The Effectiveness of Prophylactic Inferior Vena Cava Filters in Trauma Patients
A Systematic Review and Meta-analysis

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IMPORTANCE Trauma is known to be one of the strongest risk factors for pulmonary embolism (PE). Current guidelines recommend low-molecular-weight heparin therapy for prevention of PE, but trauma places some patients at risk of excess bleeding. Experts are divided on the role of prophylactic inferior vena cava (IVC) filters to prevent PE.

OBJECTIVE To perform a systematic review and meta-analysis examining the comparative effectiveness of prophylactic IVC filters in trauma patients, particularly in preventing PE, fatal PE, and mortality.

DATA SOURCES We searched the following databases for primary studies: MEDLINE, EMBASE, Scopus, CINAHL, International Pharmaceutical Abstracts, clinicaltrial.gov, and the Cochrane Library (all through July 31, 2012). We developed a search strategy using medical subject headings terms and text words of key articles that we identified a priori. We reviewed the references of all included articles, relevant review articles, and related systematic reviews to identify articles the database searches might have missed.

STUDY SELECTION We reviewed titles followed by abstracts to identify randomized clinical trials or observational studies with comparison groups reporting on the effectiveness and/or safety of IVC filters for prevention of venous thromboembolism in trauma patients.

DATA EXTRACTION AND SYNTHESIS Two investigators independently reviewed abstracts and abstracted data. For studies amenable to pooling with meta-analysis, we pooled using the random-effects model to analyze the relative risks. We graded the quantity, quality, and consistency of the evidence by adapting an evidence-grading scheme recommended by the Agency for Healthcare Research and Quality.

RESULTS Eight controlled studies compared the effectiveness of no IVC filter vs IVC filter on PE, fatal PE, deep vein thrombosis, and/or mortality in trauma patients. Evidence showed a consistent reduction of PE (relative risk, 0.20 [95% CI, 0.06-0.70]; I² = 0%) and fatal PE (0.09 [0.01-0.81]; I² = 0%) with IVC filter placement, without any statistical heterogeneity. We found no significant difference in the incidence of deep vein thrombosis (relative risk, 1.76 [95% CI, 0.50-6.19]; P = .38; I² = 56.8%) or mortality (0.70 [0.40-1.23]; I² = 6.7%). The number needed to treat to prevent 1 additional PE with IVC filters is estimated to range from 109 (95% CI, 93-190) to 962 (819-2565), depending on the baseline PE risk.

CONCLUSIONS AND RELEVANCE The strength of evidence is low but supports the association of IVC filter placement with a lower incidence of PE and fatal PE in trauma patients. Which patients experience benefit enough to outweigh the harms associated with IVC filter placement remains unclear. Additional well-designed observational or prospective cohort studies may be informative.

Published online November 6, 2013.

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Venous thromboembolism (VTE), including pulmonary embolism (PE) and deep vein thrombosis (DVT), affects as many as 600,000 Americans, killing more than 100,000 people each year and resulting in significant morbidity and mortality. Trauma is known to be one of the strongest risk factors for VTE. A prospective study reported rates of DVT as high as 58% among those who experience severe trauma without thromboprophylaxis, although other registry-based studies have reported lower rates. Guidelines recommend VTE prophylaxis with low-molecular-weight heparin in trauma.

However, a small proportion of patients who are at the highest risk of VTE owing to severe injury also have definite or relative contraindications to low-molecular-weight heparin therapy because of an ongoing risk of life-threatening bleeding. In certain patients with traumatic brain injury, solid-organ injury (ie, liver, spleen), or retroperitoneal hematoma, the benefit of preventing VTE with low-molecular-weight heparin prophylaxis may be overshadowed by the risk of excess bleeding. In these cases, debate about the role of prophylactic inferior vena cava (IVC) filters to prevent PE is ongoing. Some authors suggest that using IVC filters among trauma patients at very high risk of PE may prevent the most dramatic and life-threatening cases. Other authors suggest their use is not beneficial and should be curtailed. Inferior vena cava filters are associated with risk of thrombotic complications (ie, caval thrombosis) and mechanical complications (ie, strut fracture, filter migration/embolization).

The increased use of IVC filters in general and in trauma patients specifically is well documented, with wide variation between trauma centers in the rates of IVC filter placement. This practice variation may result from conflicting guidelines. The Eastern Association for the Surgery of Trauma practice management guideline promotes IVC filters in certain patients. The American College of Chest Physicians has a more recent guideline stating that “for major trauma patients, we suggest that an IVC filter should not be used for primary VTE prevention.” For this systematic review and meta-analysis, we critically evaluated the data regarding the safety and efficacy of prophylactic IVC filters in trauma patients with the goal of providing evidence to guide practice and further research about their use.

Methods
We developed the protocol for the review and posted it online following guidelines for systematic reviews. Additional methodological details are in our evidence report prepared for the Agency for Healthcare Research and Quality (AHRQ). The full protocol was posted online (http://effectivehealthcare.ahrq.gov/index.cfm/search-for-guides-reviews-and-reports/). We developed an analytic framework that depicts our population of interest, interventions tested for VTE prevention, outcomes of treatment, and harms of interventions.

Data Sources and Search
We searched the following databases for primary studies: MEDLINE, EMBASE, Scopus, CINAHL, International Pharma-
sented along with a 95% confidence interval. Given the fragility of the data set, 2 independent experts, including one of us (S.S.) replicated the results in 2 different statistical programs. All analyses were conducted using StatsDirect\textsuperscript{29} and replicated in STATA, version 11.0.\textsuperscript{21}

We calculated the number needed to treat (NNT) to prevent PE with IVC filters among trauma patients using an online calculator (http://www.nntonline.net). We used a range of possible baseline PE rates (0.13%-1.15%) from the published literature\textsuperscript{22,23} and assumed that approximately 10% of PEs are fatal.

Grading the Evidence and Applicability
We graded the quantity, quality, and consistency of the best available evidence by adapting an evidence-grading scheme recommended by the AHRQ.\textsuperscript{2,4} In assigning evidence grades, we considered the following 4 recommended domains: risk of bias in the included studies, directness of the evidence to the question of interest, consistency across studies, and precision of the pooled estimate or the individual study estimates. We found that few of the studies reported precision, although we were able to calculate confidence intervals for some of the outcomes. We classified results by outcome into the following 4 grades: high (indicating high confidence that the evidence reflects the true effect and that further research is very unlikely to change our confidence in the estimate of the effect), moderate (indicating moderate confidence that the evidence reflects the true effect and that further research may change our confidence in the estimate of the effect and may change the estimate), low (indicating low confidence that the evidence reflects the true effect and that further research is likely to change our confidence in the estimate of the effect and is likely to change the estimate), and insufficient (evidence is unavailable or is so imprecise or of such low quality that the estimate of effect is unreliable).

Results
Study Characteristics
We identified 30,902 unique citations, of which 21,687 were excluded by title screen (Figure 1). Fifty-eight studies addressed IVC filter use in trauma, although most (n = 48) were uncontrolled studies. We included 8 controlled studies that assessed the effectiveness of IVC filters compared with no filter placement on VTE events in trauma patients (Table 1). Of the 8 studies, 1 was a small pilot feasibility RCT\textsuperscript{25}; 2 prospective cohort studies with concurrent comparison groups\textsuperscript{26,28,4}, prospective cohort studies with historical controls\textsuperscript{27-29,31}, and 1, a retrospective cohort study.\textsuperscript{32} All 8 studies were performed within single institutions in North America, most of which were level I trauma centers.

All studies analyzed patients in 2 groups. One group received standard therapy alone, and the other group received prophylactic IVC filter placement in addition to standard VTE prevention. The most common standard therapy was a combination of venous compression devices with subcutaneous low-molecular-weight heparin. Most studies used duplex ultrasonography for DVT diagnosis, although some older studies used outdated modalities, such as impedance plethysmography.\textsuperscript{26,27} For the diagnosis of PE, most studies used computed tomographic angiography, but some used conventional angiography or, infrequently, ventilation/perfusion scans.

We excluded 2 studies\textsuperscript{26,29} from the pooled analyses because we considered them to have substantial flaws. The first study had severe prognostic imbalance in Injury Severity Scores (ISSs) between study groups (mean ISS, 22.8 vs 9.8, filter vs control).\textsuperscript{26} The second study was excluded because of concerns about overlapping participants with another study by the same authors from the same institution and the same study period.\textsuperscript{29}

Participant Characteristics
The patients in the controlled observational studies ranged in mean age from 31.4 to 58.4 years. Most of the patients in each study were men (58.0%-96.0%). Seven studies reported mean ISS. Mean ISS for patients receiving IVC filters ranged from 22.8 to 31.5, with 5 of 7 studies reporting a mean ISS greater than 25, a common cutoff for very severe injury. Mean ISS for patients not receiving filters were not uniformly reported, but the scores were lower than those for the patients receiving IVC filters in all 5 studies in which they were reported (Table 1).

Outcomes
Pulmonary Embolism
We included 6 controlled studies for the meta-analysis on PE outcomes.\textsuperscript{25,27-29,30-32} We found fewer PEs with IVC filter use compared with no IVC filter use without evidence of statistical heterogeneity (RR, 0.20 [95% CI, 0.06-0.70]; P = 0%) (Figure 2). Our results were robust to alternative approaches for continuity correction and showed largely similar results.

In the small RCT,\textsuperscript{25} we found no statistically significant difference in the incidence of PE between the 2 groups, with no PEs in the IVC filter group and 1 PE among patients without filters. Five of the 6 observational studies included in the meta-analysis reported lower PE rates with IVC filter placement\textsuperscript{27-31} (Supplement [eTable 1]). The single study with a higher incidence of PE with IVC filter placement\textsuperscript{32} included only patients with spinal cord injuries and a single patient who had a PE diagnosed after placement of an IVC filter. Both studies by Rogers et al,\textsuperscript{26,29} which were excluded from the meta-analysis, reported higher rates of PE. The study that reported ISS\textsuperscript{26} had dramatically higher ISS in the IVC filter group.

Assuming a baseline risk of PE of 1.15% among trauma patients,\textsuperscript{27} the NNT to prevent 1 additional PE with IVC filters is estimated to be 109 (95% CI, 93-190). If the lowest reported baseline risk is used (with all National Trauma Data Bank patients in the denominator),\textsuperscript{27} the NNT is 962 (95% CI, 819-2565) (Supplement [eTable 2]).

Fatal PE
We included 4 studies that reported on fatal PE\textsuperscript{25,27,30,31}; one of these had no events in either arm\textsuperscript{25} (Figure 3). We found consistent evidence of a reduction in fatal PE with IVC filters.
compared with no IVC filters, without evidence of statistical heterogeneity (RR, 0.09 [95% CI, 0.01-0.81]; I² = 0%). Despite the precise and consistent evidence of a reduction in fatal PE with IVC filters, sensitivity analyses with alternative continuity corrections (used if 0 events occurred in 1 treatment arm) were not uniformly robust to the outcome of fatal PE. The Peto odds ratio approach showed a statistically significant reduction in fatal PE (Peto odds ratio, 0.22 [95% CI, 0.08-0.58]), which is consistent with the primary analysis. Alternative continuity corrections, such as the 0.5 correction (RR, 0.22 [95% CI, 0.04-1.16]) or 0.01 correction (0.01 [0-425.5]), were not statistically significant. The NNT to prevent 1 fatal PE with IVC filters is estimated to be 1099 (95% CI, 1011-5264), although this assumption is fragile with multiple assumptions (Supplement [eTable 2]).

No fatal PEs occurred in the IVC filter arms of any included study (Supplement [eTable 1]). Twenty fatal PEs occurred in the 407 patients not receiving IVC filters. No VTE-related deaths were recorded in the RCT.25 The prospective cohort study with historical controls identified a statistically significantly higher incidence of fatal PE in patients who did not receive IVC filters (4% vs 0%; P = .03).30

We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist13 to refine the search for eligible studies, resulting in 8 controlled studies for analysis. HIT indicates heparin-induced thrombocytopenia; IVC, inferior vena cava; VTE, venous thromboembolism. *Total exceeds the number excluded because reviewers were allowed to mark more than 1 reason for exclusion.
Table 1. Characteristics of Controlled Studies of Prophylactic IVC Filters Among Trauma Patients

<table>
<thead>
<tr>
<th>Source</th>
<th>Design</th>
<th>No. of Patients</th>
<th>Mean Age, y</th>
<th>Male Sex, %</th>
<th>Mean ISS</th>
</tr>
</thead>
<tbody>
<tr>
<td>IVC Filter Group</td>
<td>No IVC Filter Group</td>
<td>IVC Filter Group</td>
<td>No IVC Filter Group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rajasekhar et al,25, 2011</td>
<td>RCT</td>
<td>18</td>
<td>16</td>
<td>41.2</td>
<td>53.7</td>
</tr>
<tr>
<td>Rodgers et al,26 1997</td>
<td>PC</td>
<td>35</td>
<td>905</td>
<td>58.4</td>
<td>38.9</td>
</tr>
<tr>
<td>Gosin et al,28 1997</td>
<td>PC</td>
<td>99</td>
<td>249</td>
<td>42.6</td>
<td>57.4</td>
</tr>
<tr>
<td>Rogers et al,29 1995</td>
<td>Historical comparison</td>
<td>63</td>
<td>2525</td>
<td>38.9</td>
<td>57.4</td>
</tr>
<tr>
<td>Wilson et al,27 1994</td>
<td>Historical comparison</td>
<td>15</td>
<td>111</td>
<td>31.4</td>
<td>30.0</td>
</tr>
<tr>
<td>Gorman et al,30 2009</td>
<td>RC</td>
<td>54</td>
<td>58</td>
<td>37.1</td>
<td>48.1</td>
</tr>
<tr>
<td>Rodriguez et al,31 1996</td>
<td>Historical comparison</td>
<td>40</td>
<td>80</td>
<td>44.0</td>
<td>41.0</td>
</tr>
<tr>
<td>Khansarinia et al,30 1995</td>
<td>Historical comparison</td>
<td>108</td>
<td>216</td>
<td>35.9</td>
<td>38.3</td>
</tr>
</tbody>
</table>

Abbreviations: ISS, Injury Severity Score; IVC, inferior vena cava; NR, not reported; PC, prospective cohort; RC, retrospective cohort; RCT, randomized clinical trial.

* Study did not report characteristics by treatment group.

Figure 2. Forest Plot of Relative Risk (RR) of Pulmonary Embolism (PE) With Use of Inferior Vena Cava (IVC) Filters vs No IVC Filters in Trauma Patients

Weights are calculated from random-effects analysis. Dashed line indicates the overall weighted point estimate (0.20); diamond, same overall weighted point estimate (95% CI). Shadow size varies relative to weight assigned to each study. Overall $I^2 = 0\% (P = .48)$. Test of RR = 1 ($z = 2.52$, $P = .01$).

Figure 3. Forest Plot of Relative Risk (RR) of Fatal Pulmonary Embolism (PE) With Use of Inferior Vena Cava (IVC) Filters vs No IVC Filters in Trauma Patients

Weights are calculated from random-effects analysis. Dashed line indicates the overall weighted point estimate (0.20); diamond, same overall weighted point estimate (95% CI). Shadow size varies relative to weight assigned to each study. Overall $I^2 = 0\% (P = .94)$. Test of RR = 1 ($z = 2.14$, $P = .03$).

Deep Vein Thrombosis

The RR for the outcome of DVT was 1.76 (95% CI, 0.50-6.19; $P = .38$).2,5,31 (Supplement [eFigure 1]). Substantial statistical heterogeneity was found among the included studies ($I^2 = 56.7\%$). The sensitivity analyses had similar results. In the RCT, only a single DVT was reported (in the IVC filter group), and no significant difference in DVT incidence between groups was found25 (Supplement [eTable 1]).

Mortality

We included 3 studies reporting mortality in the meta-analysis.2,5,31 The pooled RR for the outcome of mortality was...
0.70 (95% CI, 0.40-1.23; $I^2 = 6.7\%$) (Supplement [eFigure 2]). Our results were robust to alternative approaches for continuity correction and showed largely similar results.

No differences were observed in the RCT with regard to VTE and non-VTE mortality between groups. Both non-RCT studies included in the meta-analysis showed nonsignificantly lower all-cause mortality in the IVC filter group compared with the no IVC filter group.

**Filter Complications**
Filter-related complications were only sparsely reported in the controlled studies. The complete data on complications in these controlled studies and in many uncontrolled studies are contained in the full AHRQ report.

**Risk of Bias**
We rated the only small RCT as having a high risk of bias; this was based primarily on issues surrounding blinding of the outcome assessors. Among the controlled observational studies, we rated only 1 study as having a moderate risk of bias and the remainder as having a high risk of bias.

**Strength of Evidence**
We rated the strength of evidence as low to support a reduction in PE and fatal PE in trauma patients with the use of IVC filters relative to no use of filters (Table 2). Our estimates for PE were robust to alternative statistical approaches, whereas the estimates for fatal PE were more fragile, and this significant reduction in fatal PE should be viewed with caution. We rated the strength of evidence as insufficient to support a reduction in mortality in trauma with IVC filters. We rated the strength of evidence as insufficient to support any increased or decreased probability of DVT in trauma patients with IVC filters.

**Discussion**
Overall, we found low strength of evidence that prophylactic IVC filter placement is associated with a lower incidence of PE and fatal PE in hospitalized trauma patients when compared with no filter use. We found insufficient evidence to comment on mortality or DVT incidence associated with prophylactic IVC filter placement.

We identified only a single RCT, and it had significant methodological limitations. This pilot feasibility trial randomized patients to usual care plus IVC filter or usual care alone and was underpowered for all outcomes. There was significant heterogeneity among the other included controlled studies in design and eligibility and inconsistency in the efficacy outcome assessment methods. Although many of the studies reported on the VTE outcomes, most did not provide details about anatomic locations of the DVTs or the PEs. Some studies did not completely report all outcomes for DVT and PE, which is important because IVC filters may have opposing effects on DVTs and PEs. In addition, we found differences in reporting and duration of follow-up. The included studies lacked adequate details about enrolled patient characteristics, such as race and sex and details of the extent and severity of the trauma, limiting our ability to generalize findings from these studies to other ethnic groups or age categories. A wide variation in the use of IVC filters in trauma centers was found that cannot be explained by patient characteristics.

Our present findings should be interpreted in the context of other systematic reviews. A recent review conducted a

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**Table 2. Strength of Evidence for Prophylactic IVC Filter vs No IVC Filter in Trauma Patients**

<table>
<thead>
<tr>
<th>Outcome, Source</th>
<th>Risk of Bias</th>
<th>SOE and Magnitude of Effect, %a</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE</td>
<td>High</td>
<td>Low that IVC filter placement is associated with a lower incidence of PE in hospitalized trauma patients compared with no IVC filter placement; RR = 0.70 (95% CI, 0.40-1.23; $I^2 = 6.7%$)</td>
</tr>
<tr>
<td>Rajsekhar et al,25 2011b</td>
<td>High</td>
<td>0 vs 6.2</td>
</tr>
<tr>
<td>Wilson et al,27 1994</td>
<td>High</td>
<td>0 vs 7.2</td>
</tr>
<tr>
<td>Gosin et al,26 1997</td>
<td>High</td>
<td>0 vs 4.8</td>
</tr>
<tr>
<td>Gorman et al,32 2009</td>
<td>Moderate</td>
<td>1.8 vs 0</td>
</tr>
<tr>
<td>Kphansarinia et al,30 1995</td>
<td>High</td>
<td>0 vs 6.0</td>
</tr>
<tr>
<td>Rodriguez et al,31 1996</td>
<td>High</td>
<td>2.5 vs 17.5</td>
</tr>
<tr>
<td>Fatal PE</td>
<td>High</td>
<td>Low that IVC filter placement is associated with a lower incidence of fatal PE in hospitalized trauma patients compared with no IVC filter placement; RR = 0.09 (95% CI, 0.01-0.81; $I^2 = 0%$)</td>
</tr>
<tr>
<td>Rajsekhar et al,25 2011c</td>
<td>High</td>
<td>0 vs 0</td>
</tr>
<tr>
<td>Wilson et al,27 1994</td>
<td>High</td>
<td>0 vs 2.7</td>
</tr>
<tr>
<td>Kphansarinia et al,30 1995</td>
<td>High</td>
<td>0 vs 5.5</td>
</tr>
<tr>
<td>Rodriguez et al,31 1996</td>
<td>High</td>
<td>0 vs 10.0</td>
</tr>
<tr>
<td>Mortality</td>
<td>High</td>
<td>Insufficient that IVC filter placement is associated with less mortality in hospitalized trauma patients compared with no IVC filter placement; RR = 0.70 (95% CI, 0.40-1.23; $I^2 = 6.7%$)</td>
</tr>
<tr>
<td>Rajsekhar et al,25 2011c</td>
<td>High</td>
<td>5.5 vs 0</td>
</tr>
<tr>
<td>Kphansarinia et al,30 1995</td>
<td>High</td>
<td>16.6 vs 21.7</td>
</tr>
<tr>
<td>Rodriguez et al,31 1996</td>
<td>High</td>
<td>5.0 vs 16.2</td>
</tr>
<tr>
<td>DVT</td>
<td>High</td>
<td>Insufficient that IVC filter placement is associated with a higher incidence of DVT compared with no IVC filter placement; RR = 1.76 (95% CI, 0.49-6.18; $I^2 = 56.8%$) (P = .38)</td>
</tr>
<tr>
<td>Rajsekhar et al,25 2011</td>
<td>High</td>
<td>5.5 vs 0</td>
</tr>
<tr>
<td>Rodriguez et al,31 1996</td>
<td>High</td>
<td>15.0 vs 18.7</td>
</tr>
<tr>
<td>Gorman et al,32 2009</td>
<td>Moderate</td>
<td>20.4 vs 5.2</td>
</tr>
</tbody>
</table>

Abbreviations: DVT, deep vein thrombosis; IVC, inferior vena cava; PE, pulmonary embolism; RR, relative risk; SOE, strength of evidence.

*a Graded on filter-related thrombosis. Data were too sparse on other complications, such as filter tilt and migration, to provide meaningful SOE grades on these specific complications.

*b Indicates only randomized clinical trial (RCT) to address this key question.

* No deaths related to venous thromboembolism occurred in the RCT.
The advent of removable IVC filters has been suggested as a major advantage. These removable filters may change the calculation of the benefit to harm ratio for patients by mitigating the long-term complications of having an indwelling IVC filter for life. Filter-related complications may be obviated by filters with those of patients not receiving filters and paid little attention to important underlying clinical differences between these patient groups. Patients receiving IVC filters commonly had more severe injuries and a greater risk for VTE and mortality than did patients not receiving filters. With careful risk adjustment through regression or other methods (eg, propensity score matching, instrumental variable analyses), valid inferences can be drawn from retrospective studies.

Prospective observational studies, such as the National Study on Costs and Outcomes of Trauma, have answered other questions in trauma. Perhaps a study such as ours examining VTE prevention in trauma, focused on IVC filters specifically, could be performed. This prospective cohort study could compare an exposed group of trauma patients receiving filters with a carefully matched comparison group of patients with comparable injuries who do not receive IVC filters. A large-scale project like this would likely require a multicenter research collaboration and need national funding and/or sponsorship by a professional trauma organization.

Our systematic review has several limitations. Our search strategy was comprehensive, and we included study designs other than RCTs; however, we were unable to assess the possibility of publication bias or selective outcomes reporting and its effect on our findings. In addition, the scope of this AHRQ-sponsored project was to “undertake scientific analysis and evidence syntheses” (http://www.ahrq.gov/legacy/clinic/epc/epctopicn.htm), not to produce recommendations or guidelines. This report has performed nearly all of the GRADE (Grading of Recommendations, Assessment, Development, and Evaluation) method steps but stops short of making a recommendation. The Eastern Association for the Surgery of Trauma has recently adopted the GRADE method and may perform this additional step in the future. Our report highlights the need for additional research on the comparative effectiveness and safety of IVC filters in hospitalized trauma patients. The American Venous Forum and the Society of Interventional Radiology Multidisciplinary Consensus Conference have placed a high priority on studies of IVC filters in trauma. The all-too-common answer that RCTs must be performed is at first glance appealing, and Rajasekhar et al have shown us that RCTs can be performed on this topic. However, an appropriately powered, multicenter RCT may be prohibitively expensive. We therefore suggest other possible options for well-designed observational research that may be less expensive yet still informative.
cient manner. Some authors note that filters are not removed as frequently as clinicians expect and that many filters are not actually removed from trauma patients. Recent efforts to actively and aggressively remove filters through a more disciplined follow-up approach have been shown to be effective in increasing removal rates.

The baseline risk of all VTE outcomes depends greatly on the use of appropriate, timely VTE prophylaxis in patients at risk. Although once thought to occur late after trauma, PE is frequently found earlier in the hospital course. However, the use of early pharmacologic thromboprophylaxis in patients considered to be at increased risk of bleeding (eg, traumatic brain injury) remains controversial. The AHRQ report asked the question, “What is the optimal timing of initiation and duration of pharmacologic prophylaxis to prevent VTE in hospitalized patients with traumatic brain injury?” The published data did not allow us to answer this question definitively. However, a retrospective series, prospective observational case series, and RCT appear to show that early pharmacologic thromboprophylaxis is likely safer than originally thought. If pharmacologic prophylaxis is initiated earlier, more patients would receive appropriate VTE prophylaxis, driving down the baseline VTE rate and changing the risk/benefit profile of IVC filters and the NNT to prevent PE and fatal PE.

Clinicians need guidance regarding the use of prophylactic IVC filters in high-risk trauma patients. Overall, we found that prophylactic IVC filter placement is associated with lower incidence of PE and fatal PE in trauma patients. However, risks to patients with IVC filter placement remain, and we were unable to fully examine these risks in this review. In most of the less severely injured trauma patients, particularly those receiving VTE prophylaxis, these risks likely outweigh the benefit of prophylactic IVC filter placement. However, the ratio of benefit to harm likely differs for patients with a higher underlying probability of developing PE, such as those who are more severely injured or who cannot receive pharmacologic prophylaxis. As with many patient care decisions, these difficult clinical judgments must balance the ratio of benefit to harm for individual trauma patients.

ARTICLE INFORMATION

Accepted for Publication: May 1, 2013.
Published Online: November 6, 2013.

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Author Contributions: Drs Haut and Singh had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Haut, Garcia, Brotman, Sharma, Shermock, Segal, Singh. Acquisition of data: Haut, Shihab, Brotman, Sharma, Chelladurai, Akande, Shermock, Kebede, Singh. Analysis and interpretation of data: Haut, Garcia, Shihab, Stevens, Chelladurai, Shermock, Segal. Drafting of the manuscript: Haut, Garcia, Sharma, Chelladurai, Akande, Shermock, Kebede, Singh. Critical revision of the manuscript for important intellectual content: Haut, Shihab, Brotman, Stevens, Chelladurai, Shermock, Segal, Singh. Statistical analysis: Shihab, Chelladurai, Shermock, Singh. Obtained funding: Segal. Administrative, technical, or material support: Stevens, Sharma, Chelladurai, Shermock, Kebede.

Study supervision: Haut, Sharma, Chelladurai, Segal.

Conflict of Interest Disclosures: None reported.

Funding/Support: This study was supported by contract HHSN-290-2007-10061 I from the AHRQ.

Role of the Sponsor: The AHRQ participated in formulating the key question and reviewed planned methods and data analyses, as well as interim and final evidence reports. The AHRQ had no role in the preparation, review, or approval of the manuscript, and decision to submit the manuscript for publication.

Additional Contributions: S. Swaroop Vedula, MD, MPH, PhD, helped with the replication of the results in 2 different statistical programs. He did not receive any financial compensation.

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