

# Traumatic Brain Injury Patients and Deep Vein Thrombosis

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# Terminology

- Deep Vein Thrombosis = Blood Clot
- Anticoagulation= Keeping Blood Thin

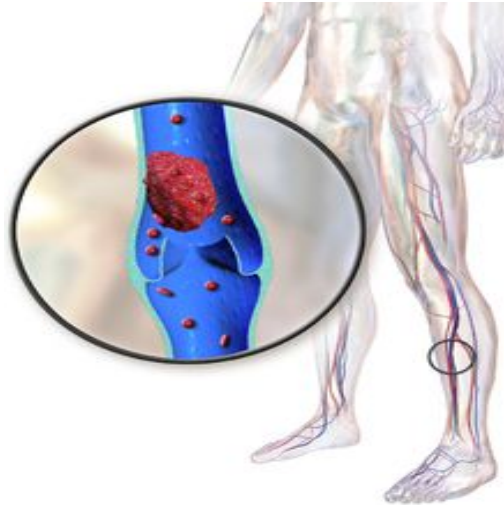
# Virchow's Triad-Factors leading to DVT

- Hypercoagulability
- Endothelial Injury- injury to lining of blood vessels
- Hemodynamic Changes (stasis, turbulence)



# Deep Vein Thrombosis

- It is the formation of a blood clot in the deep veins oftentimes of the legs
- Can travel in vasculature to cause Pulmonary Emboli



# Traumatic Brain Injury

- TBI Patients are often in:
  - Hypercoagulable State- s/p surgery and resulting blood loss
  - Stasis- less ambulatory
  - Endothelial Injury- polytrauma with LE injuries, cerebrovascular injuries

# Less Ambulatory



# Traumatic Brain Injury

- Patients often cannot be anticoagulated:
  - for fear of rebleeding after surgery
  - patients' high fall risk

# 2010 Study by Ekeh MD

- Sequential Compression Devices were routinely used
- Anticoagulation was not used on brain injuries
- DVT Screenings performed at 7-10 days after admission and weekly thereafter



# RESULTS

- 34.3% had DVT in patients with combined head and extracranial injuries
- 25.8% had DVT with only head injury

# Preventing DVT

- 8.5%-18% incidence of DVT on admission to inpatient rehabilitation
- Therefore, in a patient that cannot be anticoagulated and at a high risk of developing DVT. What can be done?

# Ultrasound to Detect DVT

- U/S regarded as most sensitive and specific noninvasive test for detection of lower extremity DVT
- Positive Predictive Value for Positive Scan is 97%-98% in both symptomatic and asymptomatic patients
- Downside of U/S: Expense? Yes and No

# U/S

- Previous study shows that U/S is as cost effective as mammography recommendations for woman per year of life saved
- But as people are transferred more rapidly from Acute Care to Rehab, Could anything else work in a more cost-effective manner over an extended time period?

# D-Dimer

- Monitor D-Dimer Levels on Admission and Weekly

# What is D-Dimer?

- Obtained from Plasma
- Generated when the endogenous fibrinolytic system degrades fibrin such as when a venous thrombosis forms
- Fibrin is a protein involved in blood clotting
- Consists of 2 fibrin molecules

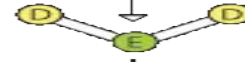
# Generation of D-dimer from cross-linked fibrin

Fibrinogen



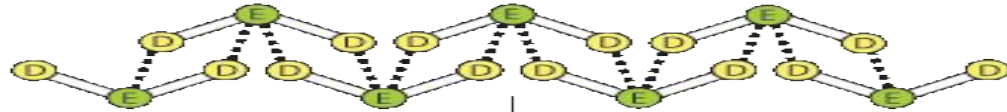
Thrombin cleavage

Fibrin



Fibrinopeptide A & B

Fibrin polymer



Factor XIIIa cross-linking

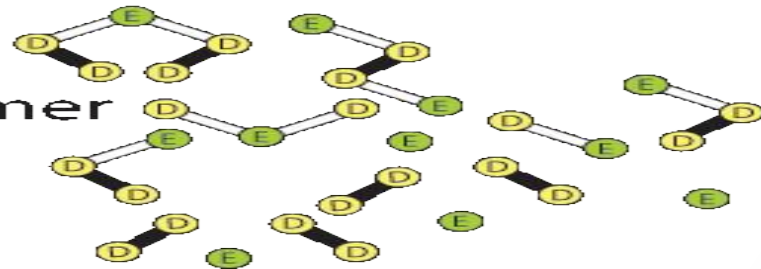
Crosslinked Fibrin



Plasmin cleavage

Fibrin Degradation Products

D-dimer



# D-Dimer

- Acute Phase reactant like ESR or CRP
- Value increases when fibrinolytic system degrades Fibrin such as in trauma, surgery, myocardial infarct, liver disease, malignancy, pregnancy
- Sensitive test, not a specific test
- Two D-Dimer Tests: Latex Immunosorbent Agglutination (LIA) and Enzyme Linked Immunosorbent Assay (ELISA)



# LIA vs ELISA

- **LIA- Inexpensive and rapid to perform, numerous studies have shown that they lack the sensitivity to detect D-dimers in critical clinical situations**

# LIA vs ELISA

- ELISA-In spite of their high sensitivity and specificity, it is **expensive, labor intensive, and time consuming to perform.** Therefore, it has not been practical in most clinical situations, where rapidly available results are needed.

# Another Study

- Assessed whether D-Dimer assays are predictive of DVT during the first 2 weeks after TBI at a predictive value of:

LIA-0.5 mg/L      ELISA-500ug/L

- Over 8 weeks the second generation LIA Assay was correlated with the ELISA after an acute TBI

# Methods

- Prospective Longitudinal Study TBI Model System Hospital (UAB)
- Subjects screened for DVT with U/S at week 2 after acute TBI
- Subjects screened for DVT with LIA and ELISA at weeks 2,4,6,8 (+/- 3 days) after acute TBI whether patient was inpatient or outpatient.
- Time Interval: 3 year period

# Participants

- 35 patients
- GCS mean score of 6.5 (range of 3-15)
- 33 had D-Dimers levels drawn at week 2.
- 21 subjects followed for 8 weeks after injury
- 25 men. 10 women.
- Average age 33 (range 17-66 y/o)
- Recruited in acute care at UAB

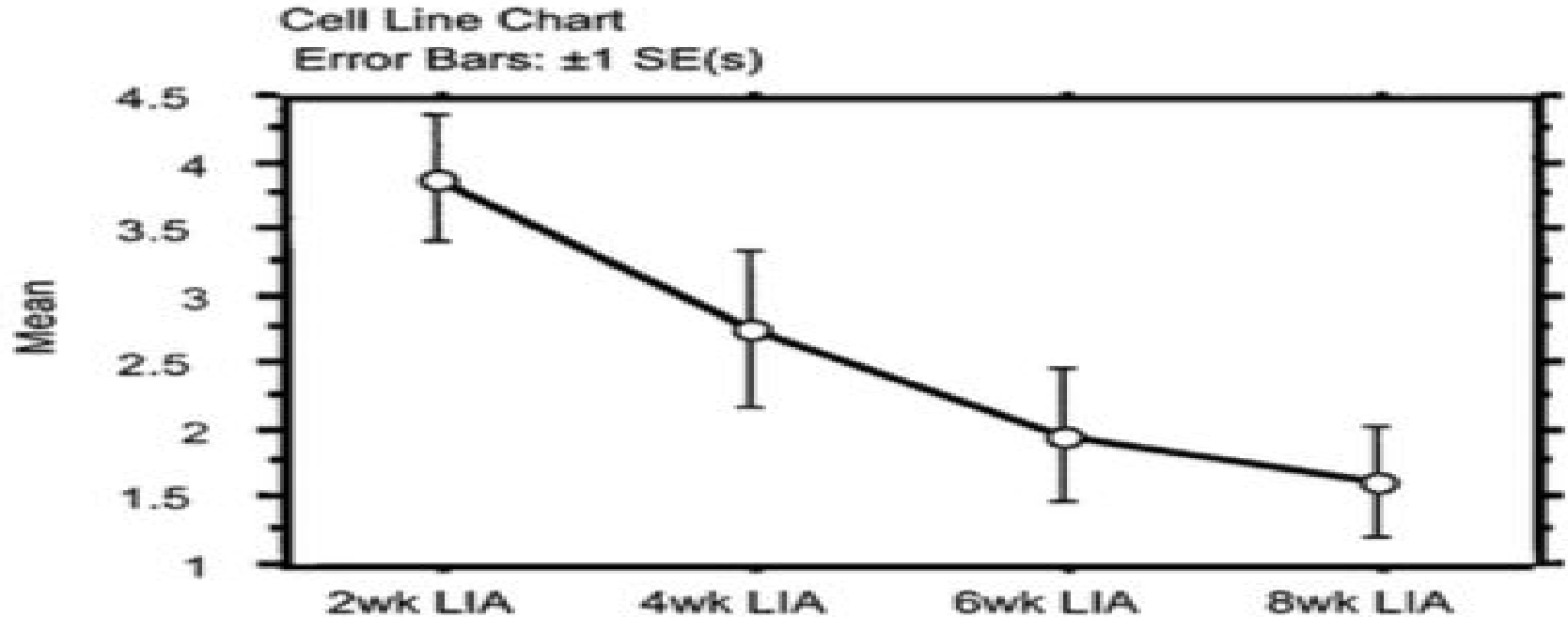
# Inclusion Criteria

- At least 16 y/o of age
- No history of DVT
- Injuries were severe enough to require inpatient rehabilitation after 48 hours
- Informed Consent obtained

# Results

- At 4, 6, 8 weeks D-Dimer Levels remained elevated, yet trended downward

# Decreasing Values



**Fig 2. Change over time of the LIA measurement for D-dimer over 2 to 8 weeks. LIA is represented in milligrams per liter.**



# 2009 Study by Chua and Kong

- 70%-80% of DVT are asymptomatic and found on autopsy
- Higher prevalence of Protein C and S deficiency in patients from Hong Kong and Taiwan
- Acute DVT in hospitalized patients is on the rise. 7.9 per 10,000 admissions in 1990 to 15.1 per 10,000 admissions in 2002.

# 2009 Study by Chua and Kong

- 56 Patients older than 15 years of age
- Admitted between November 2005-April 2007
- TBI diagnoses made by Admitting Neurosurgeon or ED based on history, admission GCS, and CT and/or MRI Scans
- Excluded if recurrent TBI or diagnosed with DVT or PE prior to transfer to rehabilitation

# 2009 Study by Chua and Kong

- D-Dimer obtained within 48 hours of Rehab Admission
- If D-Dimer elevated, U/S of weaker extremity was performed
- Bilateral Thigh length graduated-pressure compressive stockings for DVT prevention used during entire rehabilitation stay

# 2009 Study by Chua and Kong

- Average age 49.3
- Mean GCS- 9.9 (30%=13-15, 33%=9-12, 35%=3-8)
- Mean Post Traumatic Amnesia 51.3 days
- Mean Rehab Length of Stay 37.7 days

# 2009 Study by Chua and Kong

- 3 DVT's found when D-Dimer elevated
- Women, Non-Chinese, Lower Limb and Pelvic fractures, Lower FIM Walking scores- all had an increase risk of DVT but these did not reach statistical significance
- Found to be falsely elevated in patients with tracheostomy and those with greater dependency
- Limitations: small study, D-Dimer drawn only once

# Current Research I

- The previously studies helped to formulate the study I performed
- Previous studies showed that TBI patients are at an increased risk of developing DVT and that D-Dimers may correlate to the development of DVT
- Previous studies also indicated that D-Dimer levels generally decrease as time progresses from initial injury

# Objective

- Study investigated if it is reasonable to use the D-Dimer as a surveillance tool when deciding to order diagnostic lower extremity ultrasound for the detection of DVT in the TBI patient population
- Also, if it is reasonable, is there a specific rate of change in D-Dimer levels to indicate obtaining ultrasound

# Participants

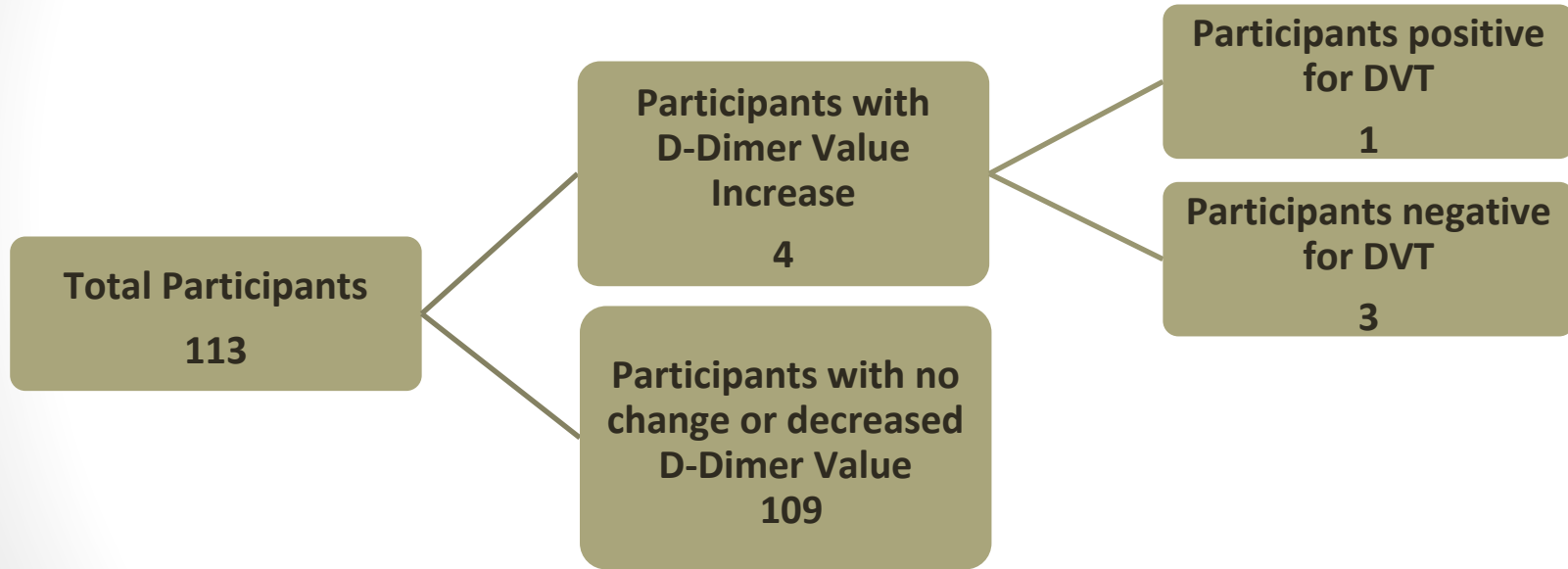
- 113 individuals enrolled in the TBI Model System Database at UAB Spain Rehabilitation
- Moderate to severe TBI (PTA>24 hours or LOC >30 minutes or GCS in ED<13 or intracranial neuroimaging abnormalities)
- Admitted to system's hospital emergency department within 72 hours of injury
- 19 years of age and older
- Received acute care and comprehensive inpatient rehabilitation within the model system hospital (UAB and Spain Rehabilitation Center)



# Design

- Retrospective Chart Review
- Enrolled between 2012-2014
- Ultrasound of lower extremities were obtained prior to admission to Spain Rehab in patients not already receiving anticoagulation
- D-Dimer values collected on admission and weekly
- Ultrasound obtained if D-Dimer values increased by no specific percentage

# Results



# Results

- D-Dimer values remained equal or decreased in 109 patients
- D-Dimer values increased in 4 patients
- 75% of the increased values were negative for DVT
- 25% of the increased values were positive for DVT
- 69 patients had ultrasound reports negative for DVT prior to admittance
- 12 patients were positive for DVT prior to admittance
- 32 patients did not have ultrasound prior to admittance

# Discussion

- Results suggest obtaining consecutive values are of minimal value in determining when to obtain ultrasound
- No deaths occurred from the DVT/PE found
- Data only limited to TBI Model System patients
- Future studies could examine functional status, anticoagulation status, presence of DVT, patients with brain tumor resection as these patients are hypercoagulable

# Discussion

- Returns to the question; Anticoagulate vs IVC Filter Placement vs Leg Compression Devices
- D-Dimer may be a marker of inflammatory processes involving neuronal cell death after TBI and not just marker of possible DVT
- Below Knee vs Proximal and ultrasound

# Current Research II

- Prior studies did not differentiate between proximal and distal DVT (below and above the knee)
- Proximal DVT more likely to migrate to heart and lungs
- Distal DVT less likely to migrate to heart and lungs
- Therefore, the location of DVT helps to inform treatment

# Objective

- Is it common for distal DVT to migrate to a proximal location?
- Are there any specific factors that might affect a migration of DVT from distal to proximal positions?

# Participants

- 140 TBI patients hospitalized at JFK Johnson Rehab Institute Brain Trauma Unit in the years 2013, 2014, 2015



# Design

- Exploratory Study
- Retrospective Chart Review
- Accounting of Medical Codes of Comorbidity and indexing them with presence and location of DVT

# Results

- 15 with Distal DVT
- 4 with Proximal DVT
- 3 with both Distal and Proximal DVT (migration)
- Hemiplegia: 1 patient with migration
- Abnormality of Gait: 2 patients with migration
- Dysphagia: 2 patients with migration
- No Pulmonary Embolus: 3 patients with migration
- Male: 2 patients with migration
- Female: 1 patient with migration

# Results

## Motor FIM Score

Mean Admission for migration: 27

Mean Discharge for migration: 68

Mean Admission with no DVT: 27

Mean Discharge with no DVT: 54

Remember only 3 with migration vs 118 with no DVT.

# Discussion

- Low Yield on patient's with migration of distal to proximal to establish results of true significance
- Need larger enrollment numbers
- Excludes oncologic patients
- Future Study could include correlating D-Dimer Values to DVT that migrates

# DVT Prophylaxis

After TBI timing is controversial

Studies:

Subcutaneous Heparin can be begun within 12 hours

LMWH (Lovenox) can be begun as soon as 36 hours after intracranial or spinal trauma.

Discuss with referral service

# DVT Prophylaxis

ASA, low-dose Coumadin, and non-thigh high sequential compression devices (SCD) reduce risk, but not to an optimal level and therefore should not be used as primary prophylaxis.

# DVT Prophylaxis

- IVC or SVC filters are not appropriate DVT prophylaxis for any patient.
- One-third of patients with DVT will develop post-Phlebotic Syndrome.
- DVT prophylaxis should continue until:
  - Patient is ambulating to/from restroom prn
  - Appropriate time has passed (SCI 8-12 weeks, hip/femur fx 4 weeks)
  - Coma: 12 weeks

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# THANK YOU

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# QUESTIONS?