Clinical Significance and Applications of D-Dimer

WOODLEY EQUIPMENT COMPANY LTD.

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Contents

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a. D-Dimer Fibrin Degradation Products (FDPs) Generation

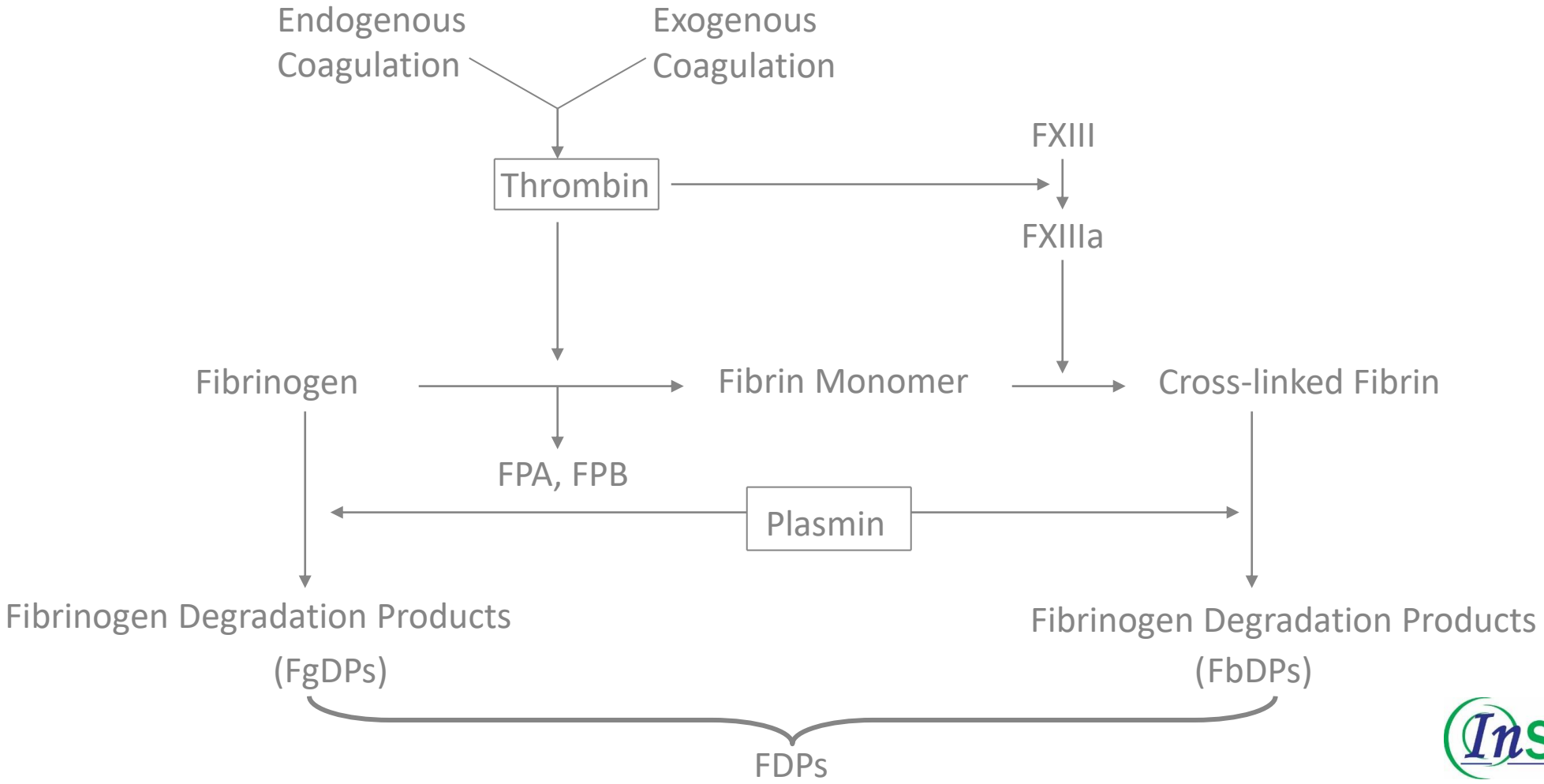
The activation of the coagulation system leads to the production of thrombin which binds to the central domain of fibrinogen, releases fibrinopeptide A (FPA) and fibrinopeptide B (FPB) and generates fibrin monomer (FM) and multimers.

Under the action of activating FXIII, cross-linked fibrin is produced. Plasmin degrades fibrinogen (Fg) and fibrin monomer (FM) to produce final products called FgDPs.

Plasmin degrades cross-linked fibrin to generate a variety of cross-linked fibrin degradation products called FbDPs, including D-Dimer and other fragments. Therefore, FDPs should include two degradation products of FgDPs and FbDPs.

a. D-Dimer Fibrin Degradation Products (FDPs) Generation

Schematic Diagram of D-Dimer Formation



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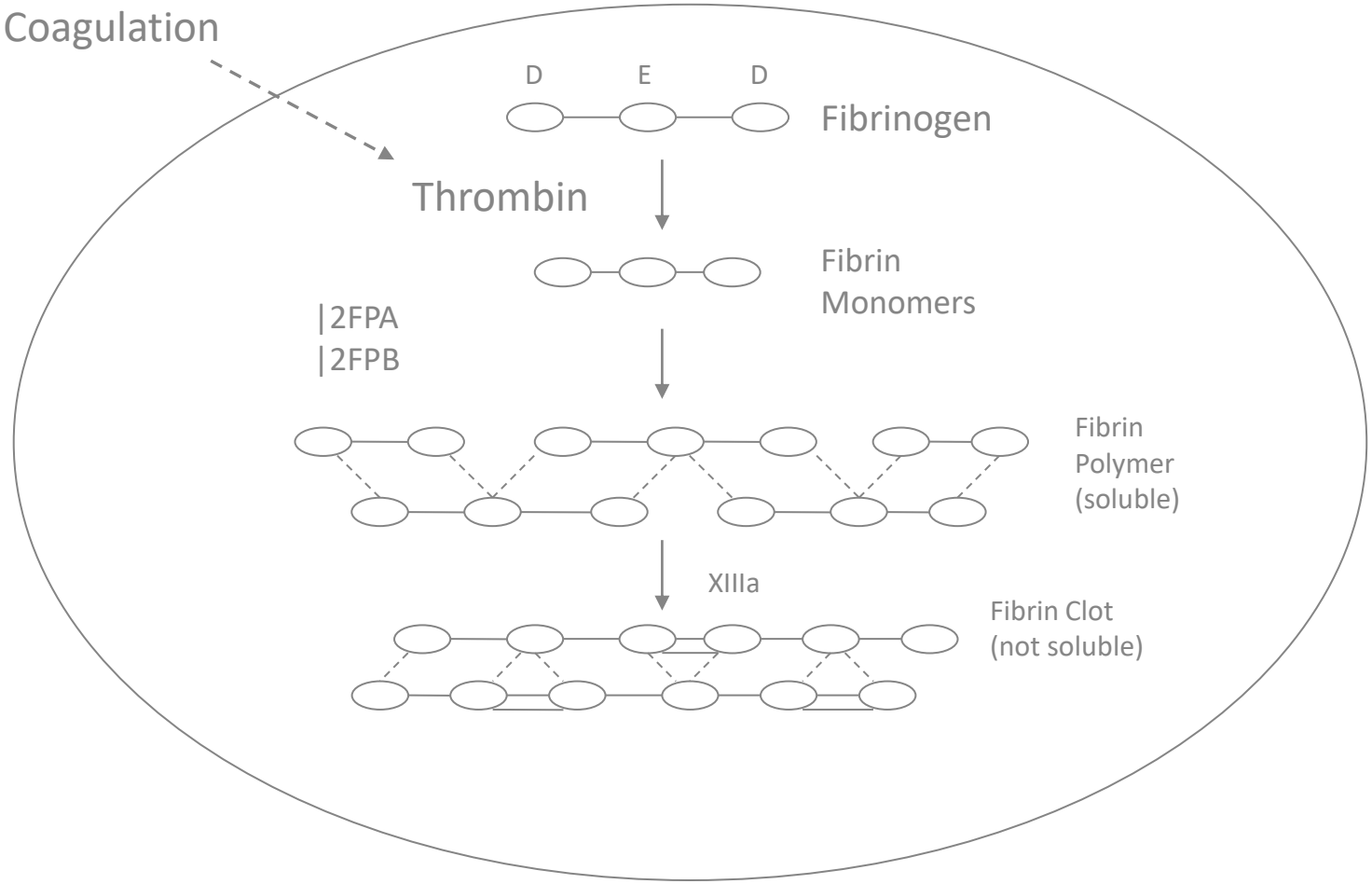
a. D-Dimer Fibrin Degradation Products (FDPs) Generation

The Final Product of Blood Coagulation – Fibrin Clot



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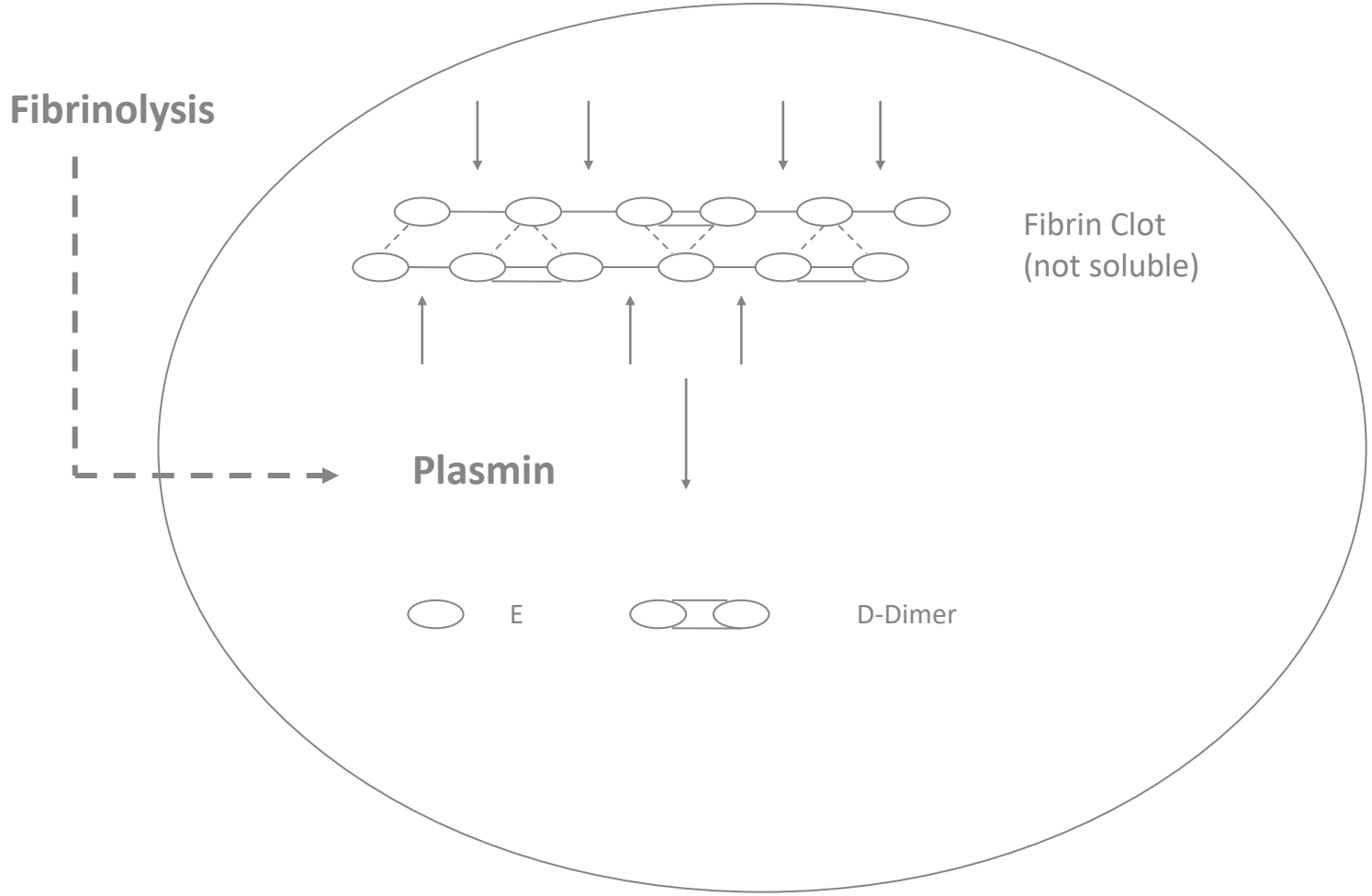
a. D-Dimer Fibrin Degradation Products (FDPs) Generation

The Final Product of Fibrinolysis – D-Dimer



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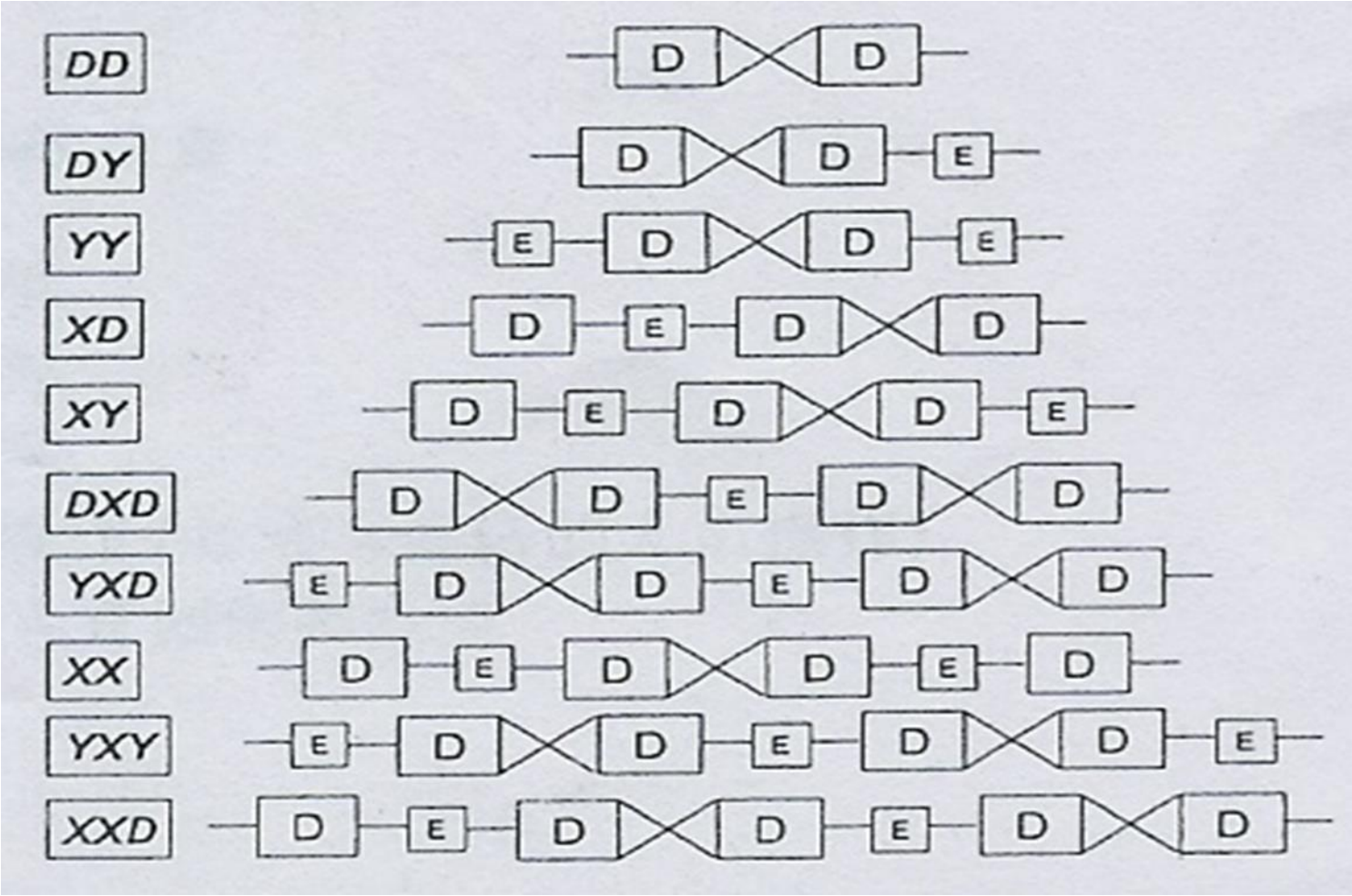
a. D-Dimer Fibrin Degradation Products (FDPs) Generation



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b. D-Dimer (FDPs) Detection Method

There are many detection methods for D-Dimer, mainly qualitative or semi-quantitative tests based on the principle of latex agglutination and quantitative determination based on the principle of ELISA.

There are also some methods that use the principle of immunoturbidity or immunofluorescence. The classic latex method has low sensitivity while the classic ELISA method is time-consuming and not suitable for emergency use.

Several rapid, highly sensitive detection methods that can detect single specimens have now been developed, such as InSight V-IA D-Dimer Rapid Quantitative Test.

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b. D-Dimer (FDPs) Detection Method

Comparison Between Two Fast D-Dimer Detection Methods and Classic Detection Methods

Single Specimen, Detection, Rapid, Quantification, Sensitivity, Specificity						
Latex Method	Classical Plasma Latex Method	+	---	---	---	---
	Whole Blood Latex Method (SimpliRed)	+	+	---	+/-	---
ELISA	Classic ELISA	---	---	+	+	---
	Rapid ELISA	+	+	+	+	---

c. Clinical Application of D-Dimer Detection

- ❑ Used to rule out DVT, not to diagnose DVT (Deep Vein Thrombosis)
- ❑ Used to rule out PTE, not to diagnose PTE (Pulmonary Embolism)
- ❑ Other applications in patients with suspected VTE (Venous Thrombosis)
  - Screen DVT/PTE in asymptomatic high-risk patients
  - Diagnosis of recurrent VTE
- ❑ Significance in the diagnosis of DIC
- ❑ Monitoring of thrombolytic therapy
- ❑ Other

c. Clinical Application of D-Dimer Detection

Venous Thromboembolism (VTE)

- Deep Vein Thrombosis (DVT)
  - Western countries incidence rate (Van Beek) = 1‰
- Pulmonary Embolism (PE)
  - Western countries incidence rate (Van Beek)=0.5‰
- American Heart Association
  - Venous Thromboembolism
  - 200,000 people die each year with Venous Thromboembolism

c. Clinical Application of D-Dimer Detection

Risk Factors for VTE (Predictive Likelihood Factors)

High Risk Factors (High Predicted Likelihood)	
Multiple fractures (40% - 76%)	Hip fracture (50% - 75%)
Severe trauma (35% ~ 50%)	Major abdominal surgery (15% ~ 30%)
Spinal cord injury (50% ~ 100%)	Stroke (30% ~ 60%)
Elder ≥ 80 years old (88%)	

c. Clinical Application of D-Dimer Detection

Risk Factors for VTE (Predictive Likelihood Factors)

Moderate Risk Factors (Moderately Predicted Likelihood)	
Lower extremity fracture (3.7% ~ 50%)	Congestive heart failure (8% ~ 12%)
Malignant tumor (5% ~ 42%)	Coronary artery bypass grafting (3% ~ 9%)
Acute myocardial infarction (5% ~ 35%)	Oral contraceptives (3% ~ 12%)
Family history of thrombosis (5% ~ 13%)	Autoimmune disease (SLE)

c. Clinical Application of D-Dimer Detection

Risk Factors for VTE (Predictive Likelihood Factors)

Low Risk Factors (Low Predicted Likelihood)	
Braking ≥ 5 days	Economy class syndrome
Smoking	Increased blood viscosity
Pregnancy/Postpartum	Hernia repair
Nephrotic syndrome	Polycythemia vera

c. Clinical Application of D-Dimer Detection

Clinical Signs and Symptoms of DVT	
Limb/Abdominal Pain	≥90%
Swelling of the Limbs	80~90%
Superficial Varicose Veins	40~50%
Systemic Symptoms	38~70%
Embolic Syndrome	20~70%

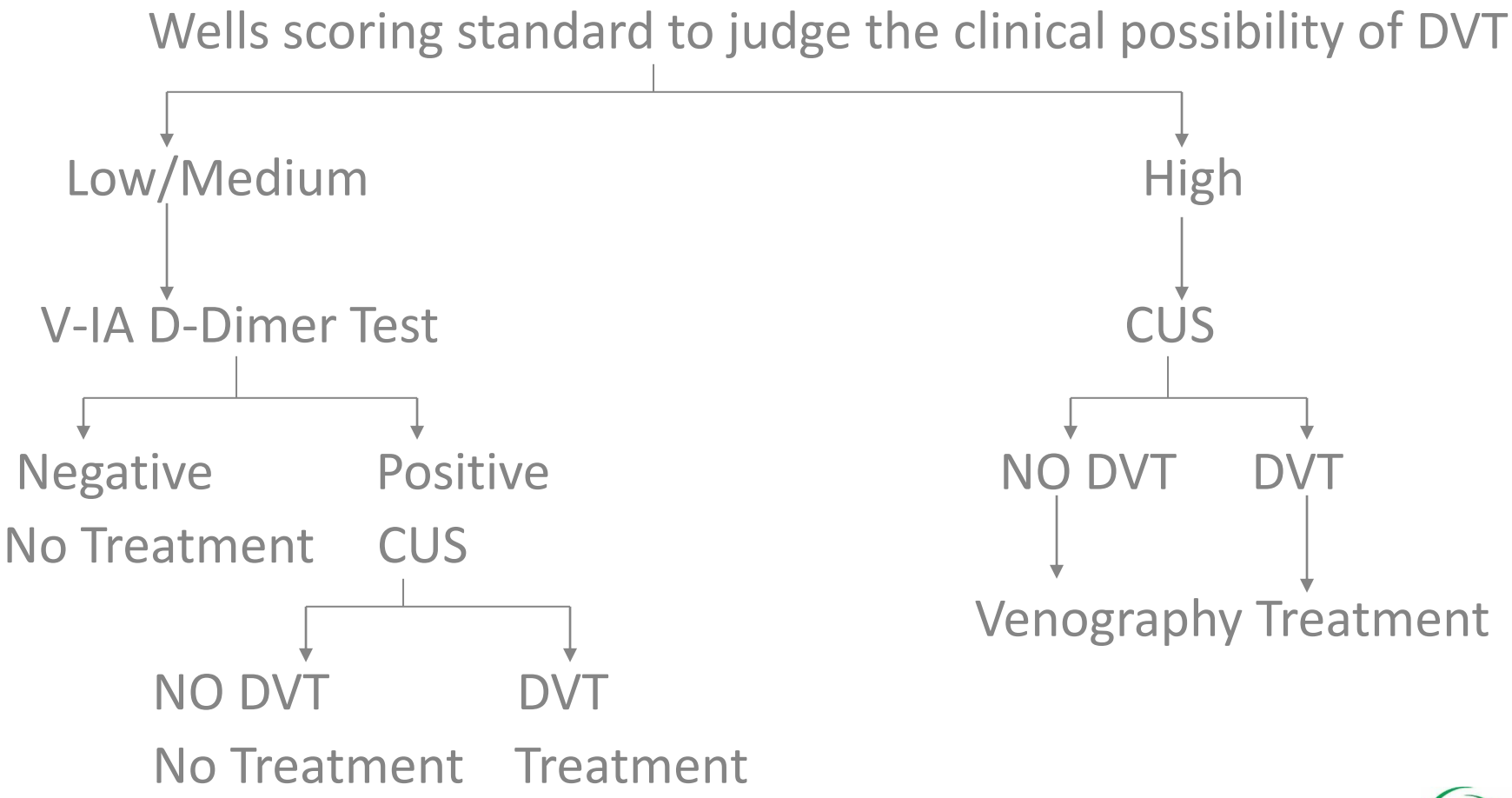
c. Clinical Application of D-Dimer Detection

DVT Main Imaging Examination

	Sensitivity （%）	Specificity （%）
Compression Ultrasound Phenomenon (CUG)	73~97	98
Magnetic Resonance (MRI)	90~100	90~100
Venography (Gold Standard)	~100	~100

c. Clinical Application of D-Dimer Detection

Diagnostic Procedures for DVT



Note: CUS, compression ultrasound imaging; DVT, deep vein thrombosis

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c. Clinical Application of D-Dimer Detection

Clinical Symptoms and Signs of PTE

Symptoms and Signs

- ❑ Difficulty breathing and shortness of breath 80 ~ 90%
- ❑ Chest pain 40 ~ 70%
- ❑ Tachycardia 30 ~ 40%
- ❑ Syncope 11 ~ 20%
- ❑ Purpura 11 ~ 16%
- ❑ Haemoptysis 11 ~ 30%
- ❑ Fever 43%
- ❑ Cough 20 ~ 37%
- ❑ Jugular vein filling 12%
- ❑ Palpitations 10 ~ 18%
- ❑ Pleural effusion 24 ~ 30%
- ❑ PO2 rise/split 23%

c. Clinical Application of D-Dimer Detection

Main Imaging Examination of PTE

	Sensitivity （%）	Specificity （%）
Radionuclide Lung Ventilation/Perfusion Scan	92	87
Spiral CT/Electron Beam CT Angiography	53~89	78~100
Pulmonary Angiography	98	95~98

c. Clinical Application of D-Dimer Detection

Suspicious PTE – Wells (2000) Scoring Standard (Simplified)

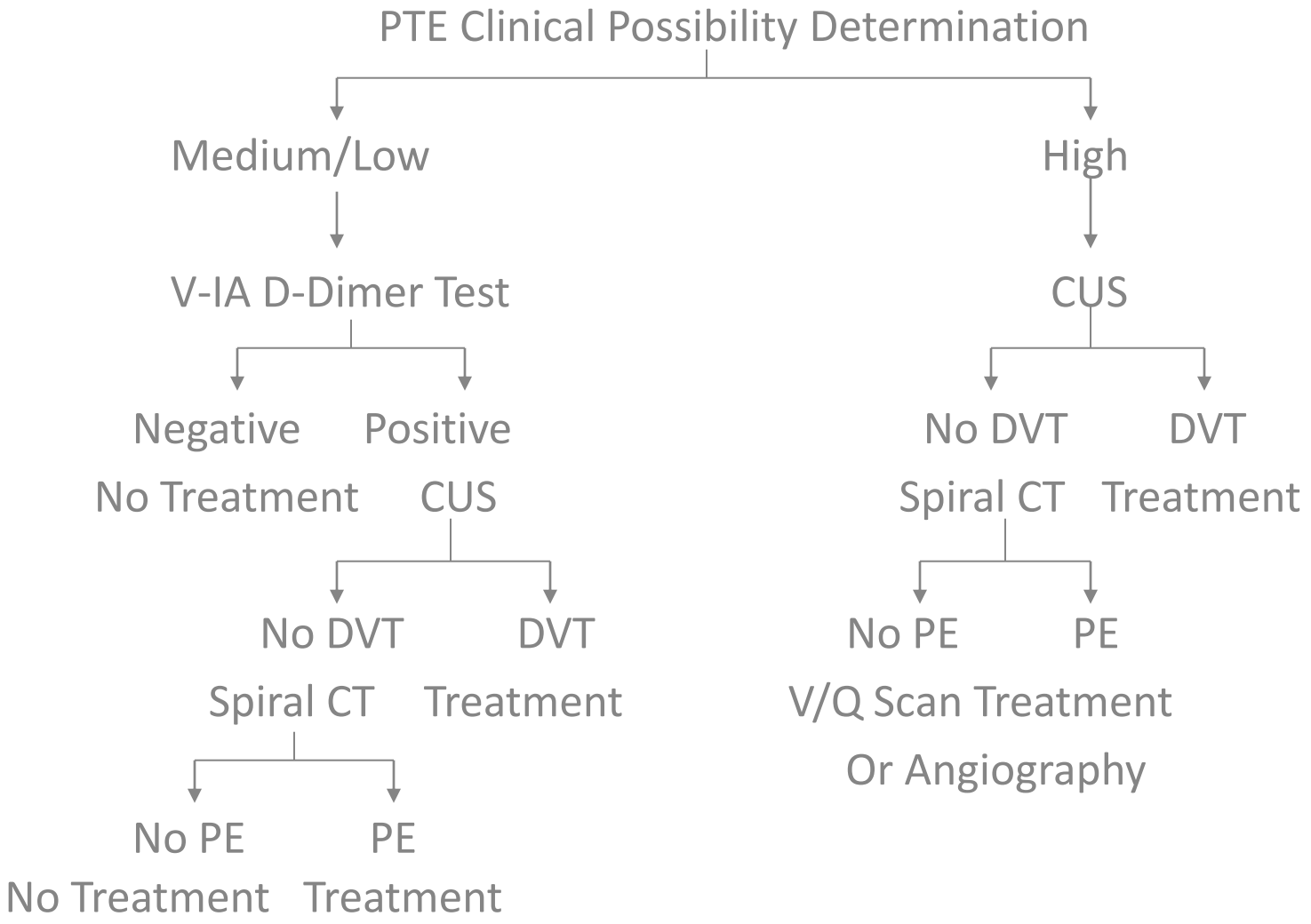
- ❑ There are clinical symptoms and signs of DVT (with edema and pain) **3**
- ❑ Compared with other diseases, PTE is more likely **3**
- ❑ Fixation/braking, staying in bed for ≥3 consecutive days or surgery within 4 weeks **1.5**
- ❑ Have a history of DVT/PTE **1.5**
- ❑ Heart rate >100 bpm **1.5**
- ❑ Haemoptysis **1**
- ❑ Active cancer (under treatment/6 months before treatment) **1**

Note: 0 – 2 points – low probability, incidence rate 4%
3 – 6 points – moderate probability, incidence rate 21%
>6 points – high probability, incidence rate 67%

c. Clinical Application of D-Dimer Detection

Diagnostic Procedures for Suspicious PTE

Note: CUS compression ultrasound imaging; V/Q ventilation perfusion scan



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c. Clinical Application of D-Dimer Detection

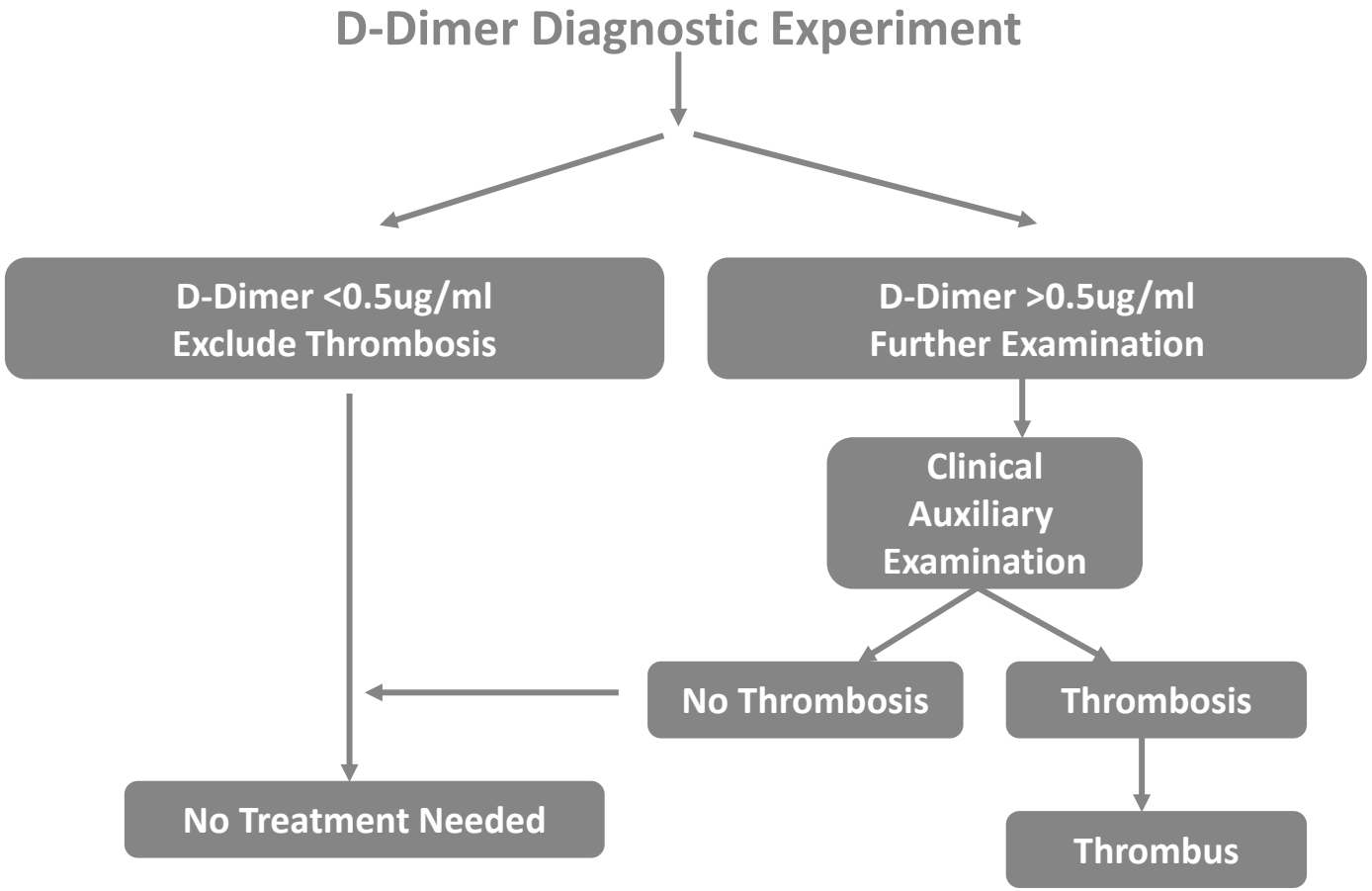
D-Dimer as a Diagnostic Solution to Exclude Venous Thromboembolism

There are two main programs for D-Dimer quantitative analysis to diagnose venous thromboembolism.

1. D-Dimer as an independent diagnostic experiment

2. D-Dimer and clinical pre-assessment combined application

c. Clinical Application of D-Dimer Detection



Clinically validated methods can be used to exclude deep vein thrombosis and pulmonary embolism (n>5000, NPV>95%).

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c. Clinical Application of D-Dimer Detection

Disseminated Intravascular Coagulation (Disseminated Intravascular Coagulation, DIC)

Existing Concepts

DIC is caused by a variety of pathogens causing damage to the microvascular endothelial cells and microcirculation system in the whole body.

Platelets and fibrin form microthrombi, causing multiple organ ischemia and hypoxia in the whole body, causing multiple organ dysfunction syndrome (multiple organ dysfunction syndrome, MODS).

c. Clinical Application of D-Dimer Detection

Clinical Manifestations of DIC

Performance	Symptoms	Incidence (%)
Extensive Bleeding	Injection bleeding, seepage	80-90
Circulatory Failure	Refractory shock, blood pressure reduction	50-60
Microcirculation Formation	Cultivation of organ dysfunction	45-50
Microvascular Haemolysis	Haemolytic expression	7-33

c. Clinical Application of D-Dimer Detection

Evaluation of Diagnostic DIC Test

Detection Indicators (several tests for tandem trials are positive)	Sensitivity (%)	Specificity (%)	Diagnostic Efficiency (%)
PT+PTT+TT	83	11	51
PT+PTT+Fg	22	100	65
PT+PTT+FDP	91	74	86
FDP+D-D	91	94	95

c. Clinical Application of D-Dimer Detection

Evaluation of D-Dimer Testing

VTE patients have high sensitivity (82%-100%) to D-Dimer detection but the specificity is not high (32%-52%), so VTE cannot be diagnosed based on elevated D-Dimer levels alone.

However, if D-Dimer levels are normal or below the pre-set cut-off range (500µg/L), the possibility of VTE is extremely small. The value of D-Dimer testing lies in its high negative predictive value (NPV), which can safely rule out the presence of VTE.

c. Clinical Application of D-Dimer Detection

Evaluation of D-Dimer Testing

- D-Dimer detecting positive patients do not necessarily have VTE
- Because D-Dimer has a specific and positive predictive value (PPV) for VTE and highly sensitive and negative predictive values (NPV).
- D-Dimer (+) is seen in elderly, pregnant women, cancer, DIC, liver disease, infection, inflammation, trauma, surgery, thrombolytic treatment and coronary heart disease.

c. Clinical Application of D-Dimer Detection

D-Dimer Detection of Anticoagulant Therapy

During anticoagulant therapy (3 to 6 months), D-Dimer value gradually decreased. If the anticoagulant is deactivated, the D-Dimer value is normal to have a higher negative predictive value (NPV) for recurrent VTE.

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D-Dimer
Rapid Quantitative Test

Woodley have developed a rapid, accurate and reliable, highly sensitive detection method for D-Dimer in cats or dogs.

The InSight V-IA D-Dimer Rapid Quantitative Test is a fluorescence immunoassay used with the InSight V-IA Veterinary Immunoassay Analyser for quantitative determination of D-Dimer concentration in canine or feline Lithium Heparin plasma.

The test is used to aid diagnosis of systemic thrombosis.

It can be stored at room temperature.

Thank You

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