value Unit in the Department of Research Quality and Scientific Affairs (methodologists) to develop this clinical practice guideline. The methods detailed below reflect the AAOS methodology.

Panel Formation and Conflict of Interest Review

The chair of the panel was nominated by the SIR Operations Committee and reviewed for potential conflicts of interest (COIs). The chair, along with the SIR Standards Division Councilor, subsequently nominated panelists, ensuring a multidisciplinary panel of experts was included. All panel nominees were reviewed for potential COIs in accordance with the AAOS COI policy for clinical practice guidelines. The final panel consisted of 3 interventional radiologists, 2 representatives from vascular surgery, 2 representatives from vascular medicine/cardiology, 1 representative from vascular medicine, a pulmonologist, a hematologist, and a trauma/critical-care surgeon.

Key Question Development

Approved panelists met during an introductory meeting on October 29, 2018, to establish the scope of the clinical practice guideline by developing key clinical questions in the patient, intervention, control/comparator, outcome (PICO) format. The panel agreed on 17 PICO questions (Table 1) that covered management and use of IVC filters in patients with or without thromboembolic disease. One PICO question covering device or patient prognostic factors leading to poorer outcomes with indwelling IVC filters was ultimately excluded during the development process, as the panel decided it was out of the scope of the present document, resulting in a total of 16 PICO questions.

Literature Searches

A medical librarian from the AAOS Clinical Quality and Value department conducted a comprehensive search of MEDLINE, Embase, and the Cochrane Central Register of Controlled Trials in November 2018 based on key terms and concepts from the clinical practice guideline development group's PICO questions. Bibliographies of relevant systematic reviews were hand-searched for additional references. An updated search was conducted on June 10, 2019, with results limited to English-language publications between 1966 and that day. The full search strategies are reported in Appendix B (available online on the article's Supplemental Material page at www.jvir.org).

Study Selection and Data Extraction

AAOS methodologists reviewed the results of the literature search for relevant studies meeting the inclusion criteria through 2 rounds of screening. During the first round, reviewers excluded studies that did not meet the inclusion criteria (Appendix C, [available online on the article's Supplemental Material page at www.jvir.org]) based on title or abstract. Full texts were retrieved for studies that passed the first round to determine their final inclusion. Details of study selection and final number of included studies can be found in the Figure.

Table 1. Key Clinical Questions**In patients with acute PE with a contraindication to anticoagulation therapy, does placement of an IVC filter lead to different outcomes than not placing an IVC filter?**

Population/Patient	Patients with acute PE with or without proximal DVT with contraindication to anticoagulation
Intervention	The procedure of placing (any type of) IVC filter
Comparator	Not placing an IVC filter
Outcome(s)	Mortality, (recurrent/change in) PE, DVT, postthrombotic syndrome, pulmonary hypertension, escalating care, subsequent procedures as an effect of complications, length of stay, readmissions, patient-reported outcomes, complications

In patients with acute PE with a contraindication to anticoagulation therapy, does placement of an IVC filter lead to different outcomes than not placing an IVC filter?

Population/patient	Patients with acute DVT without PE and with contraindication to anticoagulation
Intervention	The procedure of placing (any type of) IVC filter
Comparator	Not placing an IVC filter
Outcome(s)	Mortality, PE, (recurrent/change in) DVT, postthrombotic syndrome, pulmonary hypertension, escalating care, subsequent procedures as an effect of complications, length of stay, readmissions, patient-reported outcomes, complications

In patients who are being anticoagulated (acute or extended) for VTE (DVT, PE) and develop a contraindication to anticoagulation, does placement of an IVC filter lead to different outcomes than not placing an IVC filter?

Population/patient	Patients who are being anticoagulated for VTE (DVT, PE), either acute or extended treatment, who develop a contraindication to anticoagulation
Intervention	The procedure of placing (any type of) IVC filter
Comparator	Not placing an IVC filter
Outcome(s)	Mortality, PE, (recurrent/change in) DVT, postthrombotic syndrome, pulmonary hypertension, escalating care, subsequent procedures as an effect of complications, length of stay, readmissions, patient-reported outcomes, complications

In patients who are receiving full therapeutic anticoagulation for VTE (DVT, PE) who develop a recurrent VTE event while receiving anticoagulation, does placement of an IVC filter lead to different outcomes than not placing an IVC filter?

Population/Patient	Patients who are receiving full therapeutic anticoagulation for VTE who develop a recurrent VTE event while on anticoagulation
Intervention	The procedure of placing (any type of) IVC filter
Comparator	Not placing an IVC filter
Outcome(s)	Mortality, PE, (recurrent/change in) DVT, postthrombotic syndrome, pulmonary hypertension, escalating care, subsequent procedures as an effect of complications, length of stay, readmissions, patient-reported outcomes, complications

In patients with acute VTE who are being treated with anticoagulation, does placement of an IVC filter affect outcomes?

Population/patient	Patients with acute VTE (PE or DVT) who are being treated with anticoagulation
Intervention	The procedure of placing (any type of) IVC filter
Comparator	No IVC filter
Outcome(s)	Mortality, (recurrent/change in) DVT or PE, postthrombotic syndrome, pulmonary hypertension, escalating care, subsequent procedures as an effect of complications, length of stay, readmissions, patient-reported outcomes, complications, bleeding, anticoagulation management strategies

In patients with acute PE who are undergoing advanced therapies, does placement of an IVC filter affect outcomes?

Population/patient	Patients with acute PE who are undergoing advanced therapies (ie, any form of thrombolysis, thrombectomy, or embolectomy)
Intervention	The procedure of placing (any type of) IVC filter
Comparator	No IVC filter
Outcome(s)	Mortality, (recurrent/change in) DVT or PE, postthrombotic syndrome, pulmonary hypertension, escalating care, subsequent procedures as an effect of complications, length of stay, readmissions, patient-reported outcomes, complications, bleeding, anticoagulation management strategies

In patients with acute DVT who are undergoing advanced therapies, does placement of an IVC filter affect outcomes?

Population/Patient	Patients with DVT who are undergoing advanced therapies
Intervention	The procedure of placing (any type of) IVC filter
Comparator	No IVC filter
Outcome(s)	Mortality, (recurrent/change in) DVT or PE, postthrombotic syndrome, pulmonary hypertension, escalating care, subsequent procedures as an effect of complications, length of stay, readmissions, patient-reported outcomes, complications, bleeding, anticoagulation management strategies

continued

Table 1. Key Clinical Questions (continued)**In trauma patients without known acute VTE, does placement of a prophylactic IVC filter affect outcomes?**

Population/Patient	Trauma patients without known acute VTE
Intervention	The procedure of placing (any type of) IVC filter
Comparator	No prophylactic IVC filter placed
Outcome(s)	Mortality, DVT, PE, postthrombotic syndrome, pulmonary hypertension, escalating care, subsequent procedures as an effect of complications, length of stay, readmissions, patient-reported outcomes, complications, bleeding, anticoagulation management strategies, retrieval rates, complications of nonretrieval

In major surgery patients without known acute VTE, does placement of a prophylactic IVC filter affect outcomes?

Population/patient	Major surgery patients (eg, bariatric, spine, neurosurgery, nontraumatic orthopedic, pelvic) without known acute VTE
Intervention	The procedure of placing (any type of) IVC filter
Comparator	No prophylactic IVC filter placed
Outcome(s)	Mortality, DVT, PE, postthrombotic syndrome, pulmonary hypertension, escalating care, subsequent procedures as an effect of complications, length of stay, readmissions, patient-reported outcomes, complications, bleeding, anticoagulation management strategies, retrieval rates, complications of nonretrieval

In patients who have indwelling IVC filters with no other indication for anticoagulation, does anticoagulation affect outcomes?

Population/patient	Patients who have indwelling IVC filters with no other indication for anticoagulation
Intervention	Anticoagulation
Comparator	No anticoagulation
Outcome(s)	Mortality, DVT, PE, postthrombotic syndrome, pulmonary hypertension, escalating care, subsequent procedures as an effect of complications, length of stay, readmissions, patient-reported outcomes, complications, bleeding, anticoagulation management strategies, retrieval rates, complications of nonretrieval

In patients with indwelling IVC filters whose risk of PE has been mitigated or who are no longer at risk for PE, does removal of indwelling IVC filter affect outcomes?

Population/patient	Patients with indwelling IVC filters whose risk of PE has been mitigated or who are no longer at risk for PE
Intervention	Removal/conversion of indwelling IVC filter
Comparator	Nonremoval/nonconversion of indwelling IVC filter
Outcome(s)	Mortality, DVT, PE, postthrombotic syndrome, pulmonary hypertension, escalating care, subsequent procedures as an effect of complications, length of stay, readmissions, patient-reported outcomes, complications, bleeding, anticoagulation management strategies, successful and failed retrieval rates, complications of nonretrieval

In patients with complications associated with indwelling IVC filters, does removal of indwelling IVC filter affect outcomes?

Population/patient	Patients with complications associated with indwelling IVC filters
Intervention	Removal of indwelling IVC filter
Comparator	Nonremoval of indwelling IVC filter
Outcome(s)	Mortality, DVT, PE, postthrombotic syndrome, pulmonary hypertension, escalating care, subsequent procedures as an effect of complications, length of stay, readmissions, patient-reported outcomes, complications, bleeding, anticoagulation management strategies, successful retrieval rates, complications of nonretrieval

In patients who have an IVC filter, does structured follow-up affect outcomes?

Population/patient	Patients who have an IVC filter (any type) placed
Intervention	Structured follow-up (as defined by study as, eg, phone calls, IVC filter clinics, informatics, registries)
Comparator	No structured follow-up
Outcome(s)	Filter retrieval, complications, anticoagulation management, recurrent VTE, mortality, DVT, PE, postthrombotic syndrome, pulmonary hypertension, escalating care, subsequent procedures as an effect of complications, length of stay, readmissions, patient-reported outcomes, bleeding, anticoagulation management strategies, complications of nonretrieval

In patients who are having an IVC filter removed, does preprocedural laboratory and/or imaging affect the rate of aborted IVC filter removal procedures?

Population/patient	Patients who are having an IVC filter removed/converted
Intervention	Preprocedural laboratory and/or imaging
Comparator	No preprocedural laboratory and/or imaging
Outcome(s)	Aborted IVC filter removal procedure

In patients undergoing filter retrieval whose filter could not be removed/converted using standard snare techniques, did removal/conversion of IVC filters with advanced techniques affect outcomes vs nonremoval of IVC filter?

Population/patient	Patients undergoing filter retrieval whose filter could not be removed using standard snare techniques
Intervention	Removal/conversion of retrievable IVC filter with advanced techniques
Comparator	Nonremoval/conversion of IVC filter
Outcome(s)	Surgical retrieval of IVC filter, mortality, DVT, PE, escalating care, subsequent procedures as an effect of complications, length of stay, readmissions, patient-reported outcomes, procedural complications, bleeding, anticoagulation management strategies, successful retrieval rates, complications of nonretrieval

continued

Table 1. Key Clinical Questions (*continued*)**In patients undergoing IVC filter placement, does placement technique affect acute outcomes?**

Population/patient	Patients undergoing IVC filter placement (any type)
Intervention	Fluoroscopic vs transcatheter US vs intravascular US
Comparator	Fluoroscopic vs transcatheter US vs intravascular US
Outcome(s)	Acute outcomes, procedural complications, surgical complications, malposition

DVT = deep vein thrombosis; IVC = inferior vena cava; PE = pulmonary embolism; VTE = venous thromboembolism.

Relevant data from each eligible study were extracted into structured data tables by using AAOS templates ([Appendix D](#) [available online on the article's [Supplemental Material](#) page at www.jvir.org]).

Assessment of Risk of Bias

AAOS methodologists assessed the risk of bias in all included studies. The Cochrane risk-of-bias tool was used to assess risk of bias for randomized controlled trials (11). The Risk of Bias in Nonrandomized studies of Interventions (12) was used for observational studies. The risk of bias assessments for each included studies are included in [Appendix D](#) (available online on the article's [Supplemental Material](#) page at www.jvir.org).

Best Evidence Synthesis

According to AAOS methodology, only the best available evidence for any given outcome addressing a recommendation was included. Accordingly, we first included the highest-quality evidence (based on an assessment using the risk-of-bias tools listed above) for any given outcome if it was available. In the absence of 2 or more occurrences of an outcome at this quality level, we considered outcomes of the next lowest quality until at least 2 occurrences of an outcome had been acquired. For example, if there were 2 “moderate”-quality occurrences of an outcome that addressed a recommendation, we did not include “low”-quality occurrences of this outcome. The detailed evidence for each recommendation is provided after each recommendation.

Drafting and Defining the Strength of the Recommendations

The panel developed recommendations for each of the PICO questions at the final in-person meeting in July 2019. Panel members made decisions regarding the balance between benefit and harm, impact on patients' values and preferences, cost, feasibility, and acceptability of the intervention.

The AAOS system of defining the strength of a recommendation was used in formulating the grade for each recommendation. The strength of recommendation ([Table 2](#)) also takes into account the quality, quantity, and the trade-off between the benefits and harms of a treatment; the magnitude of a treatment's effect; and whether there are data on critical outcomes. Recommendations graded as high- or moderate-quality use the wording “we recommend,” whereas recommendations graded as “limited” or “consensus” use the wording “we suggest.” [Table 3](#) addresses how to interpret the strength of each recommendation.

Voting on the Recommendations

The recommendations and their strength were voted on by the guideline panel members during the final in-person meeting. Any panelists with COIs deemed to be significant recused themselves from voting. Recommendation statements were approved and adopted in instances in which a majority (80%) of the guideline development group voted to approve; however, the guideline development group had consensus (100% approval) when voting on every recommendation for this guideline.

Document Peer Review and Approval

Reviewers from the participating societies and the SIR Standards Venous Workgroup reviewed the content and methods, including consistency, accuracy, and completeness. The manuscript was revised after consideration by the panel of the feedback received from the peer reviewers. SIR's

Operations Committee provided final approval of the revised manuscript before submission to the *Journal of Vascular and Interventional Radiology*.

RESULTS**Acute PE**

Question.—In patients with acute PE with a contraindication to anticoagulation therapy, does placement of an IVC filter lead to different outcomes than not placing an IVC filter?

1. In patients with acute PE with a contraindication to anticoagulation therapy, we suggest an IVC filter be considered based on various clinical risk factors, as outlined in the rationale.

Strength of Recommendation: Limited ★★☆☆

Summary of the evidence.—It is well established that the mortality rate from untreated acute PE is high. The potential benefit of IVC filter insertion in this setting is prevention of morbidity and mortality from hemodynamic effects of recurrent PE. Unfortunately, there is limited high-quality evidence to support this widely accepted practice. Three low-quality observational studies met the inclusion criteria for this PICO question.

In 1 low-quality single-institution study of 451 trauma patients with filters and 1,343 matched controls (13), known VTE was found in 69 patients with IVC filters and 21 without an IVC filter at baseline. In multivariable logistic regression of this small subgroup, the authors found no significant difference in overall mortality in patients with a filter versus those without a filter ($P = .45$). Similarly, no difference in in-hospital mortality was found between groups. However, these analyses are significantly underpowered given the small subgroup being studied.

Another low-quality study found contradictory results (9). In a study of administrative claims data, Turner et al (9) assessed mortality outcomes in a cohort of 126,030 patients with VTE and a contraindication to anticoagulation ($n = 45,771$ treated with an IVC filter; $n = 80,259$ did not receive an IVC filter). IVC filter placement was associated with a significantly increased risk of 30-day mortality (hazard ratio [HR], 1.18; 95% confidence interval [CI], 1.13–1.22; $P < .001$). However, this study is limited by its retrospective design as well as its use of diagnostic codes from claims data, which can underestimate event rates.

White et al (14) retrospectively analyzed patients with acute VTE with active bleeding who had at least a temporary contraindication to anticoagulation. Of these patients with acute VTE, 1,095 had IVC filters placed and 1,922 patients did not. Use of an IVC filter was associated with a reduced risk of all-cause death at 30 days (HR, 0.61; 95% CI, 0.39–0.95) and at 90 days (HR, 0.73; 95% CI, 0.59–0.90). There was no difference in the risk of recurrent PE within 1 year between the 2 groups (HR, 1.04; 95% CI, 0.67–1.61), and the risk of recurrent DVT within 1 year was found to be significantly higher among patients with IVC filters than those without (HR, 2.35; 95% CI, 1.56–3.52).

Despite the lack of high-quality evidence, expert consensus indicates that most, but not all, patients with an acute PE and a contraindication to anticoagulation should receive an IVC filter. The patient's ongoing VTE risk, cardiopulmonary status/reserve, hemodynamic response to PE, presence/extent of residual DVT, and expected duration of contraindication to anticoagulation should all be considered. In selected circumstances, such as a small or clinically insignificant PE with minimal or no residual DVT and a short-term contraindication to anticoagulation, it may be reasonable to not place an IVC filter. Monitoring for recurrence or extension of lower-extremity clot and PE is recommended in such patients. Similarly, if a patient has completed a substantial

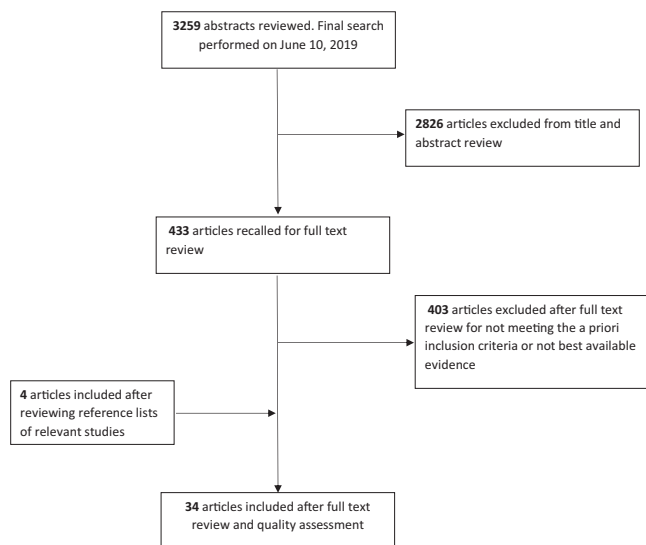


Figure. Study attrition flowchart.

portion of the expected course of anticoagulation and then develops a contraindication to continued anticoagulation, the risks and benefits of IVC filter placement should be carefully considered, weighing risk of recurrent VTE against the risks of IVC filter placement.

Benefits and harms.—The panel judged that the benefits associated with IVC filter placement (reduction in short-term PE recurrence and possibly a reduction in mortality from acute PE) outweigh the potential harms (bleeding, vascular injury, device migration, and increased risk of recurrent DVT) in most patients.

Outcome importance.—The panel judged that there is probably no important uncertainty or variability in how patients and providers value the main outcome, as untreated PE has a substantial mortality rate largely related to recurrent PE.

Cost effectiveness/resource utilization.—The panel did not identify any cost-effectiveness studies of IVC filter placement in patients with acute PE with a contraindication to anticoagulation. The panel judged that filter placement and removal entails costs for supplies, equipment, and personnel.

Acceptability.—Although invasive, placement of an IVC filter would be acceptable to most patients in comparison with the alternative of mortality from acute PE. It is generally an ambulatory procedure with modest risk.

Feasibility.—The panel judged that routine placement of an IVC filter is probably feasible. Most but not all health care facilities will have access to IVC filter placement.

Future research.—A randomized trial of filter (any type) versus no filter among patients with acute PE and contraindication to anticoagulation would be ideal, but the feasibility of such a study is low.

Acute DVT

Question.—In patients with acute DVT without PE and with a contraindication to anticoagulation therapy, does placement of an IVC filter lead to different outcomes than not placing an IVC filter?

2. In patients with acute DVT without PE and with a contraindication to anticoagulation therapy, we suggest that an IVC filter be considered based on various clinical risk factors, as outlined in the rationale.

Strength of Recommendation: Consensus statement ★☆☆☆

Summary of the evidence.—No studies were identified in the systematic review that met the inclusion criteria for this question.

DVT and PE are considered different parts of the spectrum of a single disease process, VTE. Most PEs are a consequence of embolization of clot in the deep venous system of the legs, and PE can be demonstrated in approximately half of patients with DVT. Anticoagulation is known to reduce clot propagation and embolization risk.

Despite the paucity of evidence, the panel agreed that most, but not all, patients with an acute proximal DVT and a contraindication to anticoagulation should receive an IVC filter. The patient’s cardiopulmonary status/reserve, extent and location of DVT, ongoing thrombotic risk, and expected duration of contraindication to anticoagulation should all be considered. In selected circumstances, such as a small thrombus or distal vein DVT and a short-term contraindication to anticoagulation, a newly diagnosed clot of unknown acuity, or a contraindication occurring after a patient has completed a substantial portion of a recommended course of therapy, it may be reasonable to not place an IVC filter. Monitoring for recurrence or extension of lower-extremity clot is recommended in such patients.

Benefits and harms.—The panel judged that the benefits of IVC filter placement (reduction in PE and its adverse consequences, including hemodynamic compromise and death) probably outweighs the harms (bleeding, vascular injury, device migration, and increased risk of recurrent DVT).

Outcome importance.—The panel judged that there is probably no important uncertainty or variability in how patients value outcomes.

Cost effectiveness/resource utilization.—The panel did not identify any cost-effectiveness studies of IVC filter placement in this population. The panel judged that routine IVC filter placement and removal entails moderate costs for supplies, equipment, and personnel.

Acceptability.—The panel judged that acceptability of IVC filter placement varies among different stakeholders. Although invasive,

Table 2. American Academy of Orthopedic Surgeons Strength of Recommendation Descriptions

Strength	Overall Strength of Evidence	Description of Evidence Quality	Strength Visual
Strong	Strong	Evidence from ≤ 2 “high”-quality studies with consistent findings for recommending for or against intervention	★★★★
Moderate	Moderate	Evidence from ≤ 2 “moderate”-quality studies with consistent findings or evidence from a single “high”-quality study for recommending for or against intervention	★★★☆
Limited	Low or conflicting	Evidence from ≤ 2 “low”-quality studies with consistent findings or evidence from a single “moderate”-quality study recommending for against intervention or diagnostic, or evidence is insufficient or conflicting and does not allow a recommendation for or against intervention	★★☆☆
Consensus	None	There is no supporting evidence; in the absence of reliable evidence, the clinical practice guideline development group is making a recommendation based on their clinical opinion; consensus statements are published in a separate, complementary document	★☆☆☆

Table 3. Clinical Applicability: American Academy of Orthopedic Surgeons Interpretation of the Strength of a Recommendation

Strength of Recommendation	Patient Counseling (Time)	Decision Aids	Impact of Future Research
Strong	Least	Least important unless evidence supports no difference between 2 alternative interventions	Not likely to change
Moderate	Less	Less important	Less likely to change
Limited	More	Important	Change possible/anticipated
Consensus	Most	Most important	Impact unknown

placement of an IVC filter would be acceptable to most patients in comparison with the alternative of potential mortality from acute PE.

Feasibility.—The panel judged that routine placement of an IVC filter is probably feasible. Most but not all health care facilities will have access to IVC filter placement.

Future research.—Future research should focus on randomized trials of IVC filter versus no IVC filter for patients with acute DVT and contraindication to anticoagulation.

Anticoagulation for VTE

Question.—In patients undergoing anticoagulation (acute or extended) for VTE (DVT, PE) in whom a contraindication to anticoagulation develops, does placement of an IVC filter lead to different outcomes than not placing an IVC filter?

3a. In patients undergoing anticoagulation for acute VTE (DVT, PE) in whom a contraindication to anticoagulation develops, we suggest that an IVC filter be considered in the setting of ongoing significant clinical risk for PE.

Strength of Recommendation: Consensus statement ★☆☆☆

3b. In patients receiving extended anticoagulation after acute treatment for VTE in whom a contraindication to anticoagulation develops, we suggest that an IVC filter not be placed, with rare exceptions.

Strength of Recommendation: Consensus statement ★☆☆☆

Strength of evidence (certainty of evidence): Expert opinion

Summary of the evidence.—No studies met our inclusion criteria in evaluating the role of IVC filter placement in patients in whom contraindications to continued anticoagulation developed during acute (3 mo) or extended therapy (> 3 mo) for VTE (DVT, PE).

Patients with acute VTE have a significant risk for VTE recurrence, especially during the first months after the event. Prompt and adequate anticoagulation is known to mitigate this risk of PE. As acute PE may result in serious patient decompensation and even death, an IVC filter may be beneficial in those who require interruption of anticoagulation during this acute period.

In contrast, risk of recurrence decreases as time passes from the original VTE. As indwelling IVC filters may be associated with complications, we recommend that they should be avoided in most cases for patients in whom a contraindication to extended therapy develops.

Benefits and harms.—The panel concluded that the balance between benefits and harms were judged to favor the comparison (ie, no IVC filter).

Outcome importance.—The panel judged that there is probably no important uncertainty or variability in how patients value the outcomes.

Cost effectiveness/resource utilization.—The panel did not identify any cost-effectiveness studies of IVC filter placement in this population. The panel judged that routine IVC filter placement would lead to moderate increase in costs required for IVC filter placement and retrieval.

Acceptability.—The panel judged that acceptability to different stakeholders (ie, patients, providers, payors) of IVC filter placement in this scenario probably varies.

Feasibility.—The panel judged that routine placement of an IVC filter is probably feasible. Most but not all health care facilities will have access to IVC filter placement.

Future research.—Future research should specifically compare patients who received an IVC filter after the development of contraindications to anticoagulation when treated for VTE (DVT, PE) and investigate for this indication whether their outcomes were improved or hindered by this intervention.

Recurrent VTE

Question.—In patients who are receiving full therapeutic anticoagulation for VTE (DVT, PE) who experience a recurrent VTE event while receiving anticoagulation, does placement of an IVC filter lead to different outcomes than not placing an IVC filter?

4. In patients who are receiving therapeutic anticoagulation for VTE (DVT, PE) who experience a recurrent VTE, we suggest that a filter not be placed, with few exceptions. Reasons for anticoagulation failure should always be addressed.

Strength of Recommendation: Consensus statement ★☆☆☆

Summary of the Evidence.—No studies were identified evaluating the placement of IVC filters in patients receiving anticoagulation for VTE who experience recurrent VTE.

The definition of a recurrent VTE is not well established, and it can be hard to distinguish from residual thrombus from the previous VTE unless thrombus is identified in a new anatomic location when comparing sequential imaging studies of the same modality. Many reasons for “failure” of anticoagulation are potentially addressable, including suboptimal medication adherence, achieving nontherapeutic anticoagulant levels, drug–drug interactions, inappropriate dosing, and anatomic disorders that predispose to VTE. Existing guidelines currently address these issues (2,15).

In many instances, switching to a different anticoagulant agent or dose escalation in the event of true failure of the original anticoagulant agent is sufficient to prevent recurrent VTE. We recommend IVC filter placement only in patients with objectively confirmed VTE recurrence and no modifiable issue related to anticoagulation therapy. In addition, clinicians must assess an individual patient’s cardiopulmonary reserve and determine if a subsequent PE would detrimentally impact that patient’s clinical status. Only when the potential risk of cardiopulmonary deterioration outweighs the risk of IVC filter placement and ongoing thrombotic risk from an indwelling device should placement be recommended. It is also important to weigh the risk for filter-associated DVT in patients who experience active clotting despite treatment.

Benefits and harms.—The potential to prevent subsequent PE and hemodynamic collapse is largely undefined in this clinical scenario. However, the potential procedural bleeding risk, risk of filter complication (eg, embolization or perforation), risk of IVC filter thrombosis, and increased risk of DVT following IVC filter placement are all well documented. The panel judged that the balance of benefits and harms varies in different clinical situations.

Outcome importance.—The panel judged recurrent PE, recurrent DVT, major and minor bleeding, clinically meaningful IVC filter–related complications, postthrombotic syndrome, and mortality to be meaningful

outcomes, and there is probably no important uncertainty or variability in how much people value these outcomes.

Cost effectiveness/resource utilization.—The panel did not find cost-effectiveness studies of IVC filters in patients with recurrent VTE. The panel judged that routine placement of an IVC filter does require specialized resources and has associated costs that must be considered. For most patients who are not acutely decompensated, this cost and resource utilization usually does not favor IVC filter placement.

Acceptability.—The panel judged that acceptability to different stakeholders (eg, patients, providers, payors) of IVC filter placement in this scenario probably varies.

Feasibility.—The panel judged that routine placement of an IVC filter is probably feasible to implement except in communities where interventionalists may not be available to place an IVC filter.

Future research.—Future research should focus on improved methods to detect chronic versus acute/recurrent clot in the peripheral veins and pulmonary arteries. Additionally, research is needed to better categorize reasons for anticoagulation failure and the effectiveness of various strategies aimed at specific reasons for failure. Last, prospective studies are needed to better quantify the potential benefits (if any) and associated risks of IVC filter placement in patients with VTE recurrence despite therapeutic anticoagulation.

Routine IVC Filter Placement

Question.—In patients with acute VTE who are being treated with anticoagulation, does placement of an IVC filter affect outcomes?

- In patients with acute VTE (DVT, PE) who are being treated with therapeutic anticoagulation, we recommend against routine placement of an IVC filter.

Strength of Recommendation: Moderate ★☆☆☆

Summary of the evidence.—In making this recommendation, the panel considered data from 3 large RCTs (16–19), 1 of which was specifically in patients with cancer with acute VTE (16), and 1 observational retrospective comparative study (20).

One moderate-quality RCT (16) randomized 64 patients with cancer with acute VTE to anticoagulation with fondaparinux alone versus fondaparinux with IVC filter placement. At 3-month follow-up, there were no significant differences in rates of recurrent PE/DVT (relative risk [RR], 1.06; 95% CI, 0.07–16.29), IVC filter complications (RR, 0.03; 95% CI, –0.03 to 0.09), median survival (493 d vs 266 d), or major bleeding (RR, 0.53; 95% CI, 0.05–5.58) or minor bleeding (RR, 1.06; 95% CI, 0.16–7.10).

In another moderate-quality RCT (17,18), investigators randomly assigned 400 patients with proximal DVT with or without PE to receive a permanent IVC filter or no filter in addition to standard anticoagulation. All patients received therapeutic anticoagulation. After 12 days of treatment, IVC filters were associated with a significant decrease in the incidence of symptomatic and asymptomatic PE compared with anticoagulation alone (1.1% vs 4.8%; $P = 0.03$). When only symptomatic PEs were considered, differences between the filter and no-filter groups were no longer significant (1% vs 3%). At 2 years, symptomatic PE tended to be less frequent among filter recipients than among those who had received anticoagulation alone (3% vs 6%), although this difference was not significant. However, IVC filters were associated with significantly more recurrent DVT than was observed with anticoagulation alone (21% vs 12%; $P = .02$). No difference in bleeding or mortality was documented. Sixteen of 37 patients (43%) with IVC filters who had recurrent DVT also had IVC thrombosis. At 8 years, outcome data on 99% of patients became available (18). Symptomatic PE was less frequent in filter recipients than in those treated with anticoagulation alone (6% vs 15%; $P = .008$); 50% of PEs in the no-filter group occurred during the first 2 years of follow-up. Fatal emboli were more common in patients treated solely with anticoagulation (2 of 200 [0.5%] vs 5 of 200 [2.5%]). DVT was more frequent among filter recipients (36% vs 28%; $P = .042$); 65% of DVTs occurred among filter recipients within the first 2 years of follow-up. Symptomatic filter thrombosis occurred in 13% after 8 years. Postthrombotic syndrome was observed in

70% of patients in the filter and no-filter groups. No difference in overall survival was reported (18).

In the Prevention du Risque d'Embolie Pulmonaire par Interruption Cave (PREPIC) 2 study (19), patients with acute symptomatic PE associated with a lower-extremity DVT or superficial vein thrombosis and at least 1 additional criterion for severity were randomized to anticoagulation alone or anticoagulation plus a retrievable IVC filter. Similar to the first PREPIC study, patients with a contraindication to anticoagulation were excluded from the study. A total of 399 patients were recruited in 6 years. Patients received at least 6 months of therapeutic anticoagulation. Median duration and intensity (time in therapeutic range for vitamin K antagonist) of anticoagulation was similar between the filter and no-filter groups. At 3-month follow-up, recurrent PE occurred in 3.0% of the filter group compared with 1.5% in the no-filter group (RR, 2.0; 95% CI, 0.51–0.79). No difference was found in rates of DVT (0.5% in both groups). Overall, 15 deaths (7.5%) occurred in the filter group and 12 (6.0%) occurred in the no-filter group. Filter removal was attempted at 3 months in 91% of patients and was successful in 93% of those patients. Among those who received a filter, access-site hematoma occurred in 2.6%, filter thrombosis in 1.6%, and technical retrieval failure in 5.7% (19).

Finally, 1 low-quality retrospective observational study (20) found that, at 30-day and 5-year follow-up, there was no difference among patients with acute VTE between those who received anticoagulation with an IVC filter and those who received anticoagulation alone in regard to DVT rates (RR, 1.14; 95% CI, 0.97–1.35) or PE (RR, 0.94; 95% CI, 0.56–1.58) (20). However, patients with IVC filters had increased mortality (HR, 1.4, 1.14–1.71; $P < .002$).

Taken together, these data suggest that IVC filters in addition to anticoagulation may reduce the risk of PE but increase the risk of DVT, with no difference in mortality. Other factors considered in this recommendation included harms associated with filter placement, like access-site hematoma and filter thrombosis, costs and resources needed for IVC placement, as well as low retrieval rates described in the literature.

Benefits and harms.—The balance between benefits and harms were judged to favor the comparison (ie, no IVC filter).

Outcome importance.—The panel judged that there is probably important uncertainty or variability in how patients value outcomes (ie, benefits and harms of an IVC filter).

Cost effectiveness/resource utilization.—The panel did not find cost-effectiveness studies of IVC filters in patients with acute VTE receiving therapeutic anticoagulation. The panel judged that routine IVC filter placement in this scenario would lead to a moderate increase in costs required for IVC filter placement and retrieval as well as resources used to evaluate and treat IVC filter complications.

Acceptability.—The panel judged that acceptability to different stakeholders (eg, patients, providers, payors) of IVC filter placement in this scenario probably varies.

Feasibility.—The panel judged that routine IVC filter placement is probably feasible except in communities where interventionalists may not be available to place an IVC filter.

Future research.—Given the high efficacy of contemporary anticoagulation in preventing recurrent VTE and VTE-related mortality, future research should focus on whether IVC filter placement is beneficial in patients with acute VTE who have contraindications to therapeutic anticoagulation (see recommendation 2).

PE with Advanced Therapies

Question.—In patients with acute PE who are undergoing advanced therapies (ie, any form of thrombolysis, thrombectomy, or embolectomy), does placement of an IVC filter affect outcomes?

- In patients with acute PE who are undergoing advanced therapies, we suggest considering the placement of IVC filters only in select patients.

Strength of Recommendation: Limited ★★☆☆

Summary of the evidence.—In making this recommendation, the panel considered 6 observational studies assessing IVC filter placement in patients with acute PE undergoing advanced therapies (21–26).

Stein et al (21) conducted several retrospective cohort studies using the United States Nationwide Inpatient Sample dataset from 1999 to 2008. This database was used to identify patients with PE receiving thrombolytic therapy with and without IVC filters and found that, among patients in unstable condition (defined as having a listed code for shock or ventilator dependence) receiving thrombolytic therapy, those with an IVC filter had significantly lower in-hospital mortality than those without a filter (7.6% vs 18%; RR, 0.43; 95% CI, 0.39–0.47) (21). Stein et al (22) also found an in-hospital survival benefit with filter placement in elderly patients in unstable condition with acute PE (shock, ventilatory support). In this study (22), addition of a filter significantly decreased in-hospital mortality for patients in all age groups receiving thrombolytic therapy compared with no filter, particularly in patients aged > 80 years, who showed the greatest relative risk (RR, 0.35; 95% CI, 0.27–0.46), indicating that old age should not be a limiting factor when considering IVC filter placement in this population. However, using the National Inpatient Sample dataset from 2009 to 2012, Liang et al (23) evaluated the impact of IVC filters on in-hospital mortality. Among the subset of patients with high-risk PE (hemodynamic shock) undergoing thrombolysis, no significant difference in mortality between the filter placement group and no-filter group was seen (HR, 0.86; 95% CI, 0.61–1.21).

In a recent study, Stein et al (24) used the Premier Healthcare Database to identify patients in unstable condition (in shock or on ventilatory support) with acute PE undergoing thrombolytic therapy or pulmonary embolectomy from 2010 to 2014. Among patients in unstable condition undergoing thrombolytic therapy, all-cause mortality was lower with an IVC filter than without (21% vs 48%; RR, 0.44; 95% CI, 0.33–0.59). Patients in unstable condition undergoing pulmonary embolectomy who had an IVC filter also had lower 3-month all-cause mortality than those who did not have a filter (5.9% vs 44%; RR, 0.13; 95% CI, 0.03–0.61). Lower in-hospital mortality as a result of PE was also seen in patients in unstable condition undergoing thrombolytic embolectomy (RR, 0.42; 95% CI, 0.29–0.60) and pulmonary embolectomy (0.12; 95% CI, 0.03–0.53) who had IVC filters than in those with no filter.

In a retrospective cohort study, Isogai et al (25) compared hospitalized patients with PE receiving anticoagulation or thrombolytic therapy with and without an IVC filter by using propensity-score matching. Among the subgroup undergoing thrombolytic therapy (n = 2,398; 1,191 with filters and 1,207 without filters), IVC filter use significantly reduced the risk of in-hospital mortality (RR, 0.51; 95% CI, 0.32–0.79). It is unclear whether patients in this study undergoing thrombolytic therapy were in stable or unstable condition.

Additional low-quality retrospective cohort studies (21,26) assessed filter placement in patients in stable condition with PE who received thrombolytic therapy. By using the Diagnosis Procedure Combination database, Stein et al (21) identified hospitalized patients with PE who were receiving anticoagulant or thrombolytic therapy. Among patients in stable condition receiving thrombolytic therapy, those with an IVC filter had a lower mortality rate than those who did not (6.4% vs 15%; RR, 0.42; 95% CI, 0.38–0.45). Similarly, Stein et al (26), using the Premier Healthcare Database, found that in-hospital all-cause mortality in patients in stable condition (defined as not in shock or on ventilatory support) with IVC filters in addition to thrombolytic therapy (n = 2,660) was significantly lower than in patients who did not receive an IVC filter (n = 4,332; 5.2% vs 16.1%, respectively; RR, 0.32; 95% CI, 0.27–0.39).

Although the included studies are of low quality and subject to inherent bias from retrospective observational design, the panel recommends evaluation of patients with PE in unstable condition (in shock or on ventilatory support) for filter placement in addition to other therapies. Ideally, this evaluation will, when possible, be multidisciplinary, and the decision reached by consensus and documented in the chart.

Benefits and harms.—The panel judged that the potential benefits (reduction of in-hospital mortality from recurrent PE) probably favor the intervention in select patients.

Outcome importance.—The panel judged that there is probably no important uncertainty or variability in how people value the main outcomes (mortality, recurrent PE, recurrent VTE, filter-related complications).

Cost effectiveness/resource utilization.—The panel did not identify any cost-effectiveness studies of IVC filters in patients who are undergoing advanced therapies; however, the panel judged that routine IVC filter placement would lead to moderate costs required for IVC filter placement and retrieval as well as moderate resource utilization.

Acceptability.—The panel judged that acceptability probably varies.

Feasibility.—The panel judged that routine IVC filter placement is probably feasible except in communities where interventionalists may not be available to place an IVC filter.

Future research.—The addition of a filter to the care of patients with unstable PE who can undergo standard treatment has not been studied in a prospective comparative manner. In the setting of the progressive organization and systemization of the treatment of PE, this represents a potential research subject.

DVT with Advanced Therapies

Question.—In patients with acute DVT who are undergoing advanced therapies, does placement of an IVC filter affect outcomes?

- In patients with DVT who are undergoing advanced therapies, we suggest considering the placement of IVC filters only in select patients.

Strength of Recommendation: Limited ★★☆☆

Summary of the evidence.—One randomized controlled trial and 2 observational studies met the inclusion criteria for this question (27–29).

In a moderate-quality RCT, Sharifi et al (27) randomized 141 patients with symptomatic proximal DVT undergoing percutaneous endovenous intervention to receive an IVC filter (n = 70) or no filter (n = 71). PE was detected in 1 of 14 patients with symptoms suggestive of PE in the IVC filter group and in 8 of 22 patients in the no-filter group (1.4% vs 11.3% of total population; P = .048). The placement of filters was not associated with any complications.

A low-quality retrospective cohort study (28) compared patients undergoing catheter-directed thrombolysis or pharmacomechanical thrombolysis with and without an IVC filter. No difference in rates of PE development or complications between groups was found.

Another low quality retrospective cohort study (29) using the National Inpatient Sample database also found no significant differences in in-hospital mortality and complications such as gastrointestinal bleeding (0.7% vs 1.0%; P = .20), procedure-related hemorrhage (1.4% vs 1.9%; P = .17), and intracranial hemorrhage (0.7% vs 0.6%; P = .70) between patients with and without an IVC filter who were undergoing catheter-directed thrombolysis. However, higher rates of hematoma formation (3.4% vs 2.1%; P = .009) were found in the IVC filter group.

Given the limited available evidence, the panel recommends placing filters only in select patients undergoing advanced therapies who, in the assessment of the proceduralist, are at high risk of clinically significant procedure-related PE.

Benefits and harms.—The panel judged that the potential benefits of filter placement (prevention of PE) in patients undergoing percutaneous intervention are closely balanced with potential harms (filters are associated with potential complications).

Outcome importance.—The panel judged there is probably no important uncertainty or variability in how patients and providers value the main outcomes, as untreated PE has a substantial mortality rate largely related to recurrent PE.

Cost effectiveness/resource utilization.—The panel did not identify any cost-effectiveness studies of IVC filter placement in patients with DVT undergoing advanced therapies. The panel judged that filter placement and removal entails costs for supplies, equipment, and personnel; however, that cost might be offset by the decreased cost of treatment of the PE they prevent.

Acceptability.—The panel judged that the placement of an IVC filter would be acceptable to key stakeholders.

Feasibility.—The panel judged that routine placement of an IVC filter is probably feasible. Most but not all health care facilities will have access to IVC filter placement.

Future research.—The populations in which IVC filter placement preceding or during thrombolytic procedures is of benefit are not well defined. Trials of their use in such populations, eg, patients with coexistent PE and/or high central thrombus burden, might demonstrate that value. Definitions of the methods of thrombus removal, eg, thrombolysis with or without associated mechanical thrombectomy or (type of) mechanical thrombectomy alone, would strengthen those trials.

Trauma Patients without Known VTE

Question.—In trauma patients without known acute VTE, does placement of a prophylactic IVC filter affect outcomes?

8. In trauma patients without known acute VTE, we recommend against the routine placement of IVC filters for primary VTE prophylaxis.

Strength of Recommendation: Moderate ★★☆☆

Summary of the evidence.—Three moderate-quality studies (30–32) evaluated the role of IVC filter in trauma patients without known acute VTE.

Fullen et al (30) randomized patients diagnosed with traumatic fracture of the proximal femur to insertion of an IVC filter or no filter. Lower rates of PE were shown following injury in patients who had filter placement compared with those who did not (2% vs 20%). However, it is important to note that this study was performed before routine use of pharmacoprophylaxis that is known to mitigate the risk of VTE (PE, DVT).

Similarly, Ho et al (31) assessed whether early placement of an IVC filter reduces the risk of PE or death in patients who have a contraindication to prophylactic anticoagulation. Patients were randomly assigned to receive a retrievable IVC filter or no filter. None of the patients in the IVC filter group had symptomatic PE, whereas 5 patients (14.7%) in the no-filter group had symptomatic PE; however, this difference was not found to be significant (RR, 0.00; 95% CI, 0.00–0.55). Rajasekhar et al (32) assessed the development of PE in study a with 34 high-risk trauma patients (n = 18 with IVC filter and n = 16 with no IVC filter). At 6-month follow-up, 1 PE was diagnosed in the no-filter group.

Two low-quality studies evaluated the benefit and risk of IVC filter placement in trauma patients (33,34). Hemmila et al (33) evaluated trauma patients at high risk for life-threatening VTE. Among 59 patients who received a prophylactic IVC filter, 9 experienced a PE. Additionally, after adjusting for specific factors, IVC filter placement was found to be associated with an increased incidence of DVT (OR, 1.83; 95% CI, 1.15–2.93; $P = .01$). Stein et al (34) also found an increased rate of PE among patients with IVC filters in evaluating administrative data from the National Inpatient Sample. The prevalence of PE was higher (14.7%) in trauma patients with fractures with an IVC filter than in those without a filter (0.5%).

Increased risk of PE following injury is consistent with previous studies demonstrating an increased risk of VTE (DVT, PE) when pharmacoprophylaxis is interrupted or delayed for 5 days or greater following injury (35–39).

Benefits and harms.—Routine prophylactic filter placement has not been demonstrated to result in improvement in mortality following injury in patients who receive appropriate pharmacoprophylaxis. In fact, routine placement is associated with an increased rate of DVT, which is worsened when retrievable filters are not routinely removed. A potential benefit may exist in patients who cannot undergo adequate and appropriate pharmacoprophylaxis. Therefore, the panel judged that the balance of desirable and undesirable effects probably favors the comparison.

Outcome importance.—The panel judged that symptomatic PE, pharmacoprophylaxis, postthrombotic syndrome, and mortality are meaningful outcomes and that there is probably no important uncertainty or variability in how much people value these outcomes.

Cost effectiveness/resource utilization.—No cost-effectiveness studies were identified for this topic; however, the panel judged that routine placement of filters would be associated with moderate costs associated with increased resource utilization with regard to close follow-up and retrieval.

Acceptability.—The panel judged that the intervention is probably not acceptable to different stakeholders (eg, patients, providers, payors).

Feasibility.—The panel judged that this recommendation is probably feasible to implement.

Future research.—Future research should specifically compare patients who are unable to receive pharmacoprophylaxis following injury to determine if this patient population specifically benefits from prophylactic IVC filter placement to reduce the risk of a fatal PE.

Major Surgery in Patients without Known VTE

Question.—In major surgery patients without known acute VTE, does placement of a prophylactic IVC filter affect outcomes?

9. In patients without known acute VTE who are undergoing major surgery, we suggest against routine placement of IVC filters.

Strength of Recommendation: Consensus statement ★☆☆☆

Summary of the evidence.—No studies that met the inclusion criteria were identified in the systematic review of the literature. Given the known short- and long-term risks associated with IVC filters (insertion-related complications, migration, strut fracture, DVT, IVC thrombosis, cost) without mortality benefit even in a high-risk surgical population like the trauma setting (see *Trauma Patients without Known VTE*), the panel believed the potential risks would outweigh the benefits of routine IVC filter placement in all major surgical patients. Additionally, with increasing use of perioperative pharmacoprophylaxis around major surgical procedures, the risk of symptomatic or fatal PE has decreased. Other factors considered in this recommendation included costs of IVC filter placement and retrieval, costs of complications associated with IVC filters, resources needed for IVC placement, as well as low retrieval rates described in the literature.

Benefits and harms.—The panel judged that the balance between benefits and harms favor the comparison (ie, no IVC filter).

Outcome importance.—Outcomes included mortality, DVT, PE, postthrombotic syndrome, pulmonary hypertension, escalating care, subsequent procedures as an effect of complications, length of stay, readmissions, patient-reported outcomes, complications, bleeding, anticoagulation management strategies, retrieval rates, and complications of nonretrieval. The panel judged that there is probably important uncertainty or variability in how patients value outcomes (ie, benefits and harms of an IVC filter).

Cost effectiveness/resource utilization.—The panel did not find cost-effectiveness studies of prophylactic IVC filters in patients undergoing major surgery who do not have VTE. The panel judged that routine IVC filter placement in this scenario would lead to a moderate increase in costs required for IVC filter placement and retrieval as well as resources used to evaluate and treat IVC filter complications.

Acceptability.—The panel judged that acceptability to different stakeholders (eg, patients, providers, payors) of IVC filter placement in this scenario probably varies.

Feasibility.—The panel judged that routine IVC filter placement is probably feasible to implement except in communities where interventionalists may not be available to place an IVC filter.

Future research.—Given the high efficacy of contemporary VTE pharmacologic prophylaxis in surgical patients, future research should focus on whether certain patients deemed at high risk for VTE (eg, patients undergoing bariatric, orthopedic, or cancer surgery) would benefit from IVC filter placement.

Indwelling IVC Filters with No Anticoagulation Indication

Question.—In patients who have indwelling IVC filters with no other indication for anticoagulation, does anticoagulation affect outcomes?

10. In patients who have indwelling IVC filters with no other indication for anticoagulation, we cannot recommend for or against anticoagulation.

Strength of Recommendation: Consensus statement ★☆☆☆

Summary of the evidence.—Only 1 low-quality observational study was identified for this section (40). Jones et al (40) compared patients

who had permanent IVC filters placed, of whom 26 received anticoagulant agents and 42 did not. There were no instances of recurrent PE in either group or significant difference between the 2 groups in recurrent DVT or isolated leg edema during a mean follow-up of 18 months.

Indirect evidence from long-term follow-up of the PREPIC study patients (18) has shown a higher rate of DVT and IVC thrombosis in those who received a permanent IVC filter and anticoagulation versus patients who received anticoagulation alone. Conversely, patients with filters and anticoagulation experienced significantly fewer episodes of symptomatic PE than those without filters. This may suggest that permanent IVC filters confer a higher risk of recurrent VTE presenting as DVT or IVC thrombosis rather than as PE (18). There are no studies that have compared the use of anticoagulation after retrievable IVC filter placement.

Given the paucity of evidence, the panel favors appropriate anticoagulation that is based on the VTE-related indication rather than the presence of an IVC filter. In addition, the panel stresses the importance of assessing the ongoing need for the IVC filter and endorses prompt IVC filter retrieval when the need has resolved.

Benefits and harms.—The panel judged that the harms (excess bleeding risk) of adding anticoagulation when the VTE-related indication has resolved outweigh potential benefits.

Outcome importance.—The panel judged that recurrent PE, recurrent DVT, major and minor bleeding, postthrombotic syndrome, and mortality are meaningful outcomes, and there is probably no important uncertainty or variability in how much people value these outcomes.

Cost effectiveness/resource utilization.—No cost-effectiveness studies were identified for this topic; however, the panel judged that additional anticoagulation would be associated with moderate costs.

Acceptability.—The panel judged that acceptability to different stakeholders (eg, patients, providers, payors) of IVC filter placement in this scenario probably varies.

Feasibility.—The panel judged that the recommendation is feasible to implement.

Future research.—Future research should specifically compare matched patients with indwelling IVC filters who received anticoagulation versus those who did not or randomize patients requiring long-term indwelling filters to anticoagulation or no anticoagulation.

Indwelling IVC Filters with Mitigated PE Risk

Question.—In patients with indwelling IVC filters whose risk of PE has been mitigated or who are no longer at risk of PE, does removal of an indwelling IVC filter affect outcomes?

11a. In patients with indwelling retrievable/convertible IVC filters whose risk of PE has been mitigated or who are no longer at risk for PE, we suggest filters be routinely removed/converted unless risk outweighs benefit.

Strength of Recommendation: Consensus statement ★☆☆☆

11b. In patients with indwelling permanent IVC filters whose risk of PE has been mitigated or who are no longer at risk for PE, we suggest against routine removal of filters.

Strength of Recommendation: Consensus statement ★☆☆☆

Summary of the evidence.—No studies were retrieved in the systematic review that met our inclusion criteria for this topic.

It is widely reported that the rate of removal of retrievable IVC filters is suboptimal (41). There are also limited safety data on the long-term outcomes of filters designed with retrieval or conversion capabilities. Although some evidence for complications, such as perforations and migrations, exist, there is a lack of evidence regarding the specific timing as well as the rate of clinically meaningful IVC filter-related complications (42).

The Food and Drug Administration issued a Safety Communication (4) stating that the risk-to-benefit ratio favors IVC filter removal within 29–54 days after implantation if the risk of PE has passed. The panel, in line with this recommendation, also recommends removal of retrievable IVC

filters when the risk of PE has been mitigated, as early as retrieval of the IVC filters is considered safe.

In contrast, there is limited evidence supporting removal of permanent IVC filters even in patients in whom the indication for the IVC filter has resolved. The retrieval of permanent (and perhaps longstanding retrievable) IVC filters can be challenging. Procedural complications may be underreported. Given the paucity of evidence, the panel recommends against routine removal of permanent IVC filters in most circumstances.

Benefits/harms.—The panel judged that the benefits of removing retrievable filters (reduction in filter-related complications) probably outweigh the harms (potential for VTE if the risk had not truly resolved). On the contrary, the panel judged that the benefits of removing permanent filters probably do not outweigh the harms. The panel judged that it is important that the proceduralist weigh the individual risks and benefit of filter removal.

Outcome importance.—The panel judged that there is probably no important uncertainty or variability in how much people value the main outcomes (recurrent PE, recurrent DVT, clinically meaningful IVC filter-related complications, postthrombotic syndrome, mortality).

Cost effectiveness/resource utilization.—The panel did not identify any cost-effectiveness studies on the removal of retrievable or permanent IVC filters in this patient population. However, the panel judged that the retrieval of filters would lead to a moderate increase in costs as well as resources required.

Acceptability.—The panel judged that the acceptability of these recommendations probably varies among key stakeholders.

Feasibility.—The panel judged that the intervention is probably feasible to implement.

Future research.—Currently, there is a lack of data regarding the cost and complications associated with IVC filter retrieval, mainly concerning retrievable IVC filters that have been implanted for long periods of time. Future studies should explore these outcomes.

Complications and Indwelling IVC Filters

Question.—In patients with complications associated with indwelling IVC filters, does removal of indwelling IVC filter affect outcomes?

12. In patients with complications attributed to indwelling IVC filters, we suggest filter removal be considered after weighing filter- versus procedure-related risks and the likelihood that filter removal will alleviate the complications.

Strength of Recommendation: Consensus statement ★☆☆☆

Summary of the evidence.—No studies were retrieved in the systematic review that met the inclusion criteria for this topic.

The panel agreed that symptomatic complications conclusively related to an IVC filter such as penetration, moderate to severe pain, filter embolization, filter fragment embolization, or infection are unlikely to improve with conservative management. In these cases, assessment for filter retrieval is warranted. These can be more complex procedures than usual IVC filter retrieval and may require adjunct procedures such as retrieval of filter fragments from the heart or pulmonary circulation. These procedures should therefore be performed by physicians who have experience performing them and with access to the necessary equipment and devices (eg, laser sheath, forceps) for advanced retrieval techniques. When considering one of these procedures, the patient's ongoing VTE and PE risk should be assessed, and measures to treat or prevent recurrent VTE included in the management plan after filter removal.

Benefits and harms.—The panel judged that the benefits of removal of filters causing symptomatic complications may likely to contribute to a resolution of symptoms and prevent future complications. The potential harms include performing an unnecessary procedure if the filter is not the source of the symptoms, the increased risk of procedural complications if the procedure requires advanced techniques, increased exposure to radiation, and placing the patient at risk for recurrent PE after filter removal. Based on this, the panel judged that the balance between benefits and harms varies.

Outcome importance.—The panel judged that clinically significant filter-related complications, recurrent PE, recurrent VTE, and procedural complications are meaningful outcomes and that there is probably no important uncertainty or variability in how much people value these outcomes.

Cost effectiveness/resource utilization.—No cost-effectiveness studies were retrieved for this topic; however, the panel judged that the retrieval of filters causing symptomatic complications would be associated with moderate costs and increased resource utilization.

Acceptability.—The panel judged that the intervention is probably acceptable to key stakeholders.

Feasibility.—This recommendation is feasible to implement but requires consensus on the attribution of the complication to the filter, and potentially the identification of physicians or institutions that can provide advanced filter retrieval/conversion procedures.

Future research.—There are very few high-quality prospectively collected comparative data on the clinical benefits and cost effectiveness of IVC filter retrieval compared to nonretrieval in patients with complications attributed to these devices. Such studies present structural and ethical challenges related to control versus treatment arms.

Structured Follow-up

Question.—In patients who have an IVC filter, does structured follow-up affect outcomes?

13. In patients who have an IVC filter, we suggest the use of a structured follow-up program to increase retrieval rates and detect complications.

Strength of Recommendation: Limited ★★☆☆

Summary of the evidence.—IVC filter retrieval rates remain low despite national efforts to increase the rate of removal (43). Ten low-quality observational studies that met the inclusion criteria (44–53) support the use of structured follow-up programs to enhance retrieval rates, but provide limited data regarding its impact on other outcomes and complications.

Structured follow-up with the use of a multidisciplinary team and standardized protocols have been shown to improve filter retrieval rates. One study (44) found an improved rate of filter removal (from 64.6% to 84.8%; RR, 1.31; 95% CI, 1.06–1.63) after implementation of systematic daily follow-up using a multidisciplinary team involving physicians and nurses in surgery and radiology.

Similarly, another study (45) found a greater relative benefit in successful filter removal rates (from 14.1% to 50.0%; RR, 3.55; 95% CI, 2.40–5.25) following the implementation of a multidisciplinary effort including an institutional protocol involving dedicated follow-up of patients receiving IVC filters with a team that included a dedicated physician and interventional radiology and anticoagulation services. However, no significant reduction in thrombotic complication rates were observed after intervention (from 11.4% to 2.6%; RR, 0.23; 95% CI, 0.03–1.62).

Similar results were seen with structured programs that included a component of patient education. In a study conducted by Inagaki et al (48), filter retrieval rates significantly improved from 11% to 54% after implementation of a multidisciplinary task force composed of members from vascular surgery, interventional radiology, cardiology, trauma surgery, and hematology, as well as a standardized protocol that included patient education materials, an additional IVC filter procedure form, a centralized interdepartmental IVC filter registry, and a dedicated administrative coordinator. Winters et al (49) also found that the use of a multidisciplinary team along with patient education, referral by interventional radiology or surgery to a hematology clinic that scheduled follow-up appointments, standard evaluation for decision-making regarding the appropriateness of filter retrieval, and filter retrieval by interventional radiology when recommended improved retrieval rates (23% vs 45%). An IVC filter retrieval attempt was found to be 3 times more likely after the intervention was implemented (RR, 3.03; 95% CI, 1.85–4.27) (49).

Automated reminder systems have also been shown to improve retrieval rates. Ko et al (50) implemented an institutional protocol that included electronic tracking of patients with IVC filters with automated e-mail reminders to plan eventual retrieval of filters. Filter removal rates improved from 37% to 85% (RR, 2.27; 95% CI, 1.61–3.21) following implementation of this protocol. A more recent study (47) assessed the use of a computerized reminder system that provided interactive emails to the attending physician who placed the filter inquiring whether the filter had been retrieved. The IVC filter retrieval rate was higher after implementation than before (49.8% vs 31.2%, respectively), corresponding to increased odds of IVC filter retrieval (OR, 2.56; 95% CI, 1.82–3.59). The median time to retrieval was shorter after implementation of the system (112 d vs 146 d; $P = .02$), and the indwelling complication rate was lower after implementation (9.4% vs 16.1%; $P = .005$). However, the number of successful retrievals did not differ after implementation of the system (91% vs 95.9%; $P = .09$).

Formation of dedicated IVC filter clinics has also been shown to be effective in enhancing retrieval rates. A study by Makary et al (46) found that follow-up in a dedicated IVC filter clinic combined with enhanced patient instructions at discharge and provider communication enhance removal rates, primarily in those less than 60 years old, from 11.29% with no structured follow-up to 29.55% with virtual visits (RR, 1.53; 95% CI, 0.084–2.78) and 45.16% with actual clinic visits (RR, 4.0; 95% CI, 1.8–8.89). Similarly, Minocha et al (51) found that establishment of a dedicated IVC filter clinic significantly improved retrieval rates (60% vs 29%; $P < .001$).

Another study (52) found that a radiology-led intervention that included use of a standard report, structured follow-up with contact every 30 days after insertion to arrange retrieval, and departmental log sheets improved IVC filter retrieval rates (71% vs 81%) and time to retrieval (median, 10 d vs 16 d); however, neither of these were found to be significant.

Sutphin et al (53) introduced a quality-improvement program to improve IVC filter retrieval rates that included mailing of letters and automatic scheduling of clinic visits 4–6 weeks after IVC filter placement to assess need for filter removal. After implantation of this program, retrieval rates increased from 8% to 40% ($P = .007$). Average time to retrieval also improved from 64 days to 59 days.

Taken together, the evidence indicates that the use of structured follow-up with multidisciplinary programs, automated reminder systems, enhanced patient education and provider communication, and dedicated IVC filter clinics has been shown to enhance removal of retrievable IVC filters. Use of a structured program for retrievable and convertible filters should increase the rate of appropriate removal (and potential conversion) of IVC filters. For bioconvertible filters, this may help to ensure that the patient is appropriately treated for VTE after the filter spontaneously opens.

Benefits and harms.—Structured follow-up may reduce the risk of long-term filter-related complications such as perforation or migration, reduce the complexity of removal, and reduce retrieval-related complications. Potential harms of implementing this recommendation are that patients may experience a PE if the VTE risk had not truly resolved before filter removal/conversion or experience a removal/conversion procedural complication. The panel judged that the balance of these desirable and undesirable effects probably favors the intervention.

Outcome importance.—The panel judged that recurrent PE, recurrent DVT, clinically meaningful IVC filter-related complications, post-thrombotic syndrome, and mortality are meaningful outcomes, and there is probably no important uncertainty or variability in how much people value these outcomes.

Cost effectiveness/resource utilization.—The panel did not identify any evidence addressing the cost-effectiveness of structured follow-up programs; however, they judged that it would be associated with increased resource utilization and moderate costs.

Acceptability.—The panel judged that the intervention is probably acceptable to key stakeholders.

Feasibility.—The panel judged that this intervention is probably feasible to implement given that the appropriate resources are available.

Future research.—Currently, there are limited data regarding the most effective components of a structured follow-up program. There are also limited data regarding the impact of structured follow-up programs on other clinical outcomes, complications, and cost of care. Future studies should address these topics.

Planned Filter Removal

Question.—In patients who are having an IVC filter removed, do preprocedural laboratory studies and/or imaging affect the rate of aborted IVC filter removal procedures?

14. In patients who are having an IVC filter removed or converted, we suggest against routine preprocedural imaging of the filter and the use of laboratory studies except in select situations.

Strength of Recommendation: Consensus statement ★☆☆☆

Summary of the evidence.—No studies were identified in the systematic review for this topic. However, the panel recommends evaluation of existing relevant imaging or laboratory studies in all patients for whom filter retrieval or conversion is considered. Although there is little to no evidence to support routine preprocedural imaging such as computed tomography (CT) or laboratory studies, the panel does consider it to be of value in select situations, such as for patients in whom filters have been in place for an extended period of time.

For example, preprocedural imaging might be warranted in patients in whom filter dwell time is prolonged beyond several months or in whom substantial filter tilt or tip embedment is known. Filter retrieval may be more challenging with longer dwell times. In a review of 259 retrieval attempts (54), challenging retrievals were more common with filter dwell time longer than 50 days, and failed retrievals were more common with filter dwell time longer than 90 days. In 628 retrievals reported in the Cardiovascular and Interventional Radiological Society of Europe registry (55), the mean dwell time for successful retrieval was 85 days, versus 145 days for unsuccessful retrievals. Likewise, other retrospective studies (56–58) also demonstrate a correlation between filter dwell time and/or embedment of the filter apex and difficult or failed filter retrieval. In cases like this, imaging might demonstrate the likelihood that advanced filter retrieval techniques may be required.

In centers where advanced techniques are routinely employed, preprocedural imaging may be of less value, as intraprocedural imaging including venography and cone-beam CT can identify filter thrombus, tilting, penetration, and fracture to guide therapy. However, in centers in which advanced retrieval techniques are not available, preprocedural imaging might facilitate referral to centers where advanced techniques are available. Similarly, symptoms suggestive of possible filter-related complication, such as lower-extremity swelling or DVT, abdominal pain, or gastrointestinal bleeding, would warrant preretrieval imaging that could demonstrate findings suggestive of the need for advanced filter-retrieval techniques and ensure that that expertise is available when filter retrieval is performed.

Likewise, it may be advisable to obtain laboratory values such as platelet counts and coagulation status in select patients, such as those with filters that have been placed for an extended period of time, or renal studies in patients with renal insufficiency, as retrieval would likely involve advanced techniques.

Benefits and harms.—The benefits of selected preprocedural laboratory studies or imaging such as CT could allow pre-filter retrieval/conversion planning, perhaps with referral to a center with experience with advanced techniques such as forceps- or laser-assisted retrieval, and as such could increase the likelihood of a successful procedure and decreased complication rate. The harms, however, would subject patients to the risks of administered contrast medium and radiation. Based on this, the panel judged that the balance of benefits to harms varies based on the situation.

Outcome importance.—The panel judged that there is probably no important uncertainty or variability in how much people value the main outcomes.

Cost effectiveness.—The panel did not identify any cost-effectiveness studies assessing the intervention in this patient population. However, they judged that preprocedural imaging and laboratory studies are associated with moderate costs as well as resource utilization.

Acceptability.—The panel judged that the intervention is probably acceptable to key stakeholders.

Feasibility.—The panel judged that the intervention is probably feasible to implement.

Future research.—Future research should assess the impact of preprocedural imaging such as CT versus no CT before filter retrieval or conversion on procedure success, procedure duration, and costs.

Filter Removal without Standard Snare Techniques

Question.—In patients undergoing filter retrieval whose filter could not be removed by using standard snare techniques, did removal of IVC filters with advanced techniques affect outcomes compared with nonremoval of the IVC filter?

15. In patients undergoing filter retrieval/conversion whose filter could not be removed/converted by using standard techniques, we suggest attempted removal with advanced techniques, if appropriate and if the expertise is available, after reevaluation of risks and benefits.

Strength of Recommendation: Consensus statement ★☆☆☆

Summary of the evidence.—No studies were identified that met the inclusion criteria for this topic.

In patients undergoing indicated filter retrieval or conversion with standard techniques after the first procedure fails, a subsequent attempt by using advanced techniques is often successful (59). This may require referral to another physician or institution.

In some cases, there may be potential harms of an additional procedure, including an increased risk of procedural complication, additional radiation exposure, and failure with need for a subsequent procedure (56). Therefore, careful patient counseling is required, including the option of leaving the filter intact (if not causing harm to the patient).

Benefits and harms.—Filter retrieval may be associated with decreased symptomatic filter-related complications over time. This may also be true for conversion of convertible filters, although clinical experience with these devices is limited because of their novelty. In patients who have experienced a failed attempt to remove/convert the device and have no ongoing need for a filter, the panel judged that the benefits of a second attempt at removal/conversion probably outweigh the harms.

Outcome importance.—The panel judged that procedural complications, recurrent PE, recurrent DVT, and clinically meaningful filter-related complications are meaningful outcomes and that there is probably no important uncertainty or variability in how much people value these outcomes.

Cost effectiveness/resource utilization.—No studies on the cost effectiveness of this intervention were identified; however, the panel judged that the intervention of advanced removal techniques would be associated with moderate costs for additional procedures and resource utilization.

Acceptability.—The panel judged that the intervention is probably acceptable to different stakeholders.

Feasibility.—The panel judged that the intervention is feasible to implement but requires identification of physicians or institutions that can provide advanced filter retrieval/conversion procedures.

Future research.—Future research should focus on prospective studies comparing the clinical benefits and cost effectiveness of subsequent IVC filter retrieval/conversion attempts after a failed procedure compared with no retrieval/conversion.

Filter Placement Technique

Question.—In patients undergoing IVC filter placement, does placement technique affect acute outcomes?

16. In patients undergoing IVC filter placement, we cannot recommend for or against any specific placement technique.

Strength of Recommendation: Consensus statement ★☆☆☆

Summary of the evidence.—Various IVC filter placement techniques exist, including fluoroscopic guidance employing iodinated, carbon dioxide, or gadolinium contrast venography; transabdominal ultrasound (US); or intravascular US guidance for placement.

One low-quality observational study (60) was identified that compared IVC filter placement with fluoroscopic guidance versus bedside IVC filter placement with intravascular US. Ganguli et al (60) compared 117 intravascular US–placed filters versus 571 fluoroscopically placed filters. Procedural-related complications occurred more frequently with the intravascular US–guided filter placements than with the fluoroscopically guided filter placements (4.3% vs 0.4%, respectively; $P = .006$). No difference was found in any indwelling complications (IVC thrombosis, DVT, or PE) between the 2 groups.

Given the insufficient evidence, the committee cannot recommend one placement method over another. Regardless of the technique that is used, at a minimum, the technique or combination of techniques that is/are employed should clearly demonstrate vena caval anatomy and diameter(s), the location of the renal and iliac veins, and the presence or absence of thrombus in the vena cava at or near the planned implantation site.

Evidence is also insufficient to allow guidance regarding the choice of jugular versus femoral vein or other venous access. As with the method of guidance, the choice of venous access is likely dependent on operator experience and expertise, as well as patient-specific characteristics, including the site and extent of venous thrombosis and previous operation or instrumentation.

Benefits and harms.—The panel judged that the benefits and harms of each technique are closely balanced.

Outcome importance.—The panel judged that the outcomes (procedural complications, surgical complications, malposition) are meaningful, and there is probably no important uncertainty or variability in how people value them.

Cost effectiveness/resource utilization.—No cost-effectiveness studies were identified on this topic; however, the panel judged that there are moderate costs associated with filter placement because of increased resource utilization.

Acceptability.—The panel judged that any insertion method is acceptable to key stakeholders.

Feasibility.—The panel judged that insertion of an IVC filter with the techniques discussed above is probably feasible to implement.

Future research.—Future studies should compare implantation methodologies, including venous access sites, versus outcomes such as procedure-related and late-term complications.

CONCLUSIONS

This document summarizes the evidence and provides recommendations for the use of IVC filters in a range of clinical scenarios. The intent is to allow clinicians managing patients at risk of PE to make evidence-based decisions about the use of IVC filters. However, the lack of high-quality evidence limits the strength of the recommendations. This is one of the fundamental and enduring challenges with these devices. This paucity of evidence should be a driver for future research in the form of clinical trials and large registries. Future updates to this guideline are planned as new evidence becomes available. As with all interventions, clinicians must carefully assess the risk and benefit of filters for their patients and provide careful follow-up.

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