

## Pathophysiology

Disruption of intramedullary canal from trauma and/or procedure



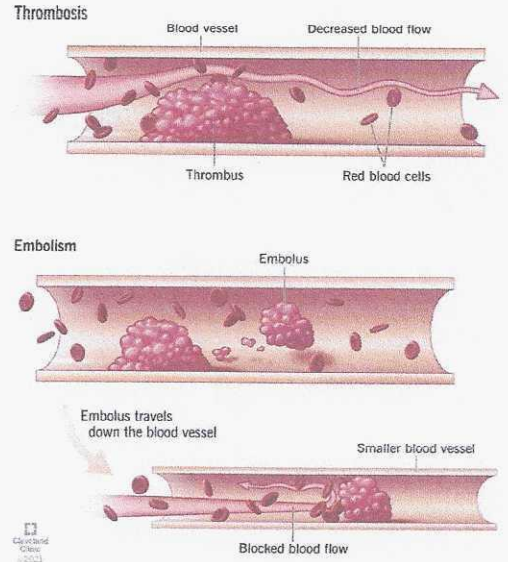
Intrusion of bone marrow fatty content into the venous sinusoid and systemic vascular tree



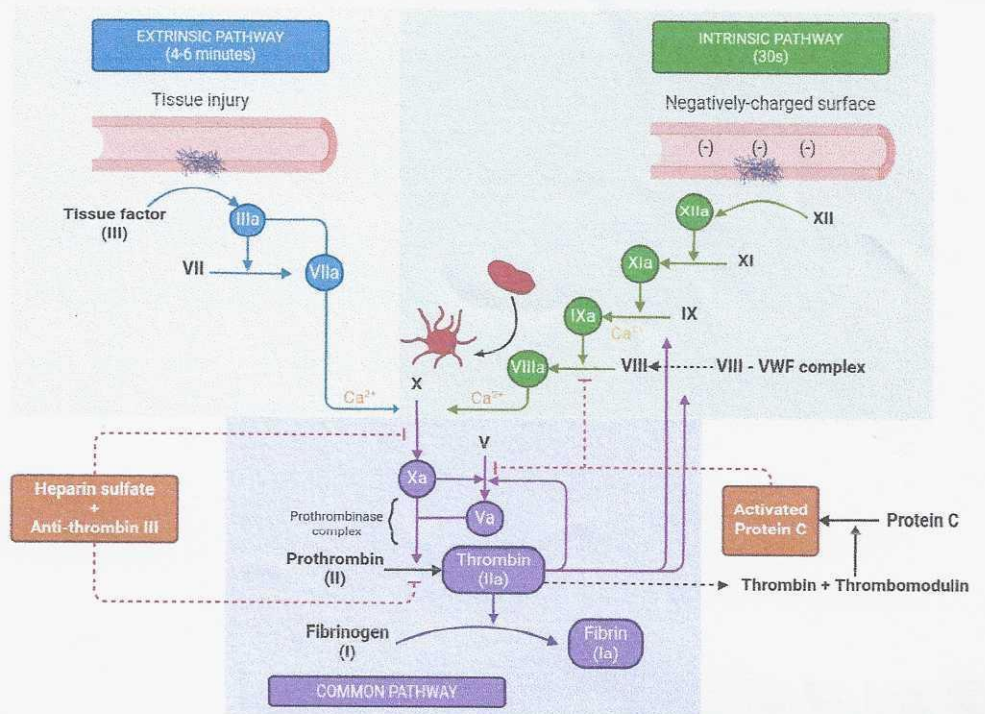
Potent activator of clotting cascade



Hypercoagulability and Clot formation



## Coagulation cascade



## Virchow's Triad

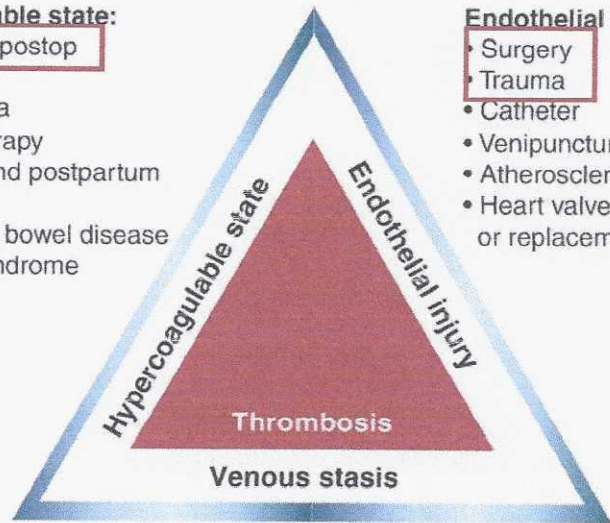


### Hypercoagulable state:

- Acute phase postop
- Cancer
- Thrombophilia
- Estrogen therapy
- Pregnancy and postpartum period
- Inflammatory bowel disease
- Nephrotic syndrome
- Sepsis

### Endothelial injury:

- Surgery
- Trauma
- Catheter
- Venipuncture
- Atherosclerosis
- Heart valve disease or replacement



### Venous stasis:

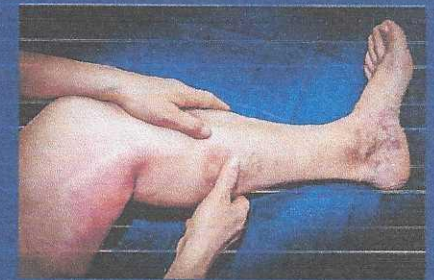
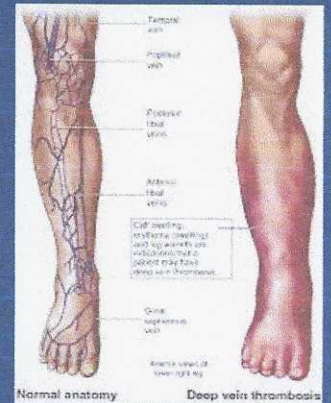
- Immobility or paralysis
- Heart failure, atrial fibrillation, left ventricular dysfunction
- Venous insufficiency or varicose veins
- Venous obstruction from tumor, obesity, or pregnancy

## Epidemiology & Risk factor

- Epidemiology
- Risk factor
  - Caprini score

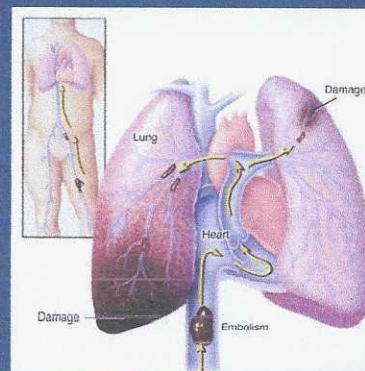
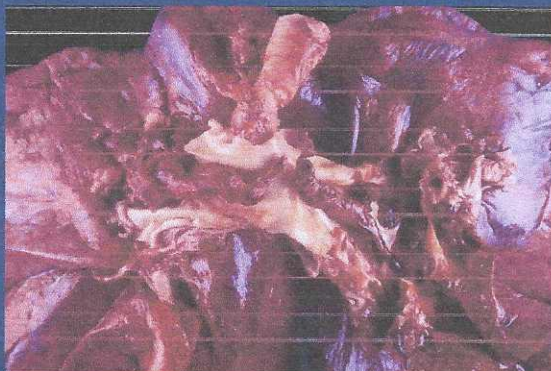
## Deep vein thrombosis (DVT)

- Common in vessels of pelvic, thigh, calf
- Peak prevalence of DVT between 4 – 17 days
- If occur, 80-90% occur in operative limbs
  - Found 10-15% in contralateral non-operative limb
- By venographic evidence, occur 84% of patients undergoing TKA without any thrombolism prophylaxis



## Pulmonary embolism (PE)

- Most common cause of death in arthroplasty patients
- Most common reasons for readmission unrelated to surgical sites
- Fatal PE occurs 0.1-0.5 % of the patients (more than 1,000 each year in USA)



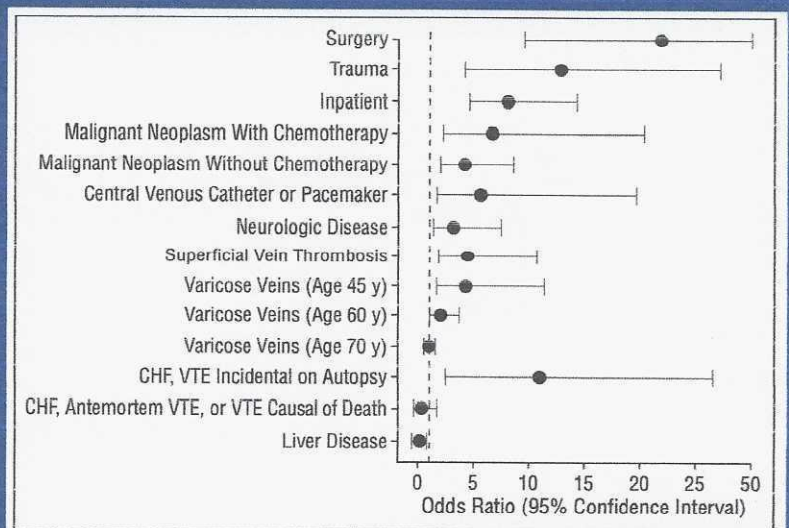
## Prevalence of VTE after total joint arthroplasty and hip fracture fixation in the absence of prophylaxis

	Total DVT	Proximal DVT	Total PE	Fatal PE
<b>Surgery</b>	%	%	%	%
<b>TKA</b>	41-85	5-22	1.5-10	0.1-1.7
<b>THA</b>	42-57	18-36	0.9-28	0.1-2.0
<b>Hip fracture</b>	46-60	23-30	3-11	0.3-7.5
	<b>50%</b>	<b>25%</b>	<b>10%</b>	<b>1%</b>

Geerts WH, Bergqvist D, Pineo GF, Heit JA, Samama CM, Lassen MR, Colwell CW. Prevention of venous thromboembolism: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition). Chest. 2008 Jun

- The most risk factor of VTE are Surgery & Trauma

Risk factors for VTE*	Odd ratio(95%CI)
<b>Surgery</b>	<b>21.7 (9.4-49.9)</b>
<b>Trauma</b>	<b>12.7 (4.1-39.7)</b>
Hospital or Nursing home	8.0 (4.5-14.2)
Cancer with chemotherapy	6.5 (2.1-20.2)
Cancer without chemotherapy	4.1 (1.9-8.5)
Central venous catheter	5.6 (1.6-19.6)
Superficial vein thrombosis	4.3 (1.8-10.6)
Neurological disease with paraparesis	3.0 (1.3-7.4)



Heit JA, Silverstein MD, Mohr DN, Petterson TM, O'Fallon WM, Melton LJ 3rd. Risk factors for deep vein thrombosis and pulmonary embolism: a population-based case-control study. Arch Intern Med. 2000 Mar 27;160(6):809-15. doi: 10.1001/archinte.160.6.809. PMID: 10737280

<u>Each risk factor=1 point</u>	<u>Each risk factor=2 points</u>	<u>Each risk factor=3 points</u>
<ul style="list-style-type: none"> <li>• Age 40-59 years</li> <li>• Minor surgery planned</li> <li>• BMI <math>\geq 30</math> kg/m<sup>2</sup></li> <li>• History of prior major surgery (&lt;1 month)</li> <li>• Swollen legs (current)</li> <li>• Varicose veins</li> <li>• Sepsis (&lt;1 month)</li> <li>• Abnormal pulmonary function (COPD)</li> <li>• Acute myocardial infarction (&lt;1 month)</li> <li>• Congestive heart failure (&lt;1 month)</li> <li>• History of IBD</li> <li>• Medical patient currently at bed rest</li> </ul>	<ul style="list-style-type: none"> <li>• Age 60-74 years</li> <li>• Arthroscopic surgery</li> <li>• Major open surgery (&gt;45 minutes)</li> <li>• Laparoscopic surgery (&gt;45 minutes)</li> <li>• Prior cancer (except non-melanoma skin cancer)</li> <li>• Present cancer (except breast and thyroid)</li> <li>• Confined to bed (&gt;72 hours)</li> <li>• Immobilizing plaster cast</li> <li>• Central venous access</li> </ul>	<ul style="list-style-type: none"> <li>• Age <math>\geq 75</math> years</li> <li>• History of VTE</li> <li>• Family history of VTE</li> <li>• Present chemotherapy</li> <li>• Positive Factor V Leiden</li> <li>• Positive Prothrombin 20210A</li> <li>• Positive Lupus anticoagulant</li> <li>• Elevated anticardiolipin antibodies</li> <li>• Elevated serum homocysteine</li> <li>• HIT</li> <li>• Other congenital or acquired thrombophilias</li> </ul>
<b>For women only (1 point each)</b>	<b>Caprini risk category based on total risk score</b>	
<ul style="list-style-type: none"> <li>• Pregnant or post-partum</li> <li>• History of unexplained or recurrent spontaneous abortion</li> <li>• Oral contraceptives or hormone replacement therapy</li> </ul>	Total score	Category
	0-4	Low
	5-8	Moderate
	$\geq 9$	High
	<ul style="list-style-type: none"> <li>• Major surgery lasting &gt;6 hours</li> <li>• Stroke (&lt;1 month)</li> <li>• Elective major lower extremity arthroplasty</li> <li>• Hip, pelvis, leg fracture (&lt;1 month)</li> <li>• Acute spinal cord fracture or paralysis (&lt;1 month)</li> <li>• Multiple traumas (&lt;1 month)</li> </ul>	

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	<b>Each risk factor=5 points</b>	

Lower extremity arthroplasty/  
Hip fracture

**At least Moderate risk group**

replacement therapy

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## VTE prophylaxis

- Mechanical prophylaxis options
- Pharmacological prophylaxis options
- Current guideline for VTE prophylaxis

# VTE prophylaxis

## Mechanical

- Early ambulation
- Ankle pumping exercise
- Graduated compression stocking (GCS)
- Above-the-knee compression device
- Below-the-knee compressive device
- Venous foot pump(VFP)

## Pharmacological

- Aspirin
- Warfarin
- Unfractional heparin
- Low-molecular weight heparin
- Fondoparinux
- Direct oral antocoagulant (DOAC)

# VTE prophylaxis

## Mechanical

- Early ambulation
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## Pharmacological

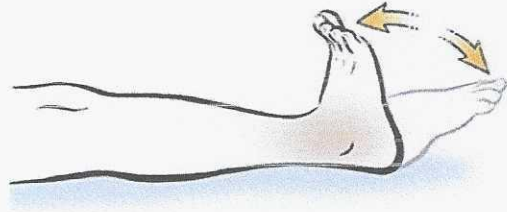
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**Mechanical**

Early ambulation



Ankle pumping exercise



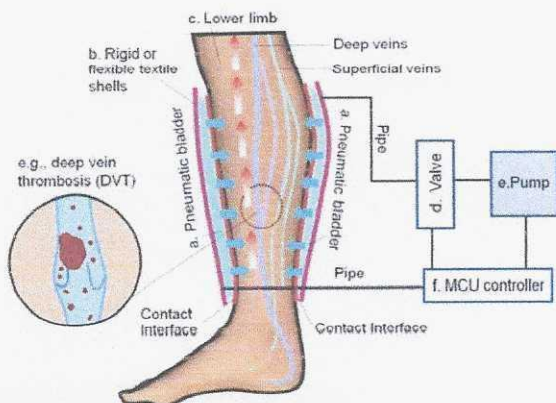
Graduated compression stocking



**Mechanical**

**Intermittent pneumatic compression device (IPCD)**

Substitute normal physiologic muscle pump during ambulation



**Contraindication**

- Open fracture
- Peripheral arterial insufficiency
- Severe cardiac insufficiency
- Infection
- Ulceration of lower limbs

**Mechanical**

**Intermittent pneumatic compression device (IPCD)**

Above-the-knee compressive device



Below-the-knee compressive device



Venous foot pump(VFP)



**VTE prophylaxis**

**Mechanical**

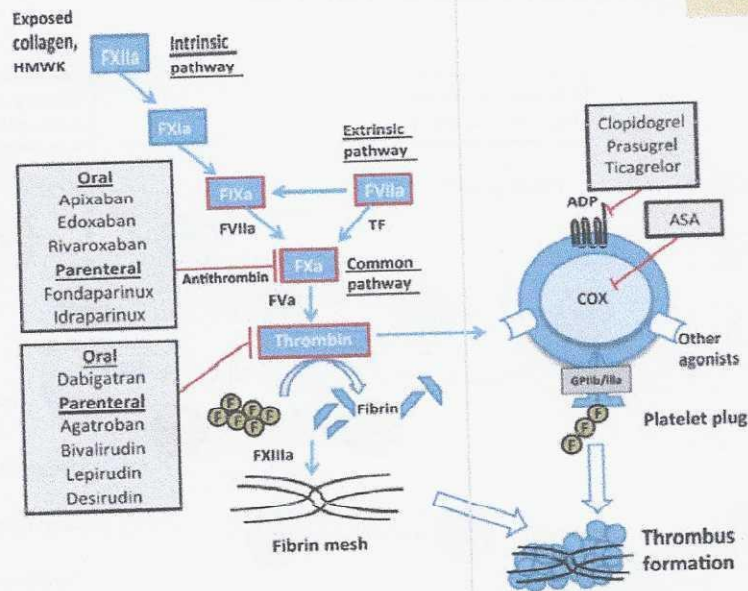
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**Pharmacological**

- Aspirin
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Anti-coagulant

- Warfarin
- Unfractional heparin
- Low-molecular weight heparin
- Fondaparinux
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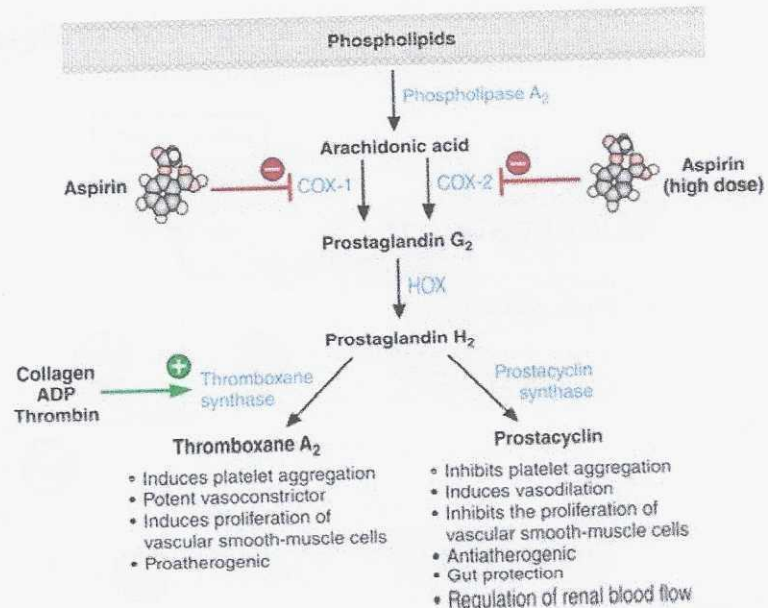


Anti-platelet

- Aspirin

Aspirin

- COX inhibitors
  - COX-1 : low dose : 81-162 mg
- Prevent production of thromboxane A2
- Reduce platelet aggregation
- Stop at least 5 days before surgery



Pharmacological

**Warfarin** (Vitamin K antagonist)

- Interfere cyclic conversion of vitamin K
- Slow onset and offset of action (mean half-life 2.5 days)
- **Need lab monitoring** (PT, PTT, INR)
- Narrow therapeutic window (INR 2-3)
- Stop 5 days before surgery + check pre-op INR 1 days
  - In moderate/high risk, need bridging therapy

	6 days prior to procedure	5 days prior to procedure	4 days prior to procedure	3 days prior to procedure	2 days prior to procedure	1 day prior to procedure	Morning of procedure
Warfarin	Take last dose of warfarin	No warfarin	No warfarin	No warfarin	No warfarin	No warfarin	No warfarin
INR test	x	x	x	x	x	Check if INR <1.5	

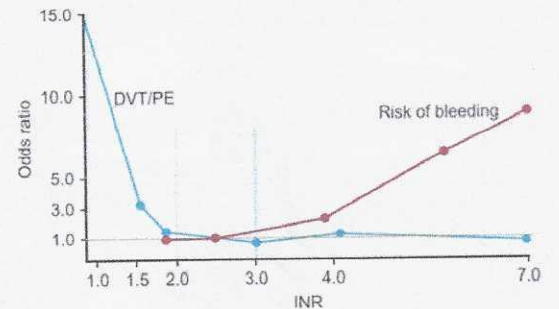
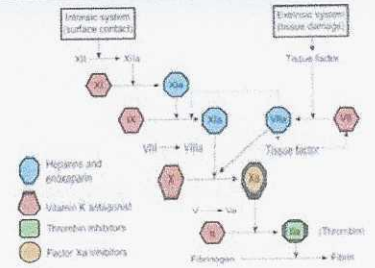


FIG 193.3 Narrow therapeutic range of warfarin. DVT, Deep vein thrombosis; INR, international normalized ratio; PE, pulmonary embolism.

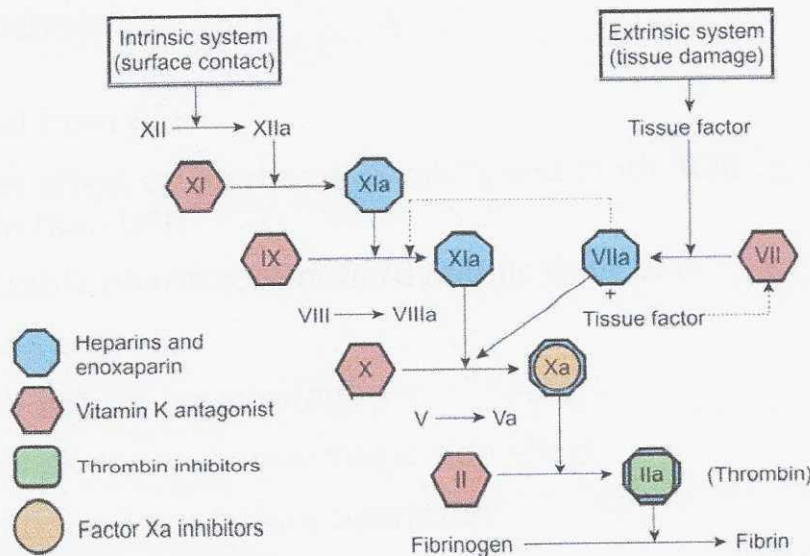
Pharmacological

Anti-coagulant

Unfractionated heparin

LMWH (Enoxaparin)

Warfarin



Fondaparinux

Rivaroxaban

Apixaban

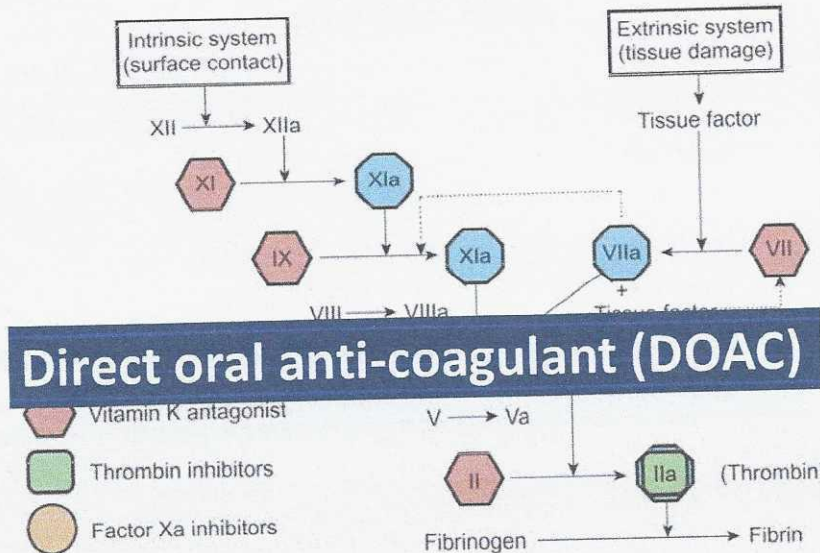
Dabigatran

Pharmacological

Anti-coagulant

Unfractionated heparin

Warfarin



Direct oral anti-coagulant (DOAC)

LMWH

Fondaparinux

Rivaroxaban

Apixaban

Dabigatran

Pharmacological

Direct oral anti-coagulant (DOAC)

Rivaroxaban

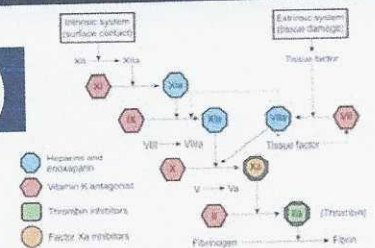
- Direct Xa inhibitor
- More effective than enoxaparin in preventing VTE after THA/TKA
- No need of lab monitoring

Apixaban

- Direct Xa inhibitor
- More effective than enoxaparin in preventing VTE after THA/TKA
- No need of lab monitoring

Dabigatran

- Direct thrombin (IIa) inhibitor
- Comparable effective as enoxaparin in preventing VTE after THA/TKA
- Reverse by Idarucizumab



# VTE prophylaxis

## VTE risk



### Asia Pacific VTE consensus

- Patient's factor :
  - Previous VTE
  - Family history of VTE
  - Varicose vein
  - Congestive heart failure
  - History of thromboembolic stroke
- Surgical factor :
  - Revision surgery
  - Bilateral surgery
  - Prolonged surgery time
  - Prolonged time to surgery after hip fracture

### Thai consensus

- Previous VTE
- Family history of VTE
- Cancer
- Hypercoagulable state
- Delayed ambulation > 4 days
- Caucasian
- Hormone replacement therapy
- Multiple comorbidity



# VTE prophylaxis

## Prophylaxis



### VTE prophylaxis based on Asia Pacific guideline

	Normal bleeding risk	Increase bleeding risk
Standard VTE risk	Mechanical and/or Pharmacological	Mechanical alone
Elevated VTE risk	Mechanical and Pharmacological	Mechanical and/or Aspirin

**Duration :** Mechanical => from early post-op period until independently ambulated  
 Pharmacological => minimum duration of 10-14 days post-operation

## Prophylaxis



### Asia Pacific VTE consensus

- Every arthroplasty & hip fracture patient should apply mechanical prophylaxis until ambulation
  - Hip & knee arthroplasty : since early post-op
  - Hip fracture : since pre-op
- Recommended pharmacological prophylaxis in patient with elective hip & knee arthroplasty
  - Standard VTE risk : Aspirin (81-162 mg/day)
  - Elevated VTE risk : DOAC, LMWH
- The most cost-effective pharmacological prophylaxis is Aspirin
- Pharmacological prophylaxis relate to increased wound drainage in THA (but not in TKA)

## Prophylaxis



### Thai consensus

- Pharmacological prophylaxis should be administrated in elevated risk of VTE patient
  - Recommended chemoprophylaxis are ASA, DOAC, VKA, LMWH
- Duration of pharmacological prophylaxis
  - 2 weeks in knee arthroplasty, 4-5 weeks in hip arthroplasty
- Tranexamic acid does not increase risk of VTE
- Prolonged tourniquet time > 2 hr is associated with increased risk of DVT
- Regional anesthesia have less risk of VTE than general anesthesia
- Patient with massive blood loss (> 500 ml) should be delayed pharmacological prophylaxis
- Patient with active bleeding should be hold pharmacological prophylaxis

# Take Home Messages

- Venous thromboembolic disease is the common complication in orthopedic patient
- Almost patient undergone orthopedic operation, especially arthroplasty, are high VTE risk
- The balance of bleeding risk and VTE risk is challenging



Don't forget to consider VTE prophylaxis to our patient

# VTE protocol in CMU



28-06-2568 08:28 00000890 ผู้บาดเจ็บ (Dipper) / แพทย์ระบบหัวใจและหลอดเลือด 1 190.00 9

Diagnosis: T12.0 Fracture of lower limb, level unspecified, closed

DX: FU FU 3 FU 3 (C) **พิมพ์ ED 2** DisCards: PAC: **พิมพ์ ED 2** **พิมพ์ ED 2** **พิมพ์ ED 2** **พิมพ์ ED 2**

EMR Page1:

**RISK FACTOR (ปัจจัยเสี่ยง)**

Concurrent heart failure/LV dysfunction:  YES  NO

Hypertension:  YES  NO

Hypotension:  YES  NO

Diabetes mellitus:  YES  NO

Ischemic heart disease:  YES  NO

Stroke/TIA/thrombo-embolism:  YES  NO

Vascular disease (Aortic AAA, PAD, Aortic aneurysm):  YES  NO

Chronic kidney disease:  YES  NO

Alcohol abuse (any amount):  YES  NO

Antipsychotic or NSAID use:  YES  NO

ECG:

การประเมินความเสี่ยงในการเกิดลิ่มเลือดอุดตัน

**ข้อมูลผู้ป่วย**

<input type="checkbox"/> อายุ > 65 ปี	<input type="checkbox"/> มีประวัติการเกิดลิ่มเลือดอุดตัน
<input type="checkbox"/> มีประวัติการเกิดลิ่มเลือดอุดตัน	<input type="checkbox"/> มีประวัติการเกิดลิ่มเลือดอุดตัน
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**การประเมินความเสี่ยงในการเกิดลิ่มเลือดอุดตัน**

<input checked="" type="checkbox"/> มีประวัติการเกิดลิ่มเลือดอุดตัน	<input type="checkbox"/> มีประวัติการเกิดลิ่มเลือดอุดตัน
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<input type="checkbox"/> มีประวัติการเกิดลิ่มเลือดอุดตัน	<input checked="" type="checkbox"/> มีประวัติการเกิดลิ่มเลือดอุดตัน
<input type="checkbox"/> มีประวัติการเกิดลิ่มเลือดอุดตัน	<input type="checkbox"/> มีประวัติการเกิดลิ่มเลือดอุดตัน
<input type="checkbox"/> มีประวัติการเกิดลิ่มเลือดอุดตัน	<input type="checkbox"/> มีประวัติการเกิดลิ่มเลือดอุดตัน

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# VTE protocol in CMU



Department of Internal Medicine  
Maharaj Nakorn Chiang Mai Hospital

ชื่อคนไข้: ๕๖๖๖

VTE assessment and prophylaxis protocol (v2023.1)

Patient's name		HN:	WARD:
DATE	Order for one day	DATE	Order for continuation
<b>VTE assessment</b> VTE risk score: Bleeding score: คะแนนประเมินความเสี่ยง VTE (VTE risk score) และคะแนนความเสี่ยงเลือดออก (Bleeding score) I. <input type="checkbox"/> VTE risk < 3 Surveillance Early ambulation Mechanical prophylaxis II. <input type="checkbox"/> VTE risk ≥ 3, Bleeding < 2 Early ambulation Mechanical prophylaxis Anticoagulant III. <input type="checkbox"/> VTE risk ≥ 3, Bleeding > 2 Early ambulation Mechanical prophylaxis		<b>VTE Prophylaxis</b> แผนการรักษาเพื่อป้องกัน VTE (VTE prophylaxis) ในผู้ป่วย (Patient) <input type="checkbox"/> Surveillance <input checked="" type="checkbox"/> Early ambulation <input type="checkbox"/> Mechanical prophylaxis <input type="checkbox"/> Intermittent pneumatic compression <input type="checkbox"/> Geko® <input type="checkbox"/> Graduated compressive stocking <input type="checkbox"/> Pharmacoprophylaxis <input type="checkbox"/> Enoxaparin 0.4 ml SC OD <input type="checkbox"/> Bemiparin 2,500 U SC QD <input type="checkbox"/> Heparin 5,000 U SC BID (if CrCl < 30 ml/min) <input type="checkbox"/> Rivoroxaban 10 mg Oral BID <input type="checkbox"/> Apixaban 2.5 mg Oral BID <input type="checkbox"/> Aspirin 81 mg Oral OD	

## VTE assessment

VTE risk score: .....

Bleeding score: .....

### คำนวณคะแนนตามความเสี่ยง

I.  VTE risk < 3

Surveillance

Early ambulation

Mechanical prophylaxis

II.  VTE risk ≥ 3, Bleeding ≤ 2

Early ambulation

Mechanical prophylaxis

Anticoagulant

III.  VTE risk ≥ 3, Bleeding > 2

Early ambulation

Mechanical prophylaxis

## VTE Prophylaxis

แพทย์เจ้าของไข้เลือกให้ VTE prophylaxis ตามความเสี่ยง (The attending physician selects VTE prophylaxis according to the risk.)

- Surveillance
- Early ambulation
- Mechanical prophylaxis
  - Intermittent pneumatic compression
  - Geko®
  - Graduated compressive stocking
- Pharmacoprophylaxis
  - Enoxaparin 0.4 ml SC OD
  - Bemiparin 2,500 U SC QD
  - Heparin 5,000 U SC BID (if CrCl < 30 ml/min)
  - Rivoroxaban 10 mg Oral BID
  - Apixaban 2.5 mg Oral BID
  - Aspirin 81 mg Oral OD



# THANK YOU

FOR YOUR ATTENTION

