

The Prevention Of Fatal Pulmonary Emboli The Missing Link



Global Thrombosis Forum Fourth Rajan Memorial Symposium 1-14-2024

Joseph A. Caprini, MD, MS, FACS, RVT, DFSVS

Emeritus, Endeavor Health, Evanston, IL

Disclosures

Sanofi - Honoraria
Recovery Force-Consultant
Arjo, Inc. Honoraria
Janssen – Honoraria
Aspen Healthcare - Honoraria

I do not anticipate discussing the unapproved/investigative use of a commercial product/device during this presentation

Fatal PE Is The Leading Cause Of Death Postoperatively



PE
J Am H

WHY

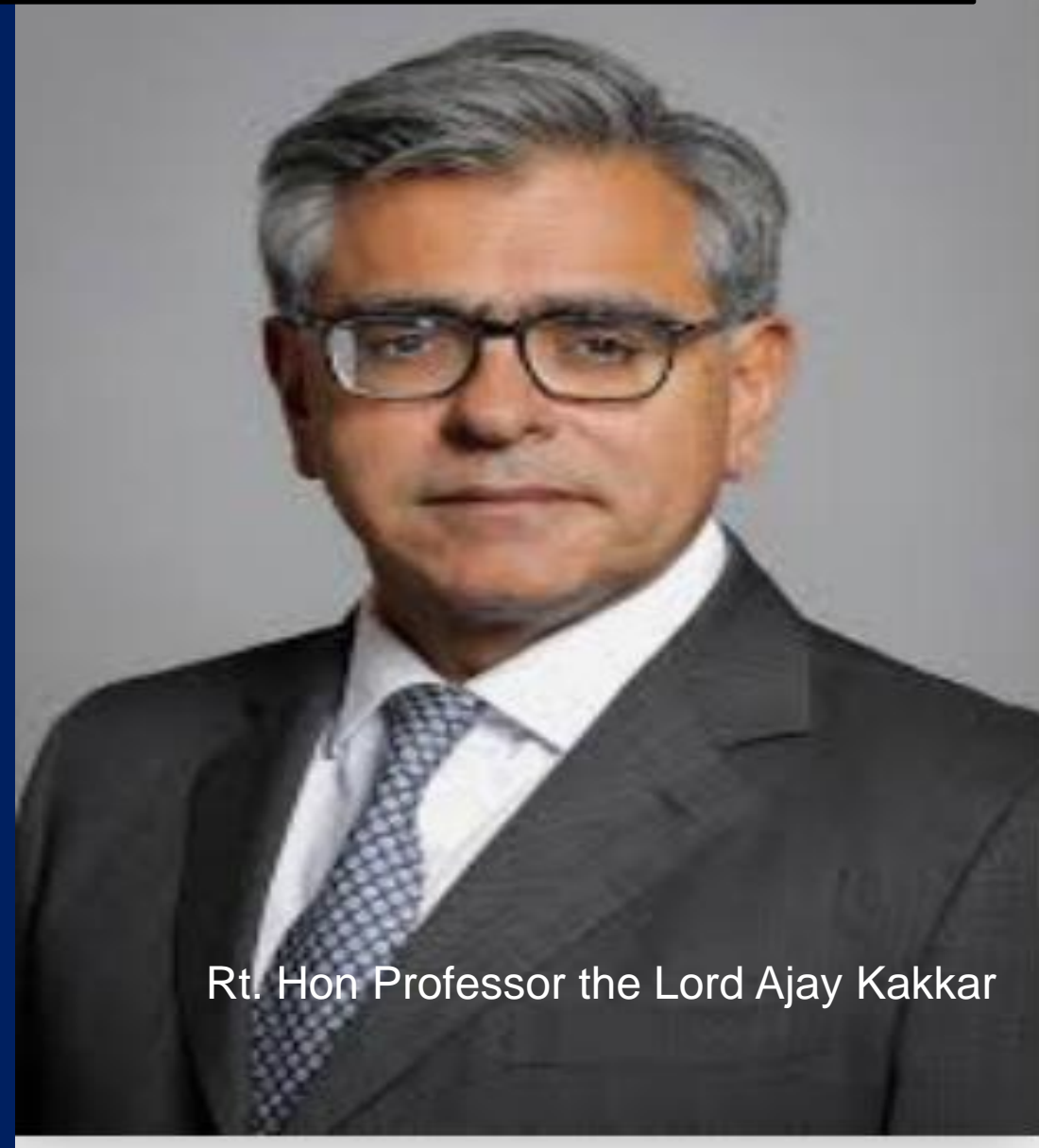
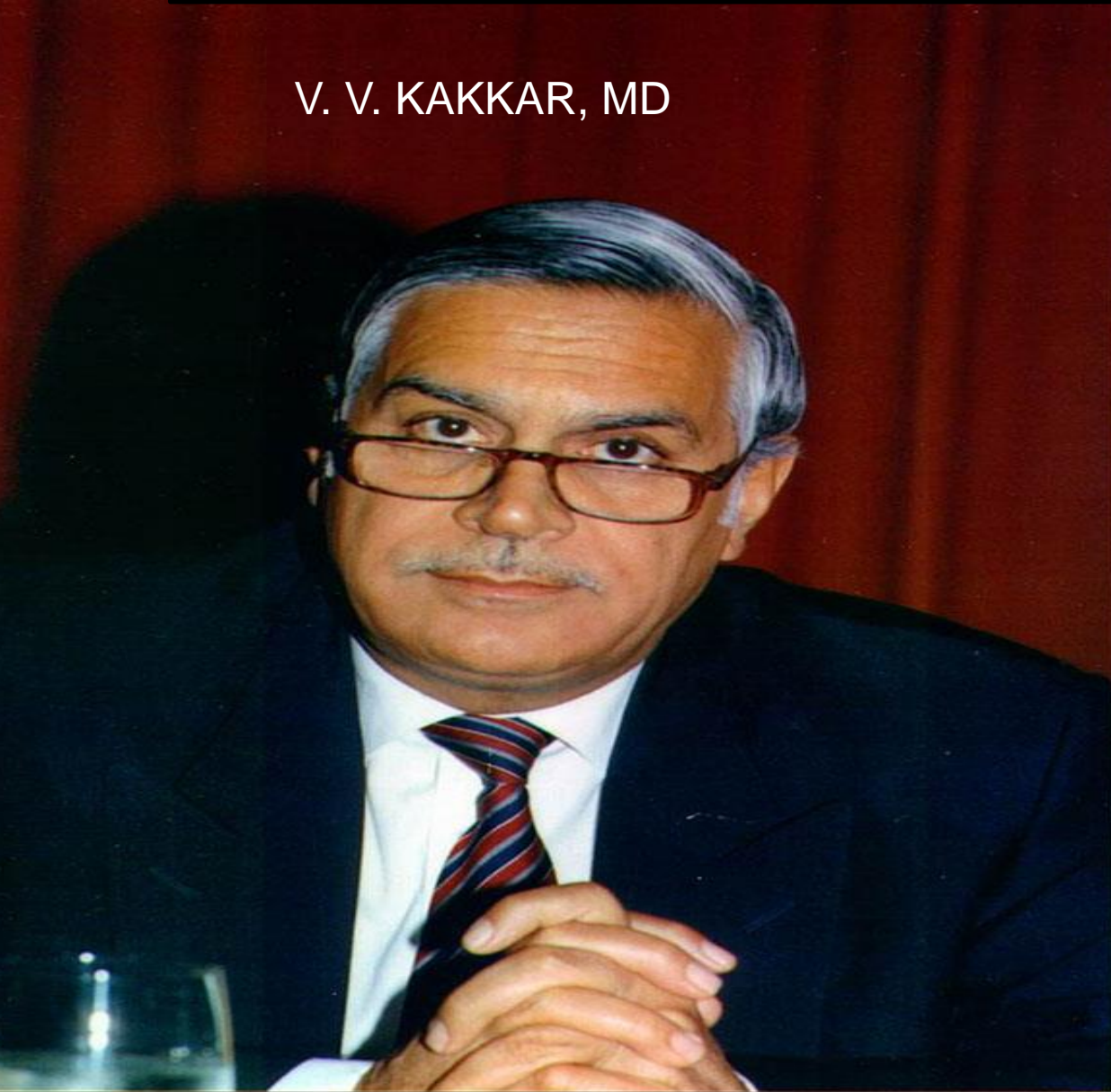
784

1.

**We Have Enough Data
And The Algorithm To
Prevent The Majority Of
These Deaths**

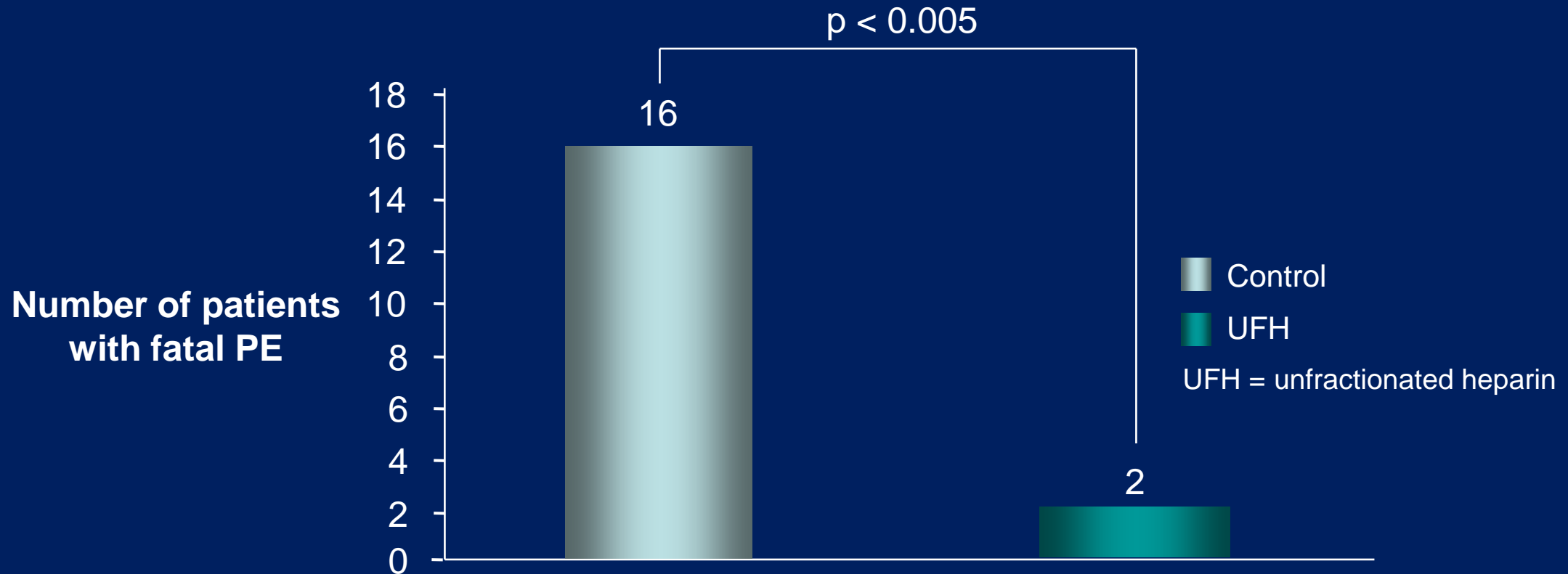
Thrombosis Giants That Shaped The World Of Surgical Prophylaxis For The Past 50 Years

V. V. KAKKAR, MD



Rt. Hon Professor the Lord Ajay Kakkar

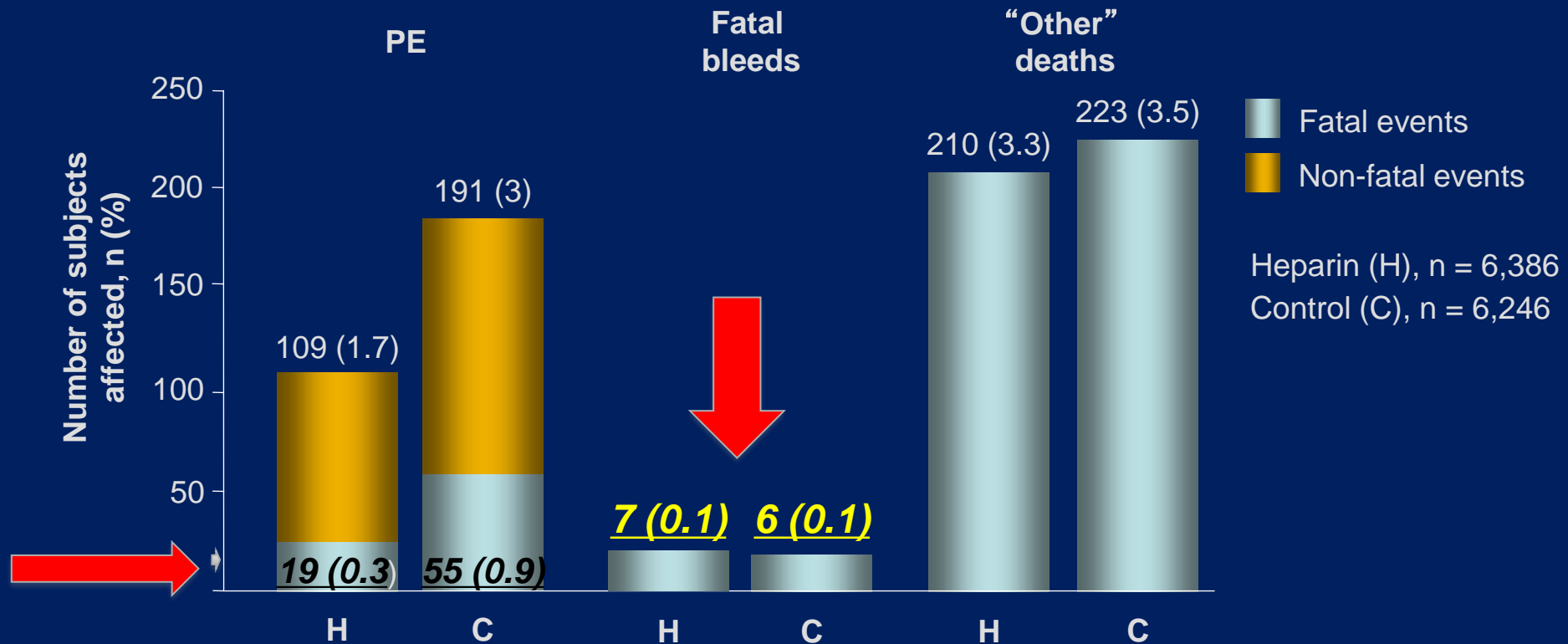
Prophylaxis Against Fatal PE with Low-dose UFH



Low-dose UFH saves 7 lives for every 1,000 operated patients.

Death From PE But Not Death From Bleeding

Evenly randomized trials of perioperative s.c. heparin in general, orthopaedic, and urological surgery



Fatal Pulmonary Embolism In Surgical Patients

- Randomized double-blind comparison of LMWH with UFH, involving 23,078 surgical patients

Outcome	LMWH (N = 11,542) N (%)	UFH (N = 11,536) N (%)	p
PE (at autopsy)	22 (0.191)	22 (0.191)	
Fatal	17 (0.147)	18 (0.156)	0.87
Non-fatal	5 (0.043)	4 (0.035)	1

Anticoagulant prophylaxis reduces the risk of death to 0.15%

No deaths from anticoagulant bleeding

occurred in this large series

Length of Anticoagulant Prophylaxis

- From 1975 to 2005
- 43,000 patients (160 centers)
- Objective diagnostic endpoints
- Anticoagulant prophylaxis for one week established efficacy

Kakkar VV, et al. Lancet. 1975;2:45-51

Collins R, et al. N Engl J Med. 1988;318:1162-73

Haas S, et al. Thromb Haemost. 2005;94:814-9

2.

**We Have A Robust And
Validated Risk
Assessment Tool**

Individual Risk Assessment Vital to Provide Optimal Thrombosis Prophylaxis

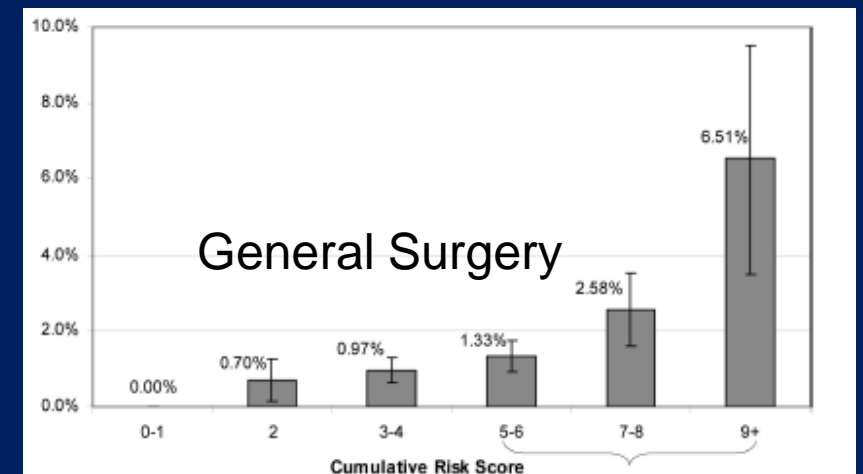
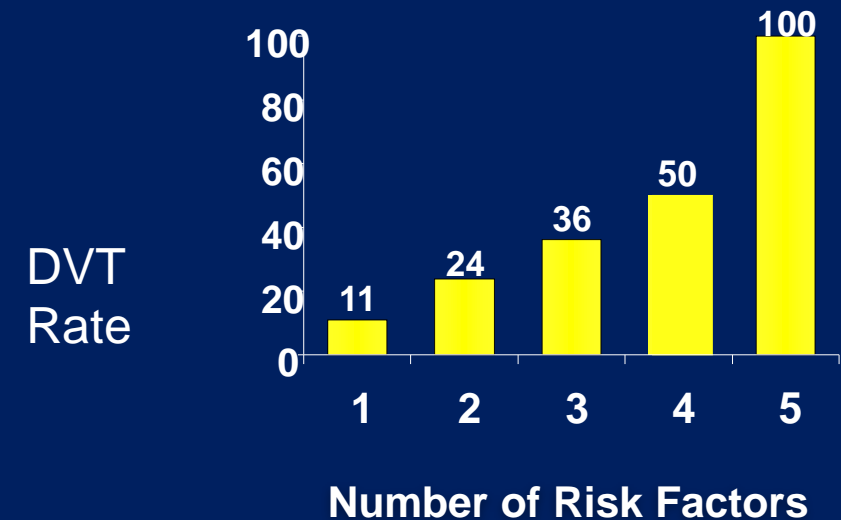
Treating everyone with the same anticoagulant strategy does not make sense



The risk of thrombosis varies widely between individuals

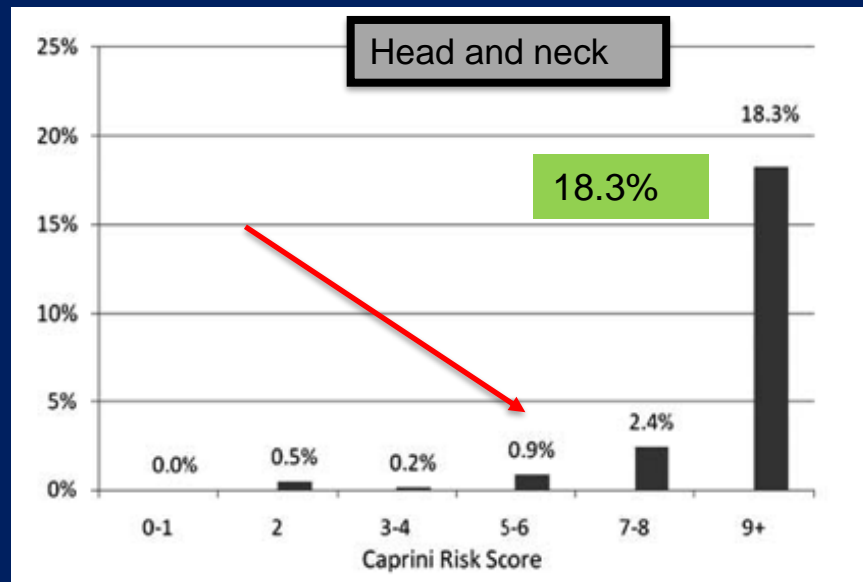
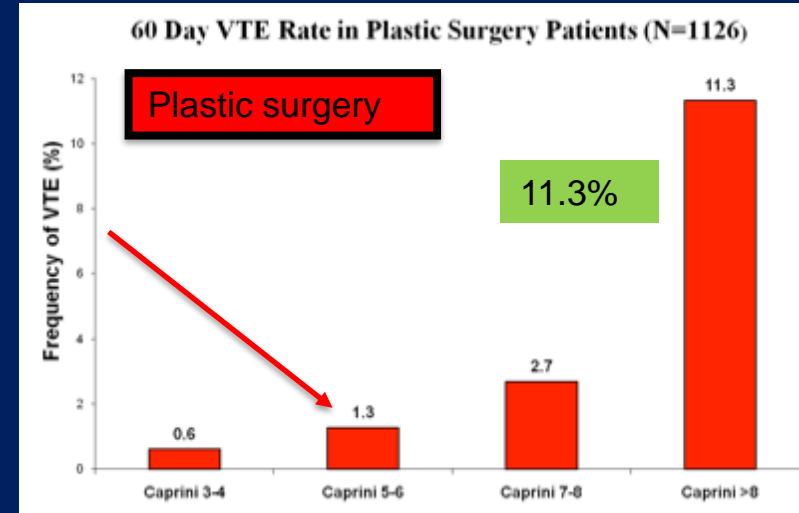
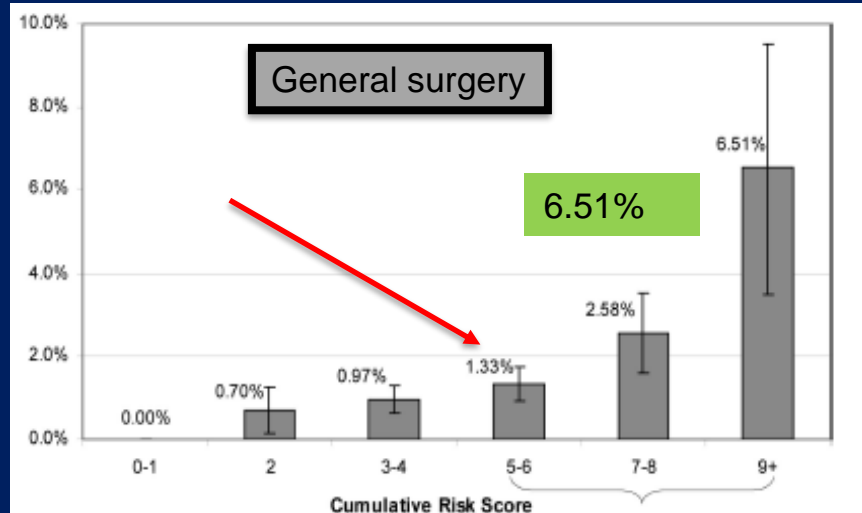
Caprini Score

1. Thorough history and physical (40 elements)
2. Power of each risk factor graded regarding VTE incidence
3. Combination of number of risk factors and their relative weights results in a score
4. Non-linear increase in clinical VTE rate with increasing score



Caprini Score Has Been Validated In About 5,000,000 Patients Including More Than 360 Publications Worldwide

High Risk 5+ 6% = VTE No Longer Valid



Vietnam 2,795,024 surgical patients



Set point for highest risk varies depending upon the population tested

Thrombosis Risk

Patient A

- Age 42 years = 1 point
- BMI 29 = 1 point
- Birth control pills = 1 point

Caprini Score 3 Moderate Risk

Patient B

- Age 76 years = 3 points
- History of PE = 3 points
- Past cancer = 2 points

Caprini Score 8 High Risk

Although each patient has 3 risk factors, the combination of NUMBER of risk factors and their POWER result in a more accurate estimate of VTE risk compared to a simple list of risk factors alone.

Set Point For Highest Risk Is Specialty Specific Or Varies By Type Of Illness

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	≥15
Mixed population*	0.2%		0.4%	0.7%		1.4%		2.0%		3.3%						
Medical patients*	0.7%			0%		0.2%		0.4%		2.2%						
COVID-19 patients	0%			4.5%		7.4%		17.6%		28.0%						
Cancer	0%					6.2%				12.9%		40.5%				
Burns*	0.2%			0.7%		0.8%		3.7%		8.8%						
Trauma and orthopedics*	1.5%			5.3%		7.2%		14.6%		15.5%		47.1%				
Urology and gynecology*	0%			0.2%		0.4%										
Vascular surgery*	X	1.6%					5.6%			14.7%						
General surgery and mixed surgery	0%		0.7%		1.0%		1.6%			15.9%						
Head and neck surgery	x	0%	0.4%		0.1%		0.7%		2.6%		15.6%					
Thoracic surgery	0%					10.5%				38.6%						
Plastic surgery	0.4%			0%		1.4%		2.3%		5.6%						
Critically ill patients	3.5%			5.5%		6.1%		6.1%		6.9%						

The Thresholds Of Caprini Score Associated With Increased Risk Of Venous Thromboembolism Across Different Specialties: A Systematic Review

Lobastov K, Urbanek T, Stepanov E, Lal B.K, Marangoni J, Cronin M, Krauss ES, Dengler N, Segal A, Welch H,

Gianesini S, Chen X, Caprini J

Annals of Surgery Published Ahead of Print

DOI:10.1097/SLA.0000000000005843

The Correlation Between Caprini Score And VTE Incidence Was Reported In 68 Studies That Enrolled 4,207,895 Patients From Different Specialties (4562 References Screened)



Colors indicate VTE incidence:

YELLOW – ≥1.0% and <5.0%;

RED - ≥10% and <25%;

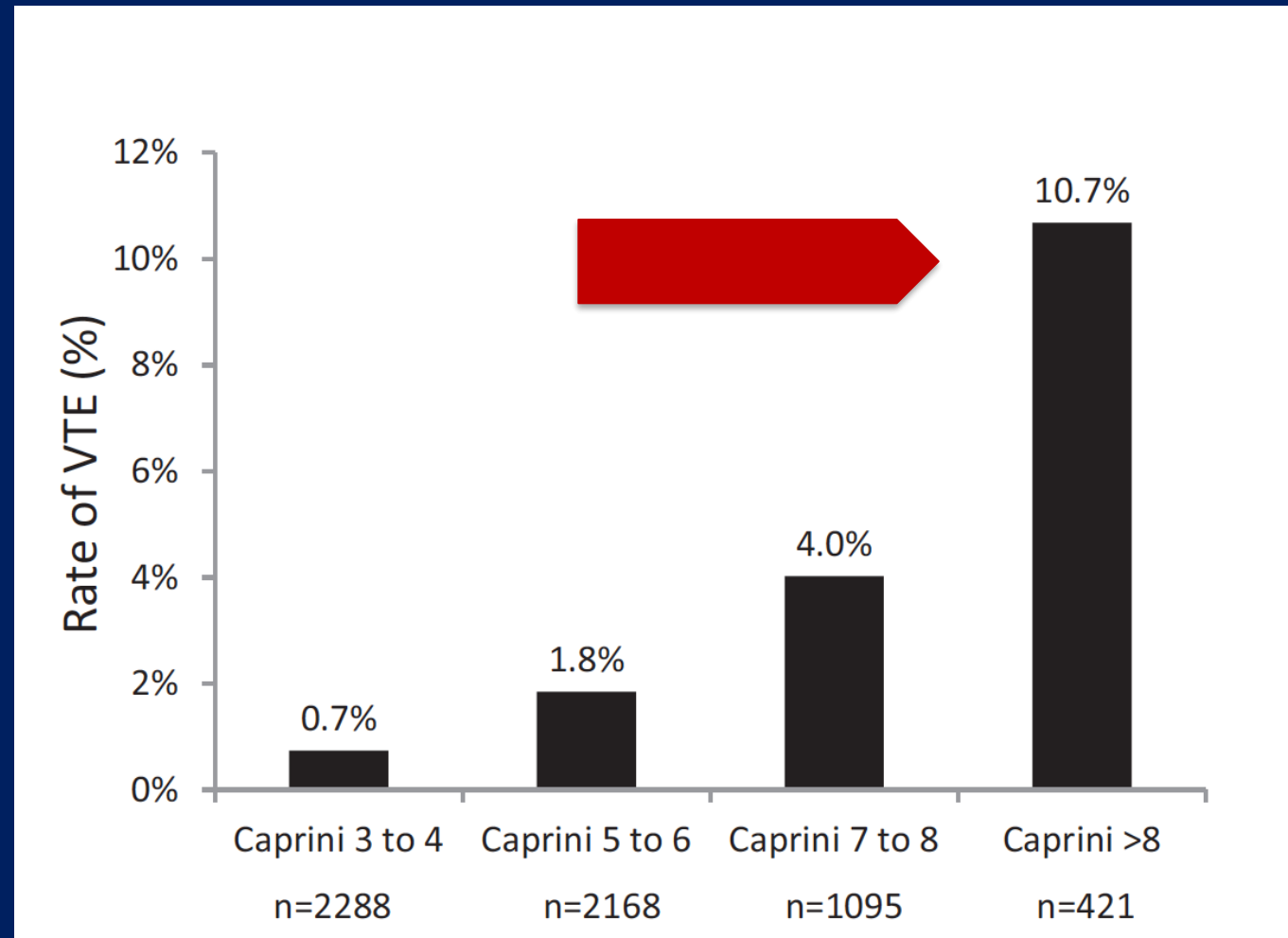
GREEN - <1.0%;

ORANGE - ≥5% and <10%;

DARK RED - ≥25%.

VTE Risk For Individual Patients Increases Dramatically At A Threshold Caprini Score Of 7-11

Caprini Scores in Patients Not Receiving Prophylaxis



Patient Friendly Risk Assessment Forms

- English
- Spanish
- Arabic
- Polish
- Thai
- Chinese
- Turkish
- Urdu South East Asia



The original Caprini Score Sheet is used in many countries and the number of translations is unknown

Are You at Risk for DVT?

Only your doctor can determine if you are at risk for Deep Vein Thrombosis (DVT), a blood clot that forms in one of the deep veins of your legs. A review of your personal history and current health may determine if you are at risk for developing this condition. Please take a moment to complete this form for yourself (or complete it for a loved one). Then be sure to talk with your doctor about your risk for DVT and what you can do to help protect against it.

1. Please select your **AGE** :

- 0 - 40 years old (0 points)
- 41 - 60 years old (1 point)
- 61 - 74 years old (2 points)
- Age 75 or older (3 points)

Score: _____

2. Add **1 POINT** for each statement that applies to you:

- Within the last month, I have had surgery under general or regional anesthesia that lasted for **MORE THAN 45 minutes**.
- Within the last month, I have had or currently have varicose veins. (**NOT spider veins**)
- Within the last month, I have had or currently have swollen legs.
- Within the last month, I have had a heart attack.
- Within the last month, I have had or currently have a serious infection and was hospitalized, for example pneumonia, cellulitis, etc.
- I have a history of inflammatory bowel disease (includes Crohn's or ulcerative colitis).
- I have or have had congestive heart failure.
- I have a chronic lung disease (for example COPD, emphysema) **NOT** including asthma.

Score: _____

3. For **WOMEN ONLY**, add **1 POINT** for each statement that applies to you:

- I currently use birth control (oral contraceptive pills, skin implantable devices, hormonal patches, IUD with hormones, depo shot) or hormone replacement therapy. Not including condoms or barrier devices.
- I am pregnant or had a baby within the last month.
- I have a history of an unexplained stillborn infant, **THREE (3)** or more spontaneous abortions, preterm, preeclampsia, or baby born smaller than appropriate (low weight at birth).

Score: _____



4. Add **2 POINTS** for each statement that applies to you:

- My doctor told me I have cancer, leukemia, lymphoma, or melanoma.
- In the last month I have had a non-removable plaster cast or mold that has kept me from bending and/or walking normally on this leg.
- In the last month, I have had or currently have a PICC line, Port, or central venous access catheter in my neck or chest that delivers blood or medicine directly into my heart.

Score: _____

5. Add **3 POINTS** for each statement that applies to you:

- I have had a blood clot in my legs, arms, abdomen, or lungs.
- Has anyone in the family (parents, grandparents, aunts, uncles, siblings, cousins) suffered from a blood clot?
- Have you or any blood relative ever been told that you have an abnormal blood test indicating an increased risk of blood clotting?



DOH VTE risk assessment tool (NHS) UK

6. Please select points for each statement that applies to you

- I have been in bed for **LESS** than **THREE (3) DAYS** associated with sustained walking of fewer than 30 feet. (1 point)
- I have been in bed for **THREE (3) or MORE DAYS** associated with sustained walking of fewer than 30 feet. (2 points)

Score: _____

7. Add **5 POINTS** for each statement that applies to you:

- Within the past month, I have had a hip or knee joint replacement surgery (including revision surgery).
- Within the past month, I have had a broken hip, pelvis, or leg.
- Within the past month, I have had a serious trauma (for example, broken bones due to fall or car accident).
- Within the past month, I have had a stroke (clot or bleed in the brain, transient ischemic attack).
- Within the past month, I have had a spinal surgery (including laminectomy or discectomy).

Score: _____

8. If you have a **SCHEDULED SURGERY** coming up, please select an option.

- I have a scheduled surgery under general or regional anesthesia for **LESS THAN 45 minutes**. (1 point)
- I have a scheduled surgery under general or regional anesthesia for **MORE THAN 45 minutes**, including laparoscopic or arthroscopic. (2 points)
- I have a scheduled total joint replacement - already included in the score of 5)

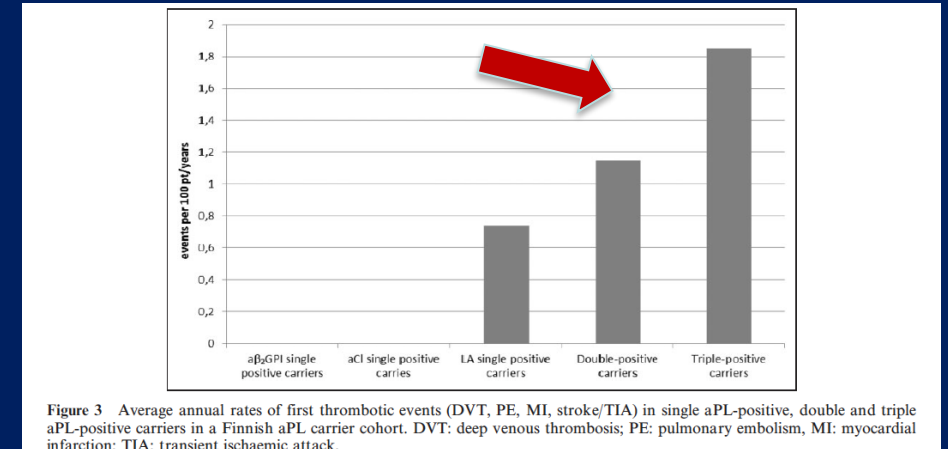
Score: _____

(over)

Estimated That 940 Deaths Prevented During A Two-year Period

Obstetrical History As A Marker For Thrombotic Events

- Recurrent unplanned abortions
- Stillbirths
- Premature birth with toxemia
- Growth-restricted infant
- Patients with any of these historical events may be carriers of one or more of the following abnormalities
 - Lupus Anticoagulant (LA) positive, single anticardiolipin antibody positive (aCL), or anti-β2glycoprotein-I antibody positive (ab2GPI)



STRONG PREDICTOR OF A THROMBOTIC EVENT FOLLOWING SURGERY

Familial Risk of Venous Thromboembolism in Relatives*

- This study shows an increased VTE risk among not only first-degree relatives but also second- and third-degree relatives and non-biologic relatives
 - The genetic component of the familial clustering of VTE is strong
 - Family history is potentially useful for clinical VTE risk assessment, even in second- and third degree-relatives.

Relation to proband	No. of pairs	No. of concordant pairs (%)*	OR (95% CI)
First-degree relatives			
Sibling	83,491	3,046 (3.7)	2.49 (2.40–2.58)
Son/daughter	131,223	1,405 (1.1)	2.65 (2.50–2.80)
Parent	65,867	5,588 (8.5)	2.09 (2.03–2.15)
Second-degree relatives			
Maternal half-sibling	5,814	109 (1.6)	1.52 (1.26–1.85)
Paternal half-sibling	8,536	179 (2.1)	2.34 (2.00–2.73)
Niece/nephew	144,831	784 (0.5)	1.69 (1.57–1.82)
Third-degree relatives			
Cousin	64,228	359 (0.6)	1.47 (1.33–1.64)
Non biological relatives			
Spouse	61,302	2,613 (4.3)	1.14 (1.09–1.18)

*Number of pairs where both individuals were affected.

***(183,515 INDIVIDUALS)**

The Value Of Family History As A Risk Indicator For Venous Thrombosis

- Family history is a risk indicator for a first venous thrombosis, regardless of the other risk factors identified
- In clinical practice, family history may be more useful for risk assessment than thrombophilia testing

Caprini Score Descriptors

Bedrest Is A Well-known Risk Factor For Venous Thromboembolism

- Defined in the MEDANOX trial as those patients unable to walk at least 30 feet or more at one time
- The MEDANOX trial compared LMWH prophylaxis in hospitalized medical patients with a control group not receiving prophylaxis
 - The rate of VTE for non-ambulatory patients in the **control** group was **19.7%** compared to **10.6%** in those walking 30 feet*
 - The rate of VTE for non-ambulatory patients receiving **LMWH** 40 mg/day was **9.0%** compared to **3.3%** for those able to walk 30 feet.

Who Should Complete The Caprini Score

- Patients should be encouraged to complete the patient-friendly risk form
 - The person responsible for the history & physical (H&P) should check the form and finalize the initial score
 - This individual is responsible to document that all questions have been asked.
 - Scoring the patient by the floor nurse or in the preoperative area or even at the time of interview with the surgeon is not appropriate.

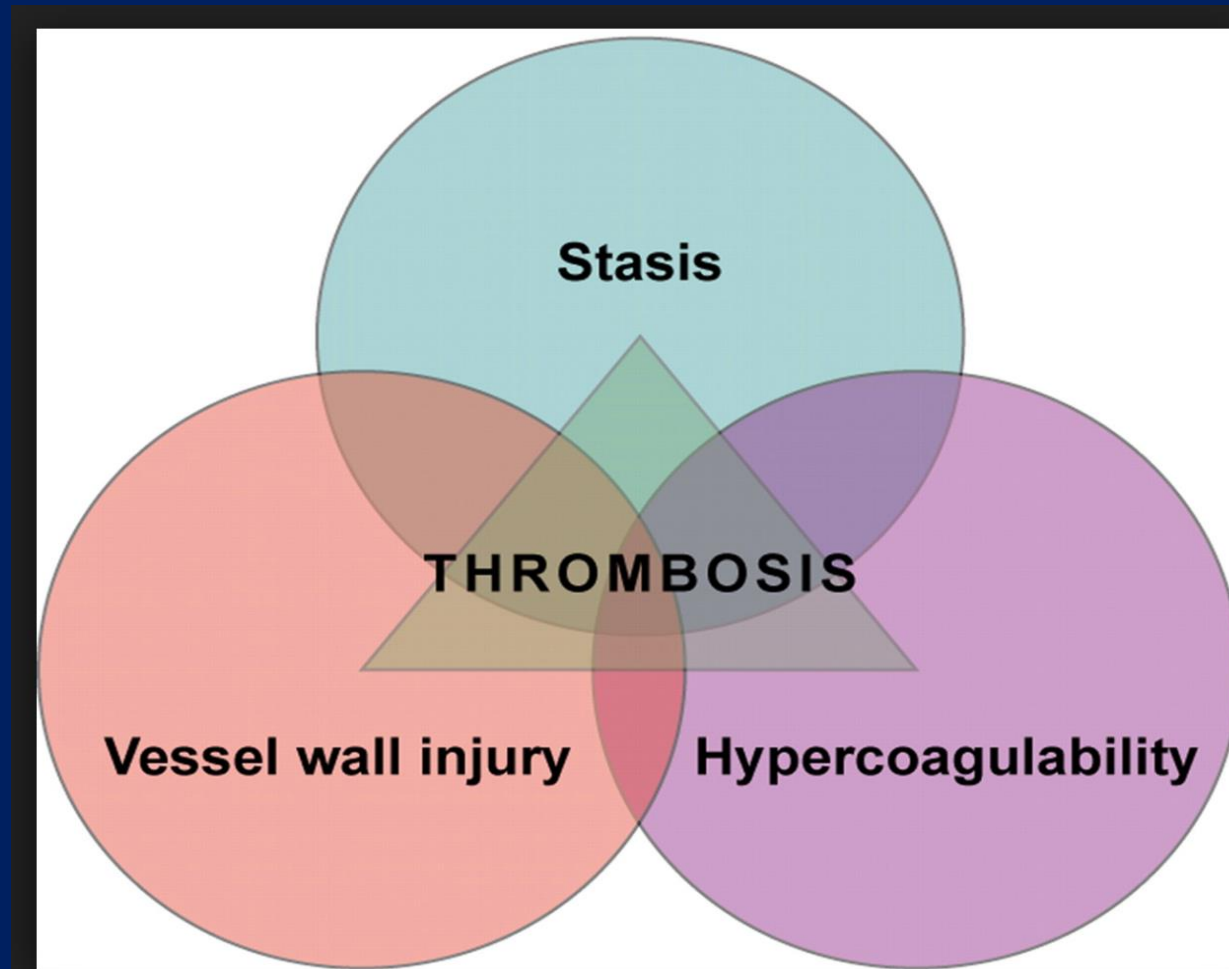
Hospital floor including ICU

Preoperative holding area

Interview with surgeon

The Operating Room

More Than 100 Years Ago The Famous Pathologist
Rudolf Virchow Described A Triad Of Factors Associated
With The Development Of Venous Thrombosis

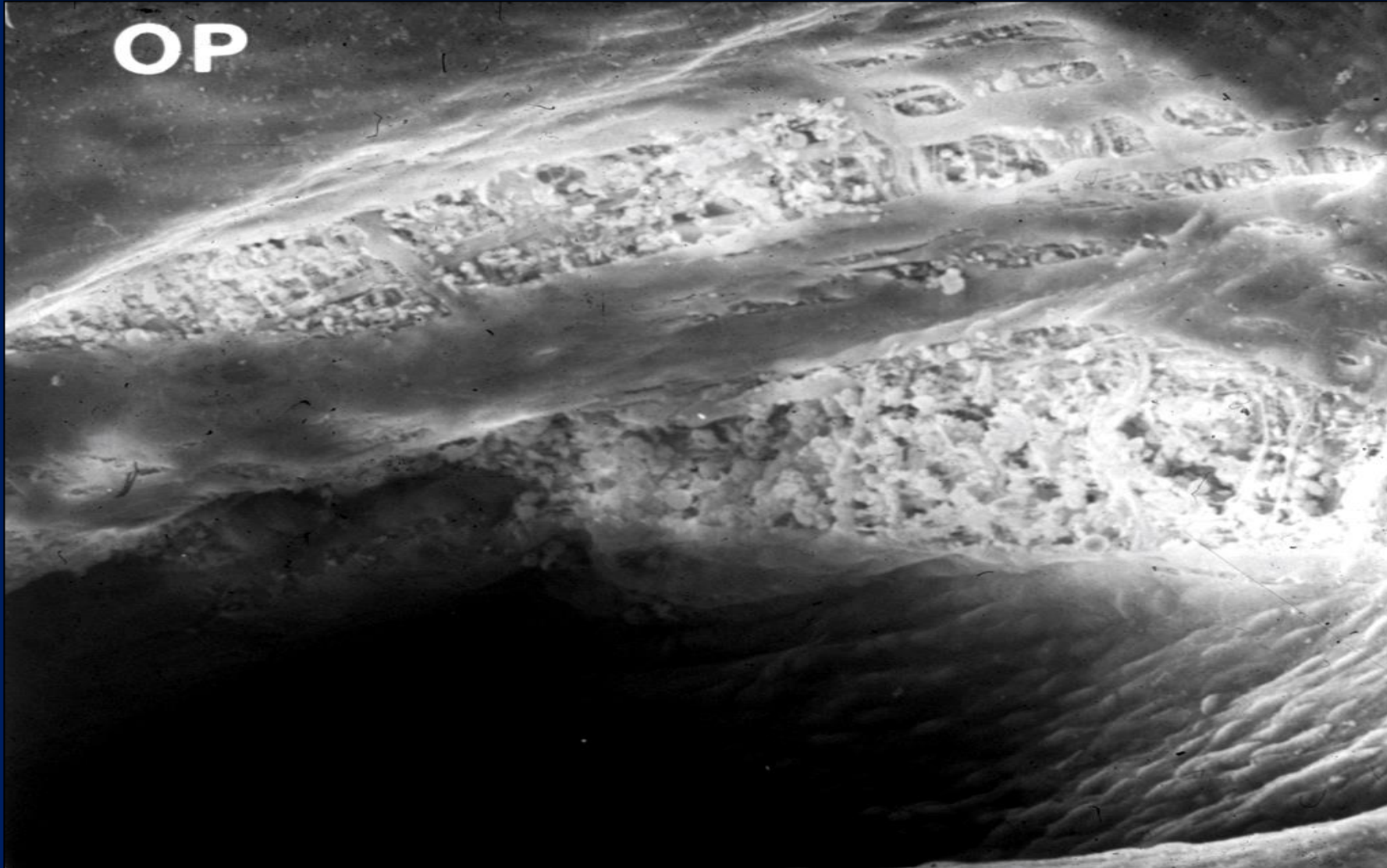


Definition Of Major Surgery As A Thrombosis Risk Factor

Effects Of Anesthesia Replicate Virchow's Triad

- Venous stasis due to calf muscle paralysis (1)
- Venous over-distension producing endothelial cracks (2)
- Hypercoagulability occurs secondary to surgical stress, retained metabolites, and underlying pathology (3)
- Time of anesthesia intensifies these effects
- IPC during surgery critical to minimize these changes

Endothelial Damage From Venous Distension Due To Slow Blood Flow



Blood flow
slows



Vein expands
overfilling
with blood

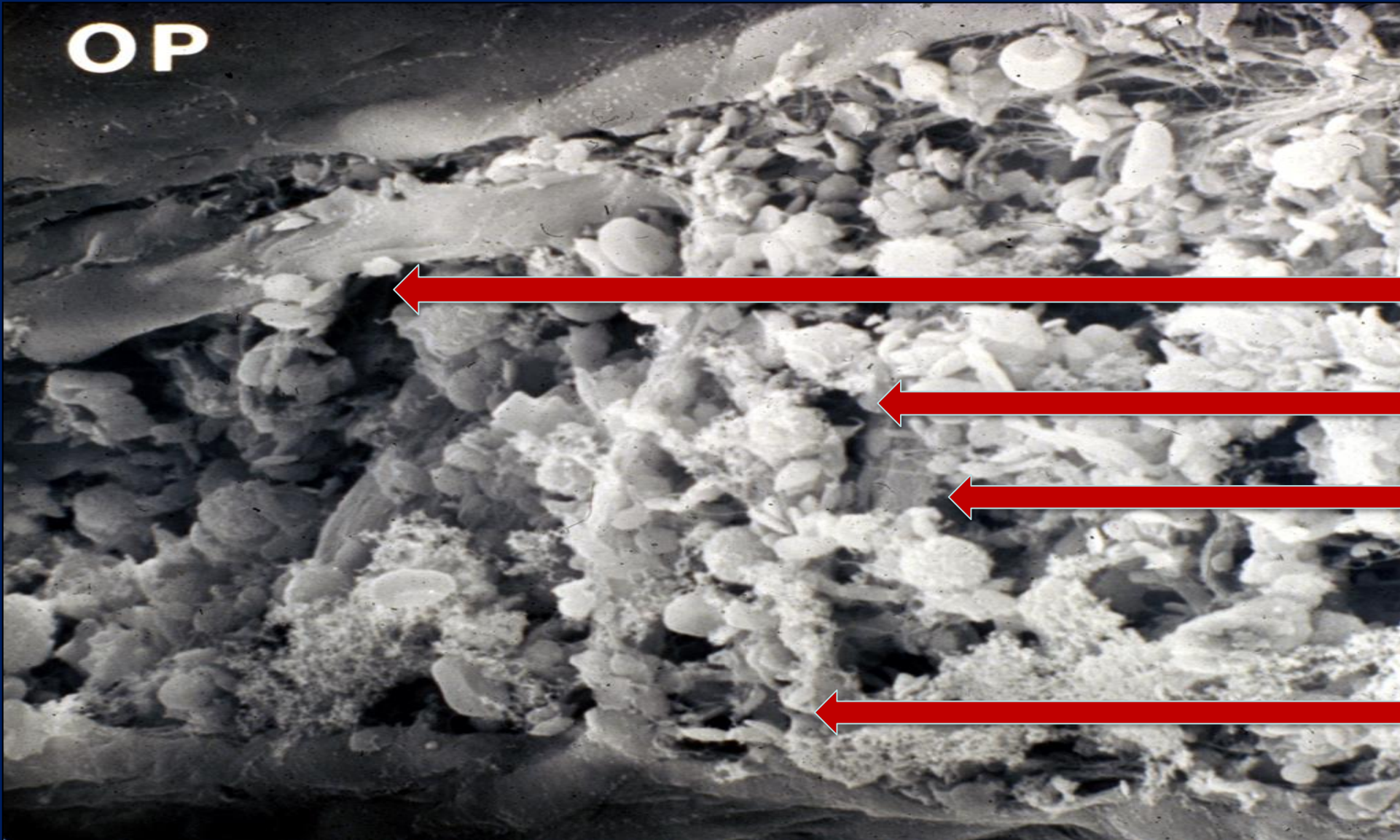


Endothelium
cracks as vein
expands
exposing
collagen



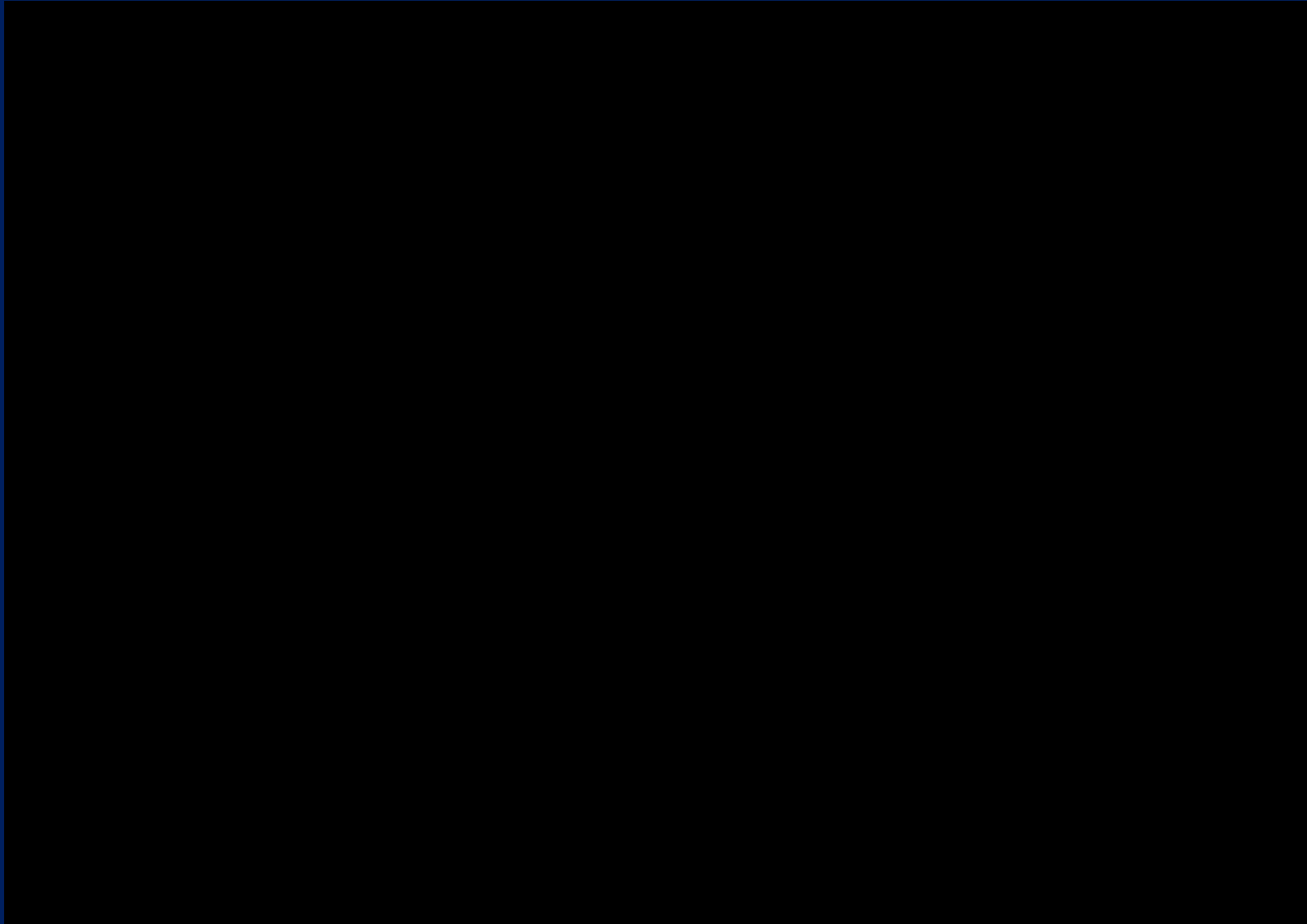
Clots form

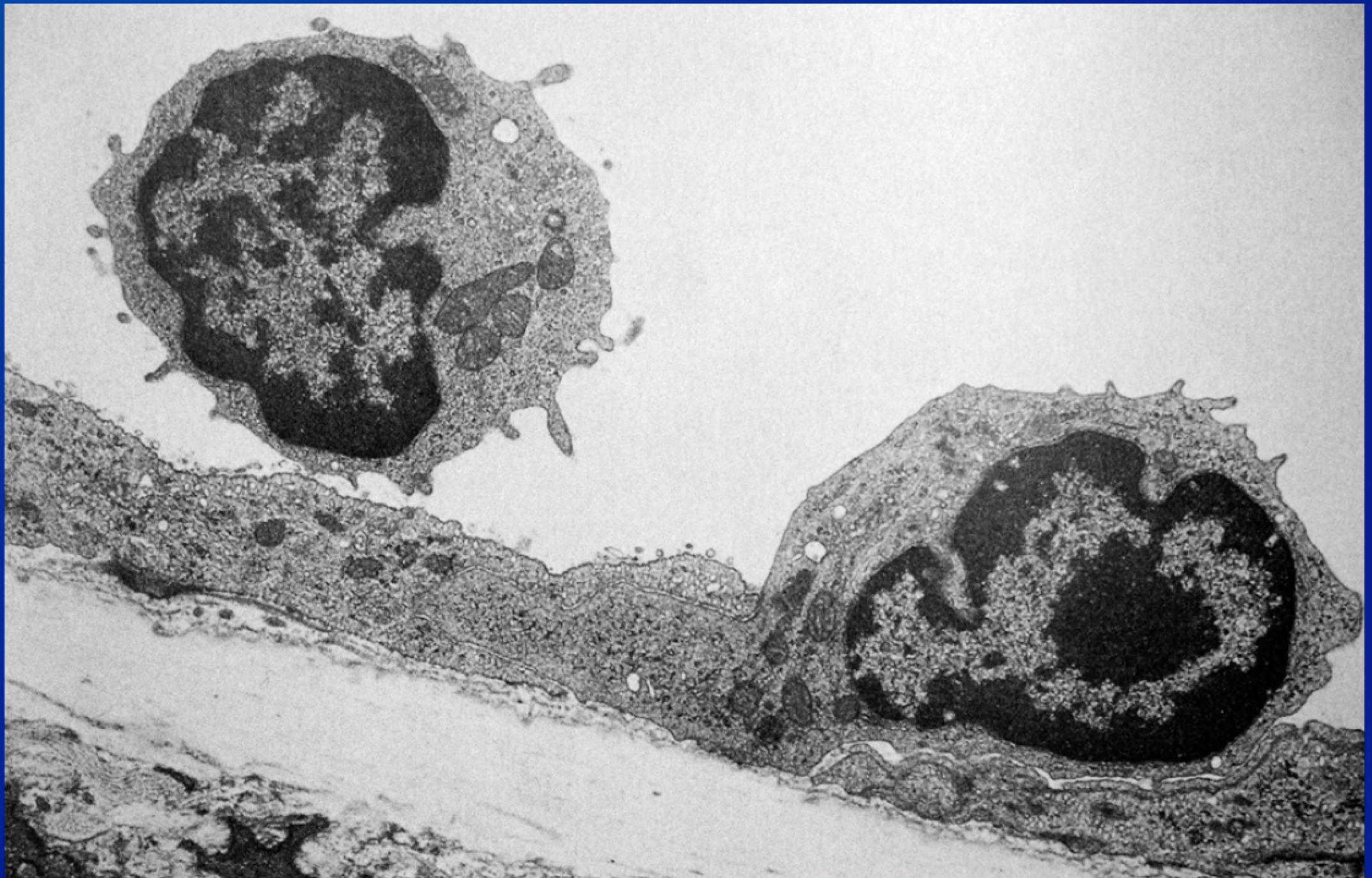
Endothelial Damage From Venous Distension Due To Slow Blood Flow



T
H
R
O
M
B
O
S
I
S

Muscle relaxant → Venous stasis → Endothelial Disruption





3.

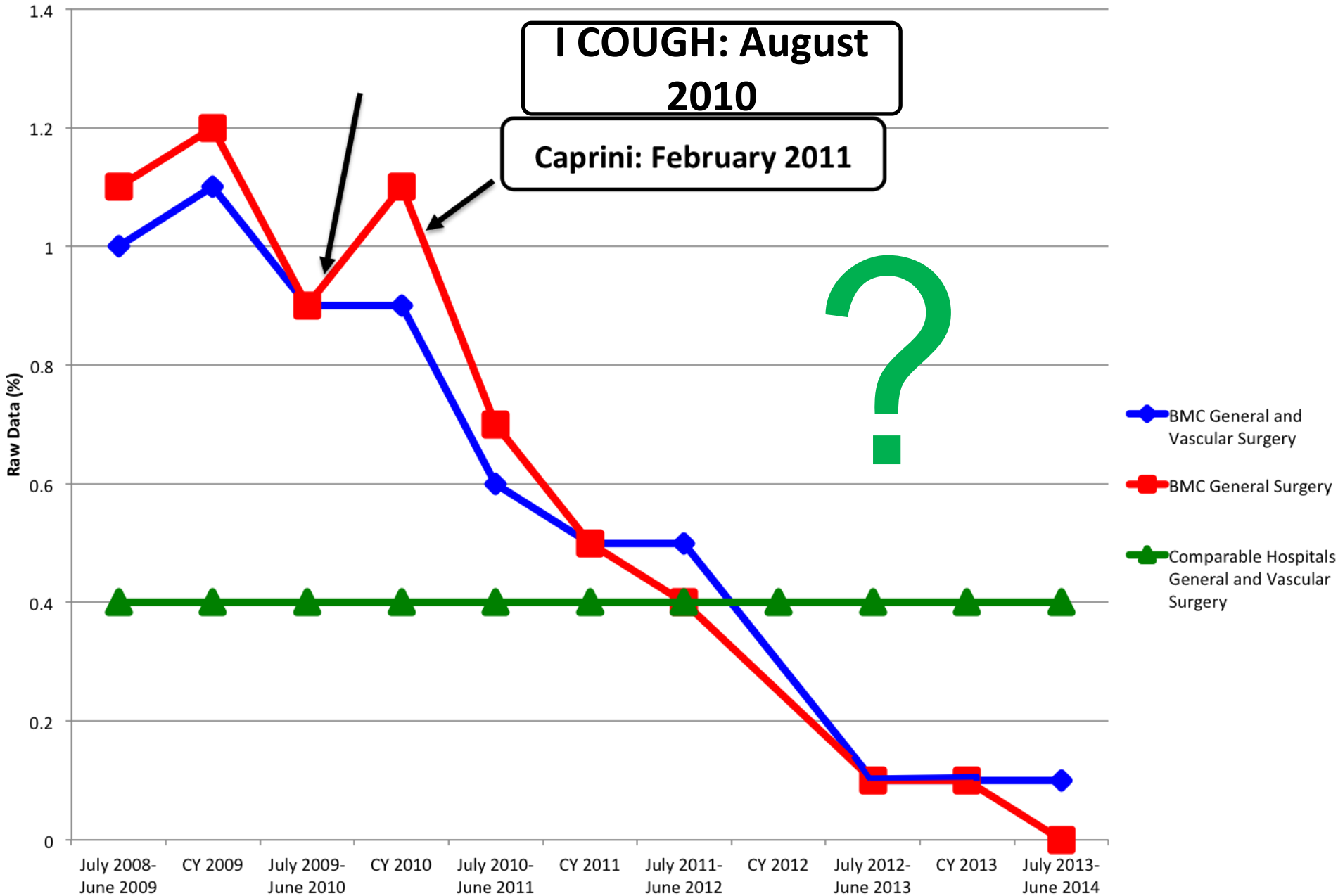
**Consistent And Mandatory
Compliance Of Evidence-
Based Pathways**



“There is a disconnect between evidence and execution as it relates to VTE prevention

Reducing VTE deaths requires mandatory implementation of appropriate care pathways

BMC General Surgery Pulmonary Embolism



Mandatory Algorithm

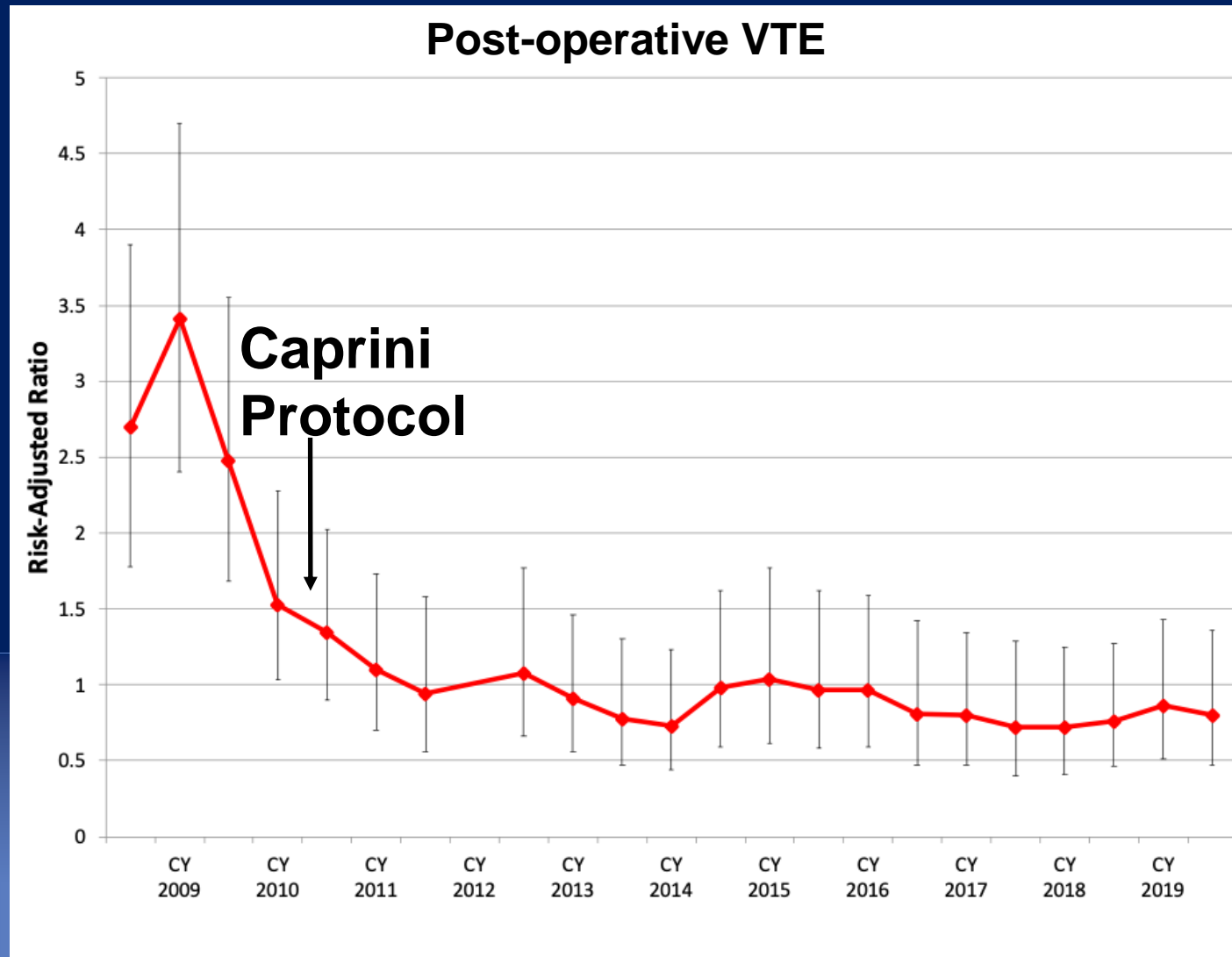
LMWH 7-10 days
Score 5-8
Compliance 89%

LMWH 30 days
Score 9+
Compliance 77%

LMWH supplied regardless of the ability of the patient to pay

POSTER CHILD FOR THE USA!

Decade Of Success Related To Physician Compliance To Partner With This Program



High scores justify anticoagulant prophylaxis which if omitted may result in fatal pulmonary emboli

For low scores the risk of bleeding outweighs the use of anticoagulant prophylaxis



Thrombosis

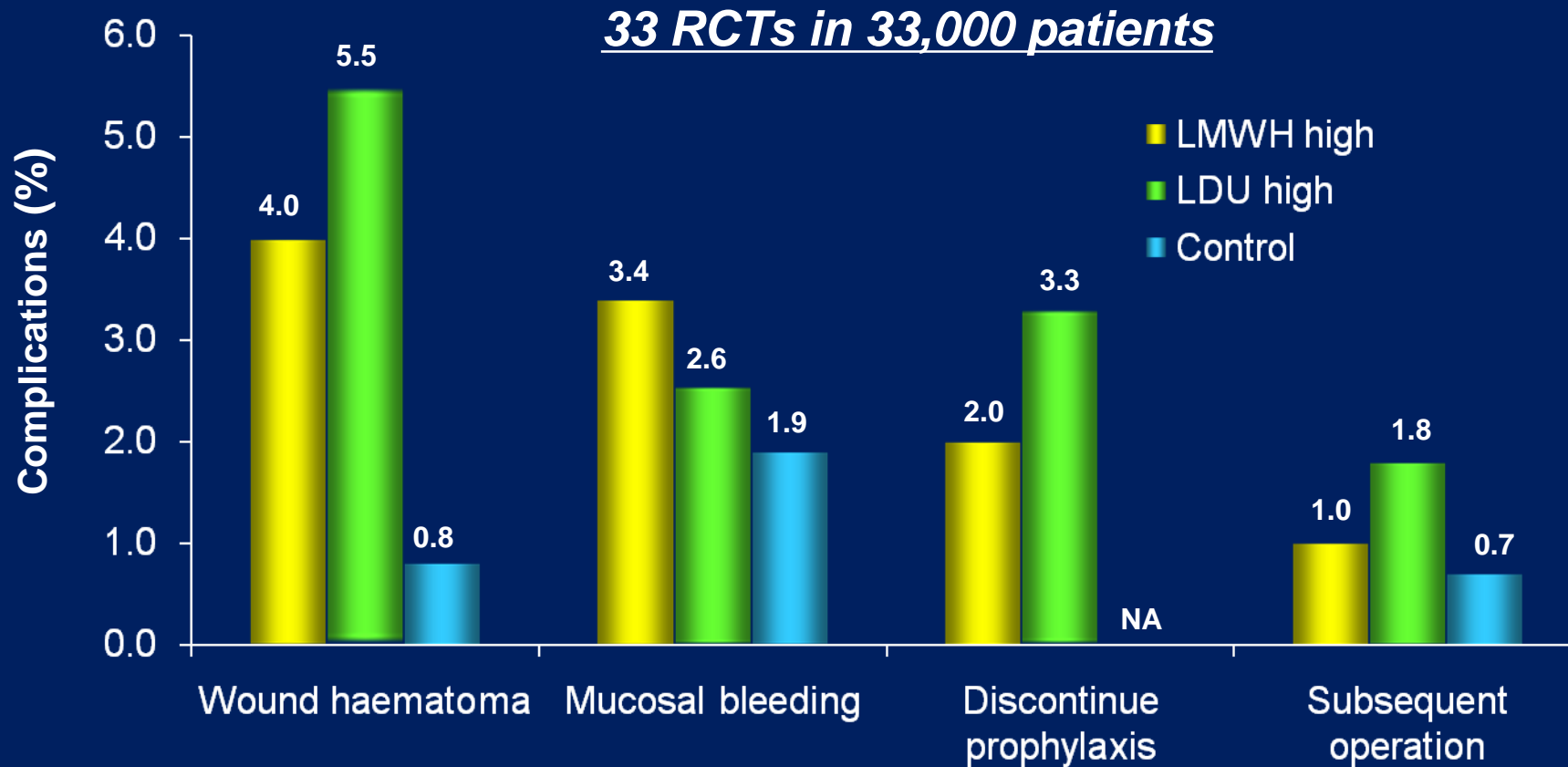
Bleeding



The Rate Of Bleeding Complications After Pharmacological DVT Prophylaxis

Leonardi MJ, et al. Arch Surg. 2006;141:790-9.

*** Bleeding incidence not trivial**



No Fatal Bleeding Events Were reported in This Series Of Patients

The Rate Of Bleeding Complications After Pharmacological DVT Prophylaxis

- Understand the relative vs. absolute contraindications for using anticoagulant prophylaxis
 - Start anticoagulation as soon as the bleeding risk decreases and continue therapy for an appropriate duration based on level of risk
 - Maximize IPC use starting in the operating room and continuing throughout the postoperative period
 - Employ vena cava filters only in extreme cases realizing the potential for thrombosis without Anticoagulant protection
 - Fatal bleeding events from anticoagulant prophylaxis are exceeding rare
 - Fatal PE events are a reality when omitted in the high-risk patient for fear of bleeding

CONCLUDING THOUGHTS

- The Caprini score set point for high and highest risk varies according to the population studied.
- Perform thrombosis risk assessment using the patient-friendly version assisted by your loved ones.
- The score is a **DYNAMIC** instrument and **MUST** be updated during hospitalization and at discharge.
- Extended prophylaxis following discharge imported for patients with high (9+) risk scores.
- Failure to track obstetrical complications and/or family history of thrombosis may result in a serious VTE event or fatal outcome.

Essential Elements To Reduce The Incidence Of Fatal Pulmonary Emboli

1. Utilizing robust data derived with hard endpoints collected over 4 decades
2. Performing a thorough individual risk assessment
3. Mandatory implementation of evidence-based algorithms with “opt-out” provisions to balance the risk of thrombosis vs. bleeding
4. Tracking 90-day outcomes and comparing the results to compliance with these algorithms
5. Sharing the results with physicians as a nudge to improve compliance



J. Caprini

"NEVER
KILL A FRIEND,

NEVER
TREAT A STRANGER"

Performing a
thorough
history and
physical gives
you
knowledge
about your
patient as if
they were a
good friend

Thank You For Your Attention



Know Your Caprini Risk Score for Blood Clots
& Save Your Life

Take Your Risk Assessment

Ask a Question

Dr. Caprini's Resource Center

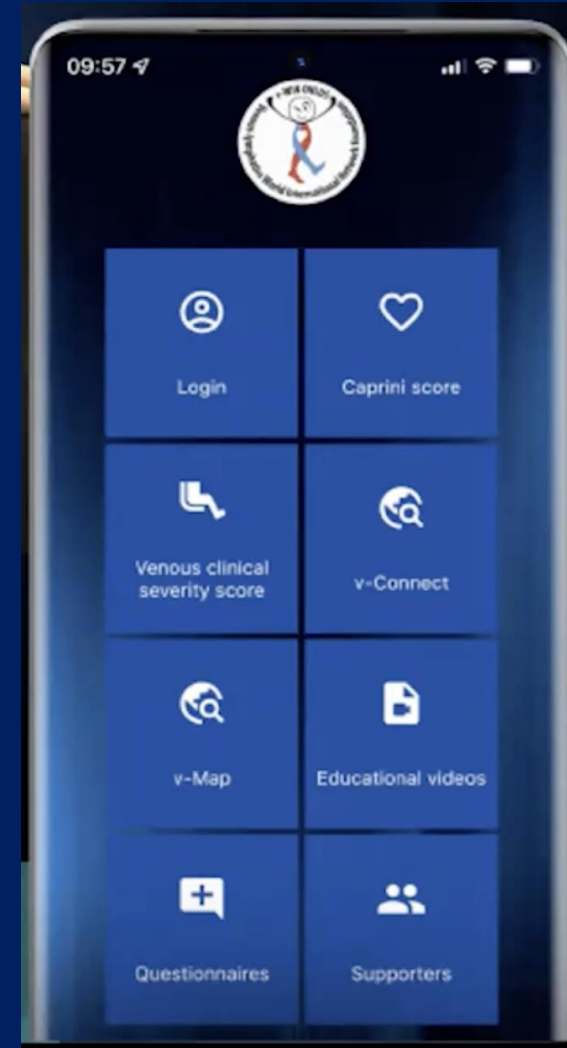
www.capriniriskscore.org

Youtube: Caprini venous resource center

Facebook: Joe Caprini

Twitter: @caprinijoseph

Instagram: venous resource center



V-WIN APP