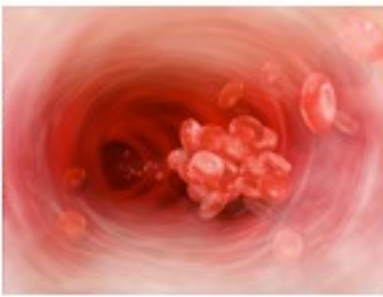


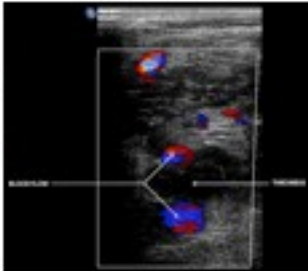
# DVT Prophylaxis in Neurotrauma



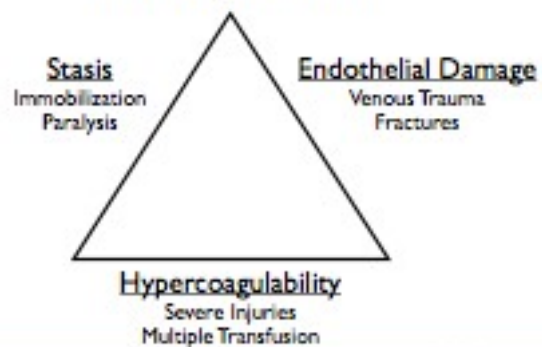
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TBI & Stroke Update  
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## Outline

- ◆ Incidence
- ◆ Risk factors
- ◆ Types of prophylaxis
  - Mechanical
  - Unfractionated Heparin
  - LMWH
  - IVC Filter
- ◆ Recommendations

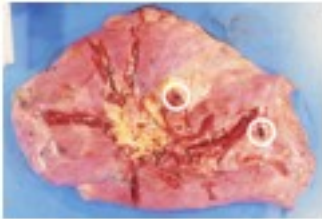


## Virchow's Triad



## Incidence

- ◆ 1934 - 3.8% PE in trauma patients on postmortem examinations (McCartney)
- ◆ 1967 - 35% DVT in trauma patients on venography (Freeark)



## Incidence

- ◆ True incidence difficult to establish
  - Clinically silent
  - Heterogenous disease
  - Screening methods and biases
- ◆ Trauma patients
  - DVT: up to 60%
  - Fatal PE: 1%



## Incidence

	Head	Spine	Lower extremities
Face, chest, or abdomen	26/43 61%	11/16 69%	31/41 76%
Head	26/43 61%	4/11 36%	21/26 81%
Spine		11/16 69%	10/16 63%
Lower extremities			31/41 76%

- ◆ 349 major trauma pts
- ◆ No prophylaxis
- ◆ 57.6% DVT
- ◆ 18% proximal leg veins
- ◆ 1.5% clinically evident

Figure 1. The Frequency of Deep-Vein Thrombosis among 349 Patients with One or More Major Injuries.

# Timing of Thrombotic Events

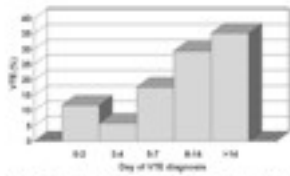


Fig. 1. The day of diagnosis of any VTE (deep venous thrombosis or pulmonary embolism) within the first 28 days after injury.

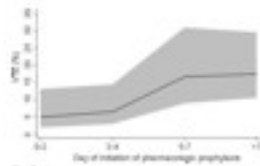


Fig. 2. The proportion of patients with VTE in relation to the day of initiation of pharmacologic prophylaxis. Gray shading represents the VTE confidence interval.

Nathan et al., J Trauma 2007

# Incidence in TBI

- ◆ In patients with TBI, VTE 20 to 31.6%
- ◆ Denson et al., 2007
  - Isolated TBI: 25%
  - All trauma: 2%
  - High-risk trauma: 18%
  - IPH associated with higher incidence of VTE

# Risk Factors

Author (Ref. No.)	Year	Patients	VTE definition	ICD9	ICD9	Risk Factors
Shapiro et al. <sup>11</sup>	1990	177	Phlebography or I/O ultrasound or venography	9	2	Age > 65 years History DVT/PE SCS > 7 fractures
Rice et al. <sup>12</sup>	1991	160	Duplex scan	11	-	Lower extremity fractures Spinal fractures/neck injury History venous thrombosis
Dennis et al. <sup>13</sup>	1992	261	Duplex scan	4,6	1	Age > 60 Immobilized > 10 days Venous catheters, bed rest
Rubin et al. <sup>14</sup>	1994	38	Venography	10	-	Fractures SCS > 8
Burke et al. <sup>15</sup>	1995	57	Duplex scan	21	2	Fractures
Mulliken et al. <sup>16</sup>	1995	37	Venography	92	2	SCS > 8
Olson et al. <sup>17</sup>	1994	32	Technetium scans	6	20	Fracture catheters Head injury, paraparesis
Wassilich et al. <sup>18</sup>	1995	76	Duplex scans	12	18	Palpating bone fractures Immobilization, age > 60
Hughes et al. <sup>19</sup>	1995	1,076	Duplex scans	7	8	Transfusions, comorbidity Immobilization > 3 days
Nathan et al. <sup>20</sup>	1999	251	Duplex scans	9	1	Palpating bone fractures Age > 60 years Transfusions, surgery
Geerts et al. <sup>21</sup>	1988	349	Venography	14	-	Paralysis, fractures

Krakauer et al., J Trauma 1994

## Risk Factors

TABLE 2. Independent Risk Factors for VTE (Multivariate Logistic Regression)

Risk Factor	Odds ratio (95% CI)	p-value
Age $\geq$ 40 years	2.01 (1.74-2.32)	<.0001
Lower extremity fracture (AIS $\geq$ 3)	1.92 (1.64-2.26)	<.0001
Head injury (AIS $\geq$ 3)	1.24 (1.05-1.46)	0.0125
Ventilator days $>$ 3	8.08 (6.86-9.52)	<.0001
Venous injury	3.56 (2.22-5.72)	<.0001
Major operative procedure	1.53 (1.30-1.80)	<.0001

Knudson et al., Ann Surg. 2004

Additional Factors:  
SCI with paralysis  
Pelvic fractures  
Immobile  $>$  3 days  
Large transfusions  
Femoral Catheters

## Prophylaxis

- ◆ Mechanical
- ◆ Pharmacological
  - Unfractionated heparin
  - Low molecular weight heparin
- ◆ Vena cava filters

## Mechanical Devices



## Mechanical Devices

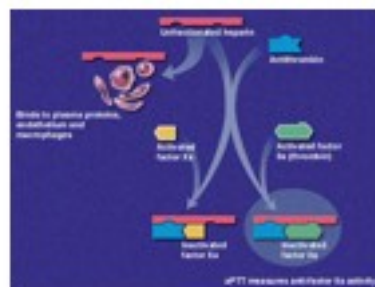
- ◆ Do not increase risk of bleeding
- ◆ Reduction of leg swelling
- ◆ Efficacy demonstrated in a variety of groups
- ◆ May enhance the effectiveness of anticoagulant thromboprophylaxis
- ◆ Cost



## Mechanical Devices

- ◆ Less rigorous testing
- ◆ Variety of designs
- ◆ Local effect
- ◆ Not suitable for lower extremity fractures
- ◆ Compliance
- ◆ Cost

## Unfractionated Heparin



# Unfractionated Heparin

Qualified Patients

**Table 3**  
Analysis of the effectiveness of prophylaxis

	Number of Patients		p-Value
	With DVT	No DVT	
<b>Group I</b>			
Heparin	1	43	NS
SCD	4	29	
Control	2	62	
<b>Group II</b>			
Heparin	1	18	NS
Control	2	25	
<b>Group III</b>			
SCD	0	26	0.027
Control	5	34	

NS = Not significant

Figure 3. Trauma DVT study design

Kruken et al., *J Trauma*, 1994

# Unfractionated Heparin vs. No Prophylaxis

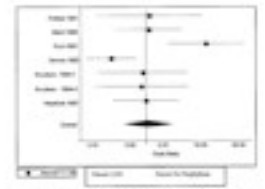


Fig. 5. Odds ratio plot of RCTs and non-RCTs, comparing rates of DVT among patients who received LDU or no prophylaxis.

**Table 2** Rates of DVT Reported in Seven Studies (Four RCT and Three Non-RCT) of Trauma Patients, Comparing Low-Dose Heparin to No Prophylaxis

Study	No. of Patients with DVT	No. of Patients with No DVT	DVT Incidence among DVT Prophylaxis (%)	DVT Incidence among No Prophylaxis (%)	Odds Ratio	95% CI of Odds Ratio
Shah et al., 1987 <sup>a</sup>	12	12	47	11	0.3	0.1-0.8
Pittler and Sessler, 1987 <sup>b</sup>	13	17	7	8	1.1	0.1-20.0
Kruken et al., 1989 <sup>c</sup>	44	68	6	6	0.7	0.1-3.0
Kruken et al., 1989 <sup>c</sup>	14	27	4	7	0.7	0.1-3.2
Denko et al., 1992 <sup>d</sup>	281	174	2	9	0.2	0.1-0.4
Holmes et al., 1993 <sup>e</sup>	25	34	28	12	2.3	0.8-5.9
Park et al., 1993 <sup>f</sup>	66	66	0	10	0.4	0.1-0.8
Random effect estimate	664	616	0.00	0.01	0.54	0.38-0.76

Holmes, et al., *J Trauma*, 2000

# Heparin + Mechanical

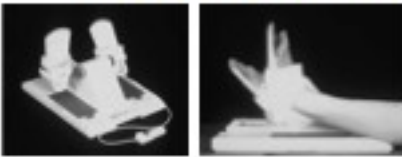


Table IV. Overall incidence of thrombosis shows a highly significant difference between both groups (chi-squared test; p < 0.001)

	Test group (n = 111)	Control group (n = 116)	Total (n = 227)
Thrombosis (%)	4 (3.6)	29 (25.0)	33 (14.6)
No thrombosis (%)	107 (96.4)	87 (75.0)	194 (85.4)



## LMWH vs. Mechanical

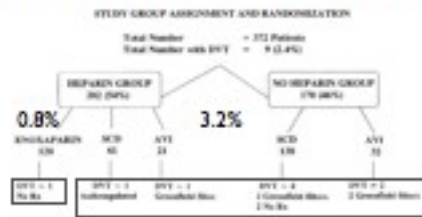


Figure 1. Study design with total number of patients in each assigned and randomization group. AVI, sequential patient; enoxaparin sodium injection device, EN; intracranial impactor device, IYT; deep-vein thrombosis, No, treatment.

Kushner et al., *J Trauma*, 1996

## Safety of LMWH in TBI

### ◆ Norwood et al., 2001

- Brain AIS ≥ 3 in 79 patients
- Craniotomy for intracranial hematoma
- Lovenox within 24 hours
- No bleeding complications

### ◆ Cothren et al., 2007

- 743 High risk trauma patients
- Once daily dose of Dalteparin
- Repeat CT 12-24 hours with no ↑ ICH
- 3% bleeding complications - NO ICH



## Vena Cava Filters





# Retrievable IVC Filters

**Table 2** Indications for Filter Placement

	Group I	Group II	p Value
n	35	161	
Major venous thromboembolic event	40% (24/35)	37% (20/161)	0.25
Major venous thromboembolic event, but not venous thromboembolic event, but not venous thromboembolic event, but not venous thromboembolic event	71% (23/35)	47% (43/105)	< 0.01

Group I - before introduction of retrievable filters

Group II - after introduction of retrievable filters

**Table 3** Rates of Pulmonary Embolism and Major Filter-Related Complications

	Group I	Group II	p Value
n	35	161	
Pulmonary embolism	0.0% (0/35)	0.0% (0/161)	0.98
Major filter-related complications	1.4% (1/35)	2.5% (4/161)	0.77

The pulmonary embolism with filter in place.  
The filter-related, venous and non-venous, and venous thromboembolism.

Arnold et al., J Trauma 2004

## Summary

- ◆ Trauma represents a heterogeneous group of patients
- ◆ Patients with TBI and SCI are at particularly high risk for venous thromboembolic events
- ◆ Routine thromboprophylaxis is recommended

# CHEST

Official publication of the American College of Chest Physicians

Prevention of Venous Thromboembolism<sup>†</sup>:  
American College of Chest Physicians  
Evidence-Based Clinical Practice Guidelines  
(8th Edition)

- ◆ All major trauma patients
  - LMWH thromboprophylaxis as soon as it is safe to do so (1A)
  - Combination of LMWH with mechanical method of thromboprophylaxis (1B)
  - If LMWH contraindicated then mechanical thromboprophylaxis (1B). When bleeding risk decreases, pharmacological agent be substituted or added. (1C)

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Prevention of Venous Thromboembolism<sup>†</sup>:  
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- ◆ All major trauma patients (Cont.)
  - Recommend against use of an IVC filter as thromboprophylaxis (1C)
  - Continuation of thromboprophylaxis until hospital discharge

# CHEST

Official publication of the American College of Chest Physicians

Prevention of Venous Thromboembolism<sup>†</sup>:  
American College of Chest Physicians  
Evidence-Based Clinical Practice Guidelines  
(8th Edition)

- ◆ Acute Spinal Cord Injury
  - Thromboprophylaxis with LMWH once hemostasis is achieved. (1B). Alternatives include the combined use of mechanical device and either LDUH (1B) or LMWH (1C).
  - Optimal use of mechanical devices if anticoagulant thromboprophylaxis is contraindicated (1A). When high bleeding risk decreases, pharmacologic agent should be substituted for or added to the mechanical thromboprophylaxis (1C)

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Prevention of Venous Thromboembolism<sup>†</sup>:  
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- ◆ Acute Spinal Cord Injury (Cont.)
  - Use of mechanical thromboprophylaxis for incomplete SCI associated with spinal hematoma (1C) Recommend against the use of LDUH alone (1A)
  - Recommend against the use of an IVC filter as thromboprophylaxis (1C)
  - For patients undergoing rehabilitation following acute SCI, LMWH thromboprophylaxis should be continued, or converted to oral anticoagulation (1C).

Thank You!