DVT Prophylaxis in High Risk Trauma Patients

David A. Spain, MD
Stanford University
We could not identify any population, except perhaps venous injuries, where such expensive and potentially harmful maneuvers seemed justified. Our experience with DVT and PE does not support either aggressive screening or prophylactic IVC filters as the standards of care.

This was 1997 ... no retrievable filters
DVT Prophylaxis

- Who needs prophylaxis
- What is adequate prophylaxis?
  - Mechanical
  - Chemical
  - IVC Filters
- Does surveillance help?
Who Needs VTE Prophylaxis?
- All pts > ISS 9, did not receive mechanical or pharmacologic antithrombotic prophylaxis during the study
- Impedance plethysmography was performed every other day in the patients who were able to undergo the procedure
- These patients underwent venography 14 to 21 days after admission, or earlier if the hospital stay was shorter than 14 days
- Any signs or symptoms = impedance plethysmography
- All positive impedance plethysmography confirmed with venography
A Prospective Study of Venous Thromboembolism after Major Trauma

<table>
<thead>
<tr>
<th>Thrombosis</th>
<th>Face, Chest, or Abdomen (N = 129)</th>
<th>Head (N = 91)</th>
<th>Spine (N = 66)</th>
<th>Lower Extremity (N = 182)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep vein</td>
<td>65 (50.4)</td>
<td>49 (53.8)</td>
<td>41 (62.1)</td>
<td>126 (69.2)</td>
</tr>
<tr>
<td>Proximal deep vein</td>
<td>19 (14.7)</td>
<td>18 (19.8)</td>
<td>18 (27.3)</td>
<td>43 (23.6)</td>
</tr>
</tbody>
</table>

*Patients with major injuries at more than one site are included in the column for each site involved.*
A Prospective Study of Venous Thromboembolism after Major Trauma

- Signs or symptoms were uncommon
- Rate of fatal PE was low (0.4 percent) even w/o prophylaxis

“We therefore consider all patients with major trauma to be at high risk for thromboembolic complications”
### TABLE 2. Independent Risk Factors for VTE (Multivariate Logistic Regression)

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Odds ratio (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age ≥ 40 years</td>
<td>2.01 (1.74–2.32)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Lower extremity fracture (AIS ≥ 3)</td>
<td>1.92 (1.64–2.26)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Head injury (AIS ≥ 3)</td>
<td>1.24 (1.05–1.46)</td>
<td>0.0125</td>
</tr>
<tr>
<td>Ventilator days &gt;3</td>
<td>8.08 (6.86–9.52)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Venous injury</td>
<td>3.56 (2.22–5.72)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Major operative procedure</td>
<td>1.53 (1.30–1.80)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Underlying conditions</td>
<td>Weight</td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
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<td></td>
</tr>
<tr>
<td>Obese (&gt;120% Metropolitan Life Table)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Malignancy</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Abnormal coagulation factors at admission</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>History of thromboembolism</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Iatrogenic factors</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central femoral line &gt;24 hours</td>
<td>2</td>
</tr>
<tr>
<td>Four or more transfusions during first 24 hours</td>
<td>2</td>
</tr>
<tr>
<td>Surgical procedures &gt;2 hours</td>
<td>2</td>
</tr>
<tr>
<td>Repair or ligation of major venous injury</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Injury-related factors</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIS &gt;2 for the chest</td>
<td>2</td>
</tr>
<tr>
<td>AIS &gt;2 for the abdomen</td>
<td>2</td>
</tr>
<tr>
<td>Spinal fractures</td>
<td>2</td>
</tr>
<tr>
<td>AIS* &gt;2 for the head</td>
<td>3</td>
</tr>
<tr>
<td>Coma (GCS score &lt;8 for &gt;4 hours)</td>
<td>3</td>
</tr>
<tr>
<td>Complex lower extremity fracture</td>
<td>4</td>
</tr>
<tr>
<td>Pelvic fracture</td>
<td>4</td>
</tr>
<tr>
<td>Spinal cord injury with para or quadriplegia</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age</th>
<th>Weight</th>
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<tbody>
<tr>
<td>≥40 but &lt;60</td>
<td>2</td>
</tr>
<tr>
<td>≥60 but &lt;75</td>
<td>3</td>
</tr>
<tr>
<td>≥75</td>
<td>4</td>
</tr>
</tbody>
</table>

AIS, Abbreviated Injury Score; GCS, Glasgow Coma Scale.

Score > 5 is “high risk”
- Very sensitive
- Not specific
Trauma service protocol

- All high-risk patients received pharmacologic and mechanical VTE prophylaxis unless contraindicated.
- High-risk patients were screened by duplex ultrasonography at 3-day intervals.
- Low- and moderate-risk patients were screened at 1 week intervals.
- If patients had below-the-knee superficial thrombosis, they were screened at 3-day intervals for evidence of proximal progression.

![Incidence of VTE by RAP category: low, medium, or high.](image)
What Defines High Risk Patients?

Injury Patterns
- Severe injuries with ventilation ≥ 72 hr
- TBI with lower extremity fractures
- Spinal column/cord injury
- Combined pelvic and lower extremity fractures
- Major infra-renal venous injuries

RAPT Score
- Cutoff > 5
- Stratify into 2 or 3 groups
What is adequate prophylaxis?
16 studies were included (n=3005)
4 trials compared the effect of any type (mechanical and/or pharmacological) of prophylaxis versus no prophylaxis
Prophylaxis reduced the risk of DVT in trauma (RR 0.52; 95% CI 0.32 to 0.84)
Pharmacological prophylaxis was more effective than mechanical methods at reducing the risk of DVT (RR 0.48; 95% CI 0.25 to 0.95)
LMWH appeared to reduce the risk of DVT compared to UH (RR 0.68; 95% CI 0.50 to 0.94)
People who received both mechanical and pharmacological prophylaxis had a lower risk of DVT (RR 0.34; 95% CI 0.19 to 0.60)
Pharmacological prophylaxis better than mechanical alone

LMWH probably better than LDUH

LMWH + mechanical probably the best
What if you really can’t use Heparin or LMWH?

- Mechanical prophylaxis (SCDs)

- Prophylactic IVC filter
  - Only prevents PE, not DVT
Comparison of Sequential Compression Devices and Foot Pumps for Prophylaxis of Deep Venous Thrombosis in High-Risk Trauma Patients

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EDDY H. CARRILLO, M.D., J. DAVID RICHARDSON, M.D.

From the Departments of Surgery, University of Louisville and Veteran Affairs Medical Center, Louisville, Kentucky

<table>
<thead>
<tr>
<th>Table 1. Demographics and Injury Pattern Data</th>
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<tbody>
<tr>
<td>SCD (n = 118)</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>ISS</td>
</tr>
<tr>
<td>Shock on admission</td>
</tr>
<tr>
<td>Head injury</td>
</tr>
<tr>
<td>GCS</td>
</tr>
<tr>
<td>Chest injury</td>
</tr>
<tr>
<td>Pelvic fracture</td>
</tr>
<tr>
<td>Lower extremity fracture</td>
</tr>
<tr>
<td>Spine/cord injury</td>
</tr>
</tbody>
</table>

ISS, Injury Severity Score; GCS, Glasgow Coma Score
* P < 0.05 by Yates corrected chi square; † P < 0.05 Behrens-Fisher t test.

<table>
<thead>
<tr>
<th>Table 2. Venous Thromboembolism Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCD (n = 118)</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Prophylactic heparin</td>
</tr>
<tr>
<td>Day heparin added</td>
</tr>
<tr>
<td>DVT suspected†</td>
</tr>
<tr>
<td>DVT confirmed</td>
</tr>
<tr>
<td>Pulmonary embolus</td>
</tr>
<tr>
<td>Total VTE‡ rate</td>
</tr>
</tbody>
</table>

* P < 0.05 by Yates Corrected chi square.
Are temporary inferior vena cava filters really temporary?

- Filters were placed for prophylaxis (n = 11) or for therapy in patients with pulmonary embolism or deep vein thrombosis (n = 17)
- Of 23 temporary filters, only 8 (35%) were removed
- Several other similar publications

Payer status is associated with the use of prophylactic inferior vena cava filter in high-risk trauma patients

Danielle M. Pickham, MD, Rachael A. Callcut, MD, MSPH, Paul M. Maggio, MD, MBA, Matthew W. Mell, MD, David A. Spain, MD, Fritz Bech, MD, MS, and Kristan Staudenmayer, MD, MS, Stanford, CA

Background. It is controversial whether patients at high risk for pulmonary embolism (PE) should receive prophylactic inferior vena cava filters (IVC) filters. This lack of clarity creates the potential for variability and disparities in care. We hypothesized there would be differential use of prophylactic IVC filters for patients at high risk for PE on the basis of insurance status.

Methods. We performed a retrospective analysis using the National Trauma Databank (2002–2007). We included adult patients at high risk for PE (traumatic brain injury or spinal cord injury) and excluded patients with a diagnosis of deep venous thrombosis (DVT) or PE. Logistic regression was performed to control for confounders and a hierarchical mixed effects model was used to control for center.
Results. A prophylactic filter was placed in 3,331 (4.3%) patients in the study cohort. Patients without insurance had an IVC filter placed less often compared with those with any form of insurance (2.7% vs 4.9%, respectively). After adjusting for confounders, we found that patients without insurance were less likely to receive a prophylactic IVC filter, even when we controlled for center (OR 5.3, \( P < .001 \)).

Conclusion. When guidelines lack clarity, unconscious bias has the potential to create a system with different levels of care based on socioeconomic disparities. (Surgery 2012;152:232-7.)
Prophylactic Inferior Vena Cava Filter Placement Does Not Result in a Survival Benefit for Trauma Patients

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¹University of Michigan, Ann Arbor, MI; ²Michigan State University, Lansing, MI; ³Covenant Medical Center, Saginaw, MI

High rates of prophylactic IVC filter placement have no effect on reducing trauma patient mortality and are paradoxically associated with an increase in DVT events.
Duplex ultrasound screening detects high rates of deep vein thromboses in critically ill trauma patients

Amir Azarbal, MD, Susan Rowell, MD, Jason Lewis, BA, Rakhee Urankar, MD, Shannon Moseley, BA, Gregory Landry, MD, and Greg Moneta, MD, Portland, Ore

Objective: American College of Chest Physician (ACCP) guidelines stratify deep venous thrombosis (DVT) risk in trauma patients based on injury pattern and pharmacologic prophylaxis. Screening is only recommended for patients with high-risk injuries who are unable to receive pharmacologic prophylaxis. However, the prevalence of lower extremity DVT (LEDVT) in trauma patients may be higher than reported in previous studies as many studies on DVT screening have not investigated calf vein DVTs (CVDVT) and have not exclusively targeted critically ill patients. Given that current ACCP guidelines recommend treatment of CVDVTs, we investigated the efficacy of duplex ultrasound (DUS) screening in critically ill trauma patients for all LEDVTs, including CVDVT, regardless of injury pattern, risk factors, or pharmacologic prophylaxis.

Table IV. Incidence of DVT stratified by LMWH prophylaxis and presence of high-risk injuries

<table>
<thead>
<tr>
<th></th>
<th>High-risk injury</th>
<th>No high-risk injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMWH</td>
<td>11/74 (14.9%)</td>
<td>5/36 (13.5%)</td>
</tr>
<tr>
<td>No LMWH</td>
<td>14/71 (19.7%)</td>
<td>10/82 (12.2%)</td>
</tr>
</tbody>
</table>

P = .667

DVT, Deep venous thrombosis; LMWH, low molecular weight heparin.
Four Years of an Aggressive Prophylaxis and Screening Protocol for Venous Thromboembolism in a Large Trauma Population

Raeanna C. Adams, MD, Miller Hamrick, MD, Christina Berenguer, MD, Christopher Senkowski, MD, and M. Gage Ochsner, MD, FACS

**Background:** This retrospective review of a prospectively collected database was conducted to analyze the efficacy of 4 years of aggressive prophylaxis and screening protocols for venous thromboembolism (VTE) in a large population of trauma patients.

**Methods:** Trauma patients at a Level I Trauma Center found to be nonambulatory or otherwise high risk were placed on a protocol of lower-extremity (LE) compression devices and subcutaneous enoxaparin as soon as feasible after admission. Duplex scans of LEs were conducted weekly.

**Results:** During 4 years, 2,939 patients were admitted to trauma with length of stay >2 days. There was a 3.2% incidence of VTE in the length of stay >2 days population, 2.5% rate of deep venous thrombosis (DVT), and 0.7% pulmonary embolism. All VTE patients had factors known to increase risk of VTE and were included in our prophylaxis and screening protocol. Twenty-one percent of these received pharmacologic prophylaxis within the first 2 days of admission; 62% received enoxaparin at some point before diagnosis of VTE. Duplex scans were conducted in 982 patients. Notably, 86% of LE DVTs were found on routine screening duplex.

**Conclusion:** To our knowledge, this is the largest population of trauma patients followed by screening duplexes. All patients with VTEs were identified as high risk, and screening revealed multiple patients with asymptomatic DVT. We conclude our aggressive prophylaxis regimen lead to low rates of VTE and think screening duplex is a critical component for identifying unsuspected DVT.

**Key Words:** Venous thromboembolism, Screening, Prophylaxis, Trauma, Deep venous thrombosis.
Duplex Ultrasound Screening for Deep Vein Thrombosis in Asymptomatic Trauma Patients: A Survey of Individual Trauma Surgeon Opinions and Current Trauma Center Practices

Elliott R. Haut, MD, Eric B. Schneider, PhD, Amar Patel, BA, Michael B. Streiff, MD, Adil H. Haider, MD, MPH, Kent A. Stevens, MD, MPH, David C. Chang, MBA, MPH, PhD, Melanie L. Neal, MS, Christopher Hoeft, BA, Avery B. Nathens, MD, PhD, MPH, Edward E. Cornwell, 3rd, MD, Peter J. Pronovost, MD, PhD, and David T. Efron, MD

Background: Many national agencies have suggested that deep vein thrombosis (DVT) rates measure quality of hospital care. However, none provide recommendations for standardized screening. If screening practices vary among clinicians or hospitals, DVT rates could be biased—centers which perform more duplex ultrasounds report more DVTs. We hypothesized that trauma surgeons have varying opinions regarding duplex ultrasound screening for DVT in asymptomatic trauma patients, which result in varying practice patterns.

Methods: We conducted two web-based surveys regarding the use of duplex ultrasound screening for DVT in asymptomatic trauma patients. The first (individual provider level) surveyed members of two national trauma surgery organizations (American Association for the Surgery of Trauma and Eastern Association for the Surgery of Trauma). The second (trauma center level) surveyed practice patterns of National Trauma Data Bank hospitals.

Results: Three hundred seventeen individual surgeons completed surveys. There was wide variation in individual opinions regarding DVT screening in asymptomatic trauma patients (53% agree, 36% disagree, and 11% neither agree nor disagree). Two hundred thirteen National Trauma Data Bank hospitals completed surveys of which 28% (n = 60) have a written guideline regarding DVT screening in asymptomatic trauma patients. The proportion of centers with a written protocol varied significantly by trauma center level (p < 0.001) but not by teaching status. Opinions and practice patterns suggest that screening should start early and be performed weekly. The main risk factors used to suggest DVT screening are spinal cord injury and pelvic fracture.

Conclusions: There are wide variations in trauma surgeons’ opinions and trauma centers’ practices regarding duplex ultrasound screening for DVT in asymptomatic trauma patients. This variability combined with the fact that performing more duplex ultrasounds finds more DVTs may influence reported DVT rates. DVT rates alone are biased and not reflective of true quality of trauma care.

Key Words: Deep vein thrombosis, Pulmonary embolism, Quality in medicine, Duplex ultrasound, Trauma outcomes, Screening.

(J Trauma. 2011;70: 27–34)
Screening Duplex US

- The more you look, the more you’ll find
- Most are asymptomatic
- Most are calf vein
- Does it impact outcome?

- Screening duplex
  - Do find more DVTs
  - No evidence that it reduces mortality
    - PE is a fairly rare events
PE Mortality

- Even in high risk group, PE rate is only about 1-2%
- Mortality rate for those is about 25% (or 0.25 to 0.5% overall)
- Will be almost impossible to prove a mortality benefit for screening duplex or IVC filter
Prevention of VTE in Nonorthopedic Surgical Patients

Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines

CHEST 2012; 141(2)(Suppl):e227S–e277S
8.4.1. For major trauma patients, we suggest use of LDUH (Grade 2C), LMWH (Grade 2C), or mechanical prophylaxis, preferably with IPC (Grade 2C), over no prophylaxis.

8.4.2. For major trauma patients at high risk for VTE (including those with acute spinal cord injury, traumatic brain injury, and spinal surgery for trauma), we suggest adding mechanical prophylaxis to pharmacologic prophylaxis (Grade 2C) when not contraindicated by lower-extremity injury.
8.4.3. For major trauma patients in whom LMWH and LDUH are contraindicated, we suggest mechanical prophylaxis, preferably with IPC, over no prophylaxis (Grade 2C) when not contraindicated by lower-extremity injury. We suggest adding pharmacologic prophylaxis with either LMWH or LDUH when the risk of bleeding diminishes or the contraindication to heparin resolves (Grade 2C).

8.4.4. For major trauma patients, we suggest that an IVC filter should not be used for primary VTE prevention (Grade 2C).

8.4.5. For major trauma patients, we suggest that periodic surveillance with VCU should not be performed (Grade 2C).
When to start (and hold) prophylaxis
60% of pts missed at least 1 dose

- 5 retrospective cohort studies were included in review
  - Total of 1624 patients: 713 received early PTP and 911 received late PTP.
  - 43 and 106 VTE respectively, with a risk ratio of 0.52 (0.37, 0.73)
  - Relative risk of ICH progression in the early compared with the late PTP group was 0.64 (0.35, 1.14)

- Early PTP (<72h) reduces the risk of VTE without affecting progression of ICH

- However, much work is yet to be done to better clarify ICH subtypes at risk of progression and the implementation of evidence-based guidelines backed up with randomized control trial level evidence.
21 studies focused on the effects of pharmacological thromboprophylaxis (PTP) post-TBI on venous thromboembolism and/or progression of intracranial hemorrhage.

Pharmacological thromboprophylaxis appears to be safe among TBI patients with stabilized hemorrhagic patterns.
UT Southwestern Protocol
Pretty much what we do
Improved Prophylaxis and Decreased Rates of Preventable Harm With the Use of a Mandatory Computerized Clinical Decision Support Tool for Prophylaxis for Venous Thromboembolism in Trauma

Objective: Venous thromboembolism is associated with substantial morbidity and mortality and is largely preventable. Despite this fact, appropriate prophylaxis is vastly underutilized. To improve compliance with best practice prophylaxis for VTE in hospitalized trauma patients, we implemented a mandatory computerized provider order entry–based clinical decision support tool. The system required completion of checklists of VTE risk factors and contraindications to pharmacologic prophylaxis. With this tool, we were able to determine a patient’s risk stratification level and recommend appropriate prophylaxis. To evaluate the effect of our mandatory computerized provider order entry–based clinical decision support tool on compliance with prophylaxis guidelines for venous thromboembolism (VTE) and VTE outcomes among admitted adult trauma patients.
Improved Prophylaxis and Decreased Rates of Preventable Harm With the Use of a Mandatory Computerized CDS Tool for Prophylaxis for VTE in Trauma

- Compliance with guideline-appropriate prophylaxis increased from 66.2% to 84.4% ($P < .001$)
- The rate of preventable harm from VTE decreased from 1.0% to 0.17% ($P = .04$)
Can we ever stop worrying about venous thromboembolism after trauma?

Laura N. Godat, MD, Leslie Kobayashi, MD, David C. Chang, PhD, and Raul Coimbra, MD, San Diego, California
Pattern was similar for all other high risk injury patterns.
FIGURE 1. Proposed algorithm for VTE prophylaxis.
DVT Prophylaxis

- Almost everyone can have SCDs on day 0
  - Foot pumps an alternative
- Start Lovenox when “stable”
  - Solid organ injury or pelvic fx: stable HCT x 24 hrs
  - TBI: 72 hrs after head CT stable
  - Try to minimize Lovenox interruptions
- If pt at high risk for DVT and really can’t get Lovenox:
  - Serial duplex scanning
  - Prophylactic IVC filter
    - Have protocol in place to retrieve
DVT Prophylaxis

- Pick a protocol (none are perfect)
- Define high risk (injury pattern or RAPT score)
- Define how and when you will provide prophylaxis
  - TBI and spine
  - Solid organ injuries and pelvic fracture
  - Perioperative strategy
- Define your use of:
  - Screening duplex
  - Prophylactic IVC filters