Q. A patient has come with a solitary femur fracture. The chances of him having fat embolism are

a) 60-90%

b) 40-60%

c) 10-30%

d) 2-10%

FE vs FES

INCIENCE: 65-90% in solitary long bone/ pelvic fractures

1

Fat Embolism

Fat in circulation causing embolic phenomena

10%

2

Fat Embolism Syndrome

Fat embolism with signs & symptoms

INCIENCE:

- *2% solitary long bone fractures*
- *5-10%: multiple fractures with pelvic involvement*

Fabian and colleagues found the an incidence of fat emboli even in pediatric long bone fractures to be as high as 10%.

HISTORY

Zenker 1862

- First described at autopsy of a railroad injury death

Von Bergman 1873

- First clinical diagnosis
- Based on his study of iv oil injection in cats
- Coined the term

Grandahl 1911

- Term 'cardiac syndrome'
- Tachycardia and hypotension

Sevitt 1962

- Classification into three recognisable syndromes
- Subclinical, non-fulminant, fulminant

Theories

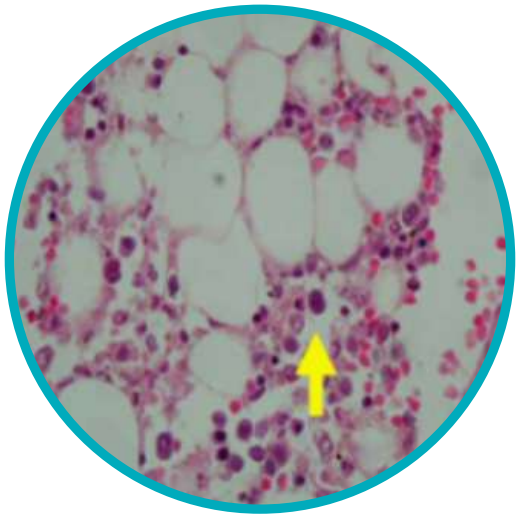
Mechanical (Gauss, 1924)

- Large fat droplets in venous circulation
- Physical obstruction of pulmonary and systemic circulation
- Produces local ischemia and inflammation

Biochemical (Lehman, 1927)

- Incriminates free fatty acids
- Hydrolysis of triglyceride emboli by pneumocyte lipase & mobilisation from periphery by catecholamines
- Explains nontraumatic forms of FES

Pathophysiology



Blockage

- Distal ischemia in capillary beds
- Arteriovenous shunting, with 'hypoxia'

Free fatty acids

- Toxic to pulmonary tissue
- Disruption of capillary membrane and reduced surfactant activity

Coagulation

- Fat activates extrinsic pathway
- Inflammation causes systemic procoagulant response

Q. A patient has come with a solitary femur fracture. The chances of him dying from fat embolism are

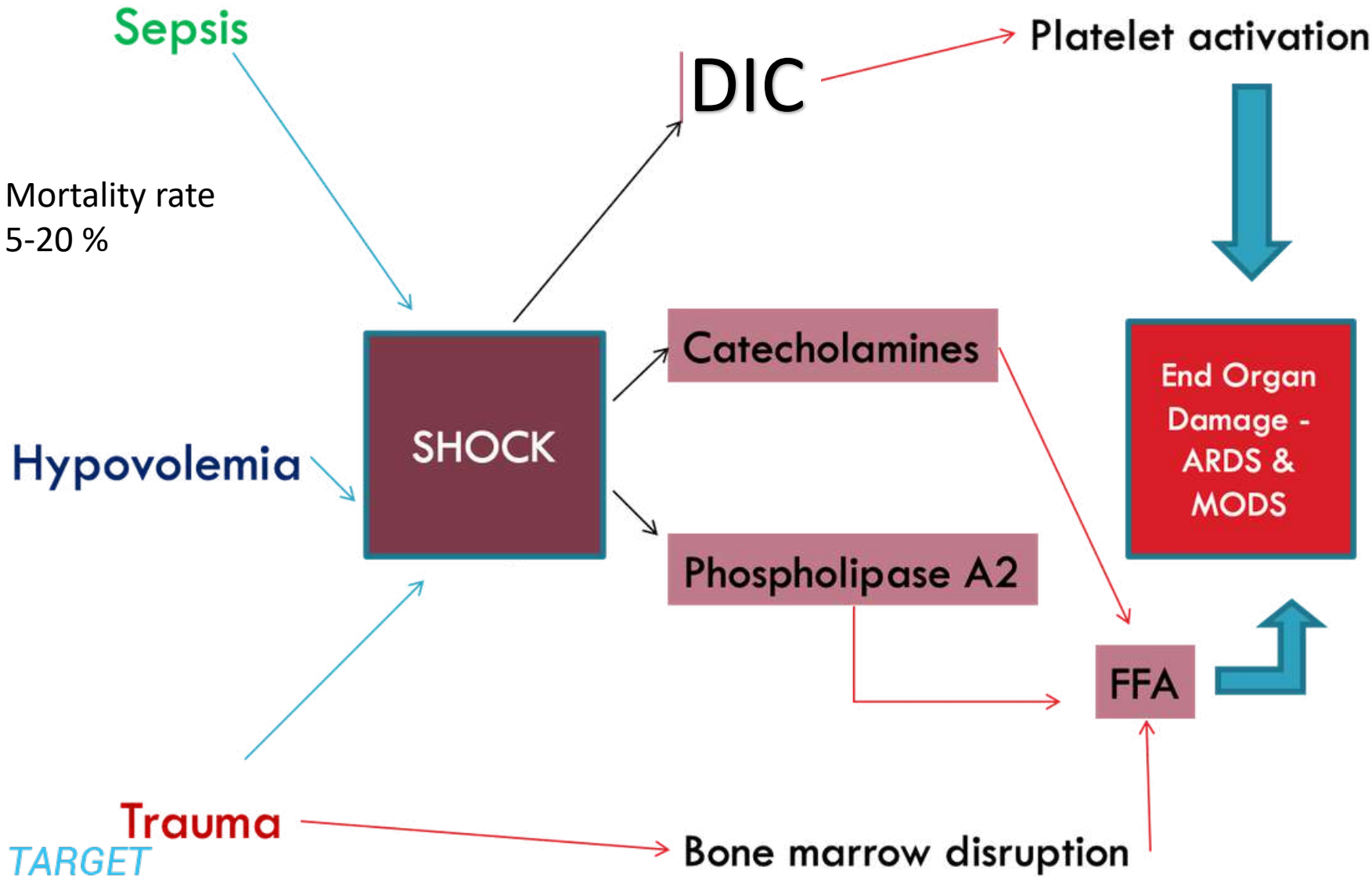
a) 50%

b) 20-40%

c) 5-20%

d) 1-5%

THE OVERALL PICTURE



Causes

FRACTURES (MC)

- 90% cases due to fractures
- Long bones, pelvis f/b closed fractures

Long bone and pelvic fractures are the most frequent causes, followed by orthopedic surgery—particularly total hip arthroplasty

Acute Pancreatitis

Diabetes Mellitus

Burns

Joint reconstruction

Liposuction

Cardiopulmonary bypass

Decompression sickness

Parenteral lipid infusion

Blunt trauma

Recent corticosteroid administration

Causes: trauma

What increases the risks?

1. Improper splintage,
2. rough transportation,
3. intramedullary instrumentation

INTERESTING fact

Femur or tibia contains 130ml of liquid fat
20ml of fat = 40 billion micro emboli of 10 µm

Clinical Features

Asymptomatic interval of 12-72 hrs, followed by classic triad

Pulmonary	Cerebral	Skin
• 30-75% cases, 10% failure • Tachypnea, dyspnea, cyanosis • Hypoxia	• 60-85% cases • Agitation, delirium, acute confusion, headache, stupor, coma, rigidity or convulsions	• 20%-50% cases, pathognomonic • Axillary & subconjunctival petechiae • 24-36hrs & resolve in a week

Lungs

Early Signs

Hypoxia, Dyspnea, Tachypnea

ARDS

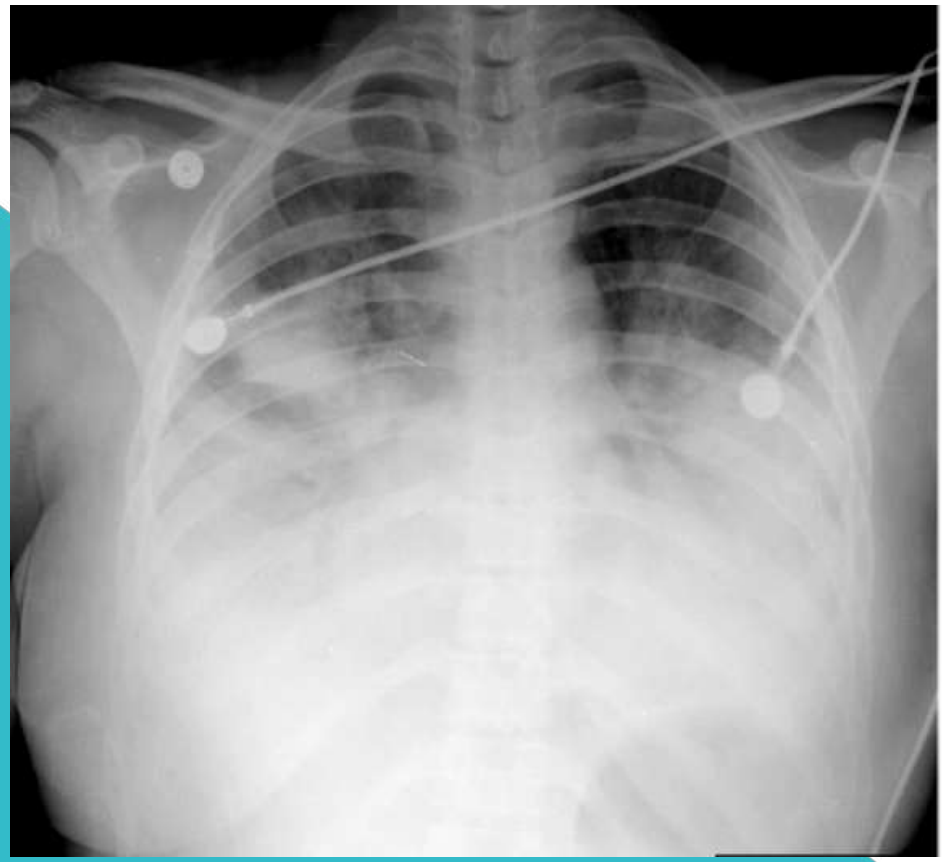
- ½ pts of FES require mechanical ventilation
- CXR- normal early, later 'snowstorm' pattern
- CT chest- ***HRCT chest is modality of choice to assess lung parenchyma***

Findings: Ground glass opacification, interlobar septal thickening

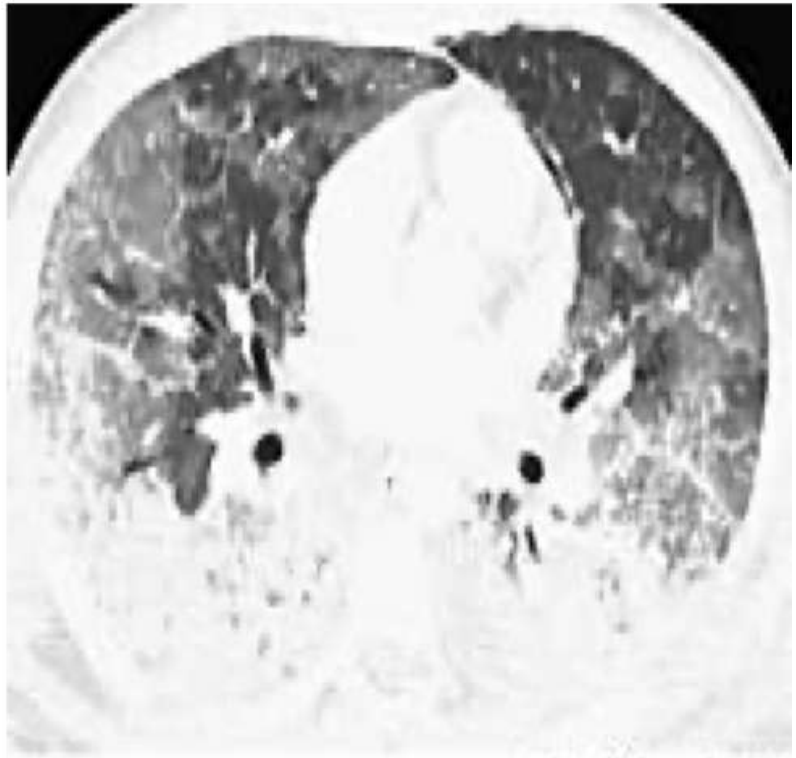
CRAZY PAVING PATTERN

Lungs - Imaging

SNOW STORM APPEARANCE



CRAZY PAVING PATTERN



Brain

60-85% patients; symptoms occur after respiratory symptoms

- Minor global dysfunction to coma.
- Seizures & focal deficits occur rarely

CT Head- Essential

- Shows general edema, more importantly helps rule out other pathology

MRI head- Provisional

- Hypointense on T1, hyper- on T2
- Correlates with degree of impairment

Rash

Appearance

- Reddish-brown non-palpable petechial rash
- Increased capillary fragility & occlusion of dermal capillaries

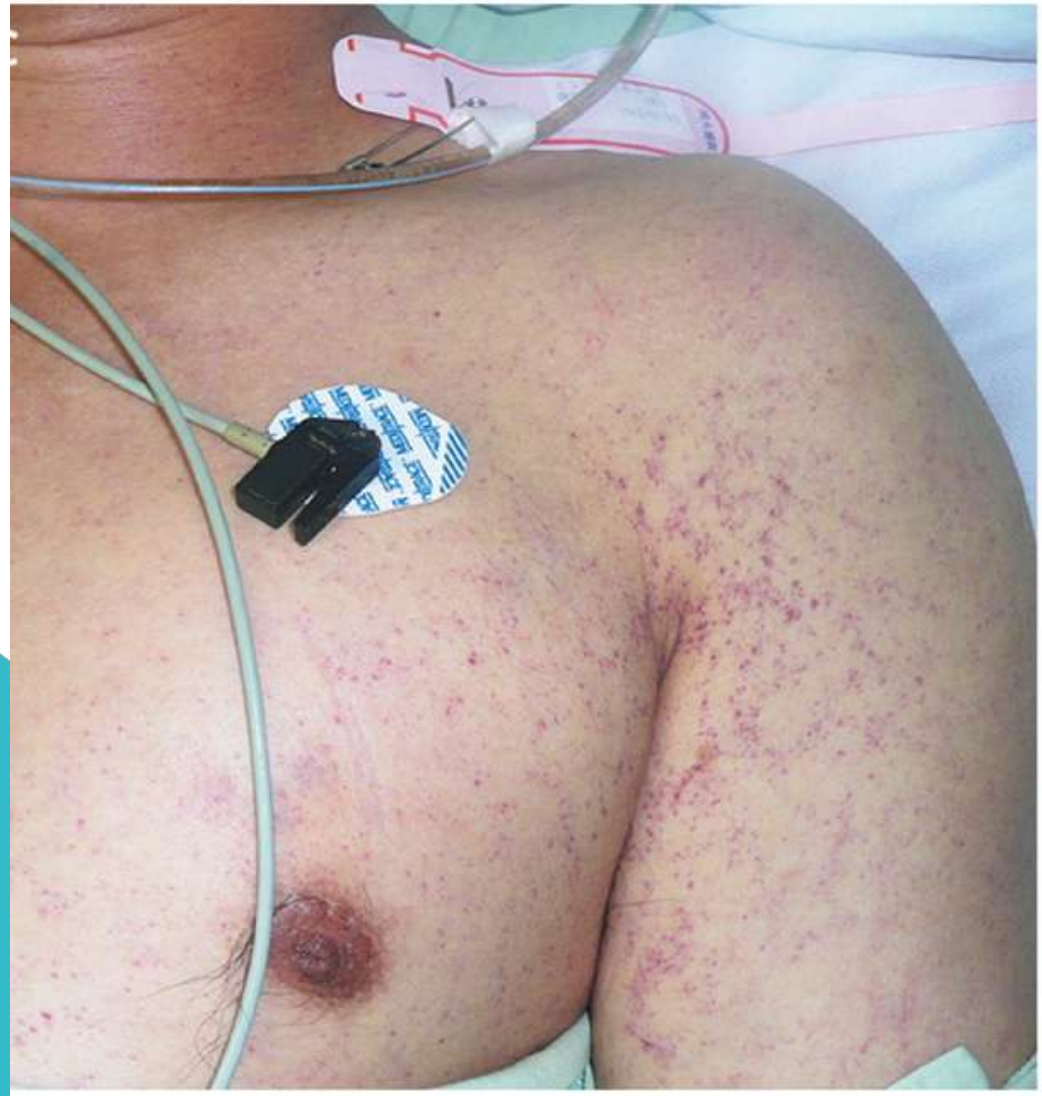
Timing

- Appears in 24-36 hrs, disappears in 5-7 days (can disappear as early as a day also)

Distribution

- Chest, neck, axillae, conjunctivae
- Possibly due to fat particles floating in the aortic arch

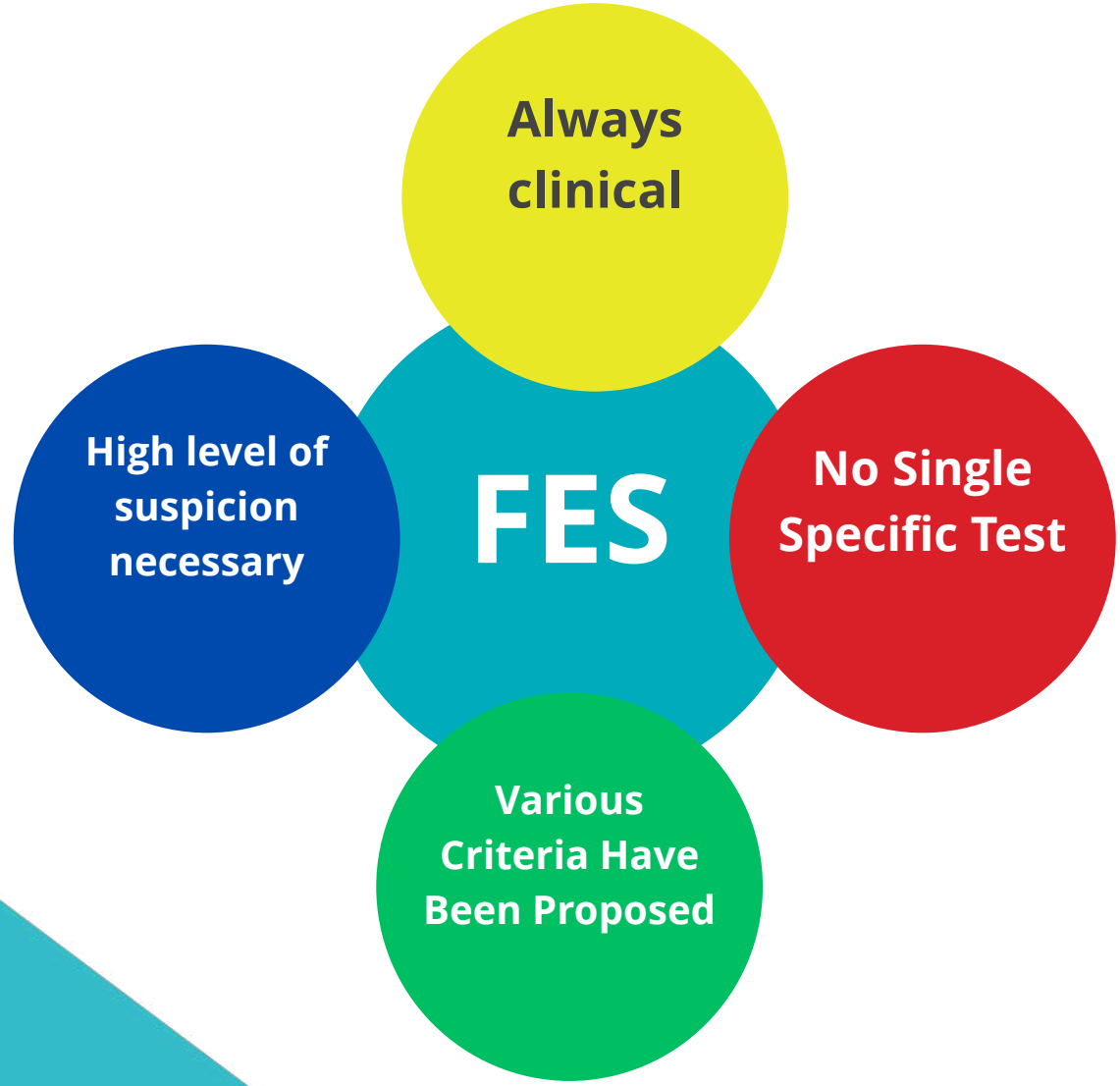
Rash- Clinical



Others

1. Fever & tachycardia
2. Retinal changes: exudates, cottonwool spots, hemorrhage, intravascular fat (Purtscher's retinopathy)
3. Lipuria
4. Jaundice
5. Thrombocytopenia (>50% decrease), anemia (>20% decrease), DIC
6. Myocardial depression (RV strain)

Diagnosis of FES



Q. Not a component of FAT EMBOLISM INDEX

A. Thrombocytopenia

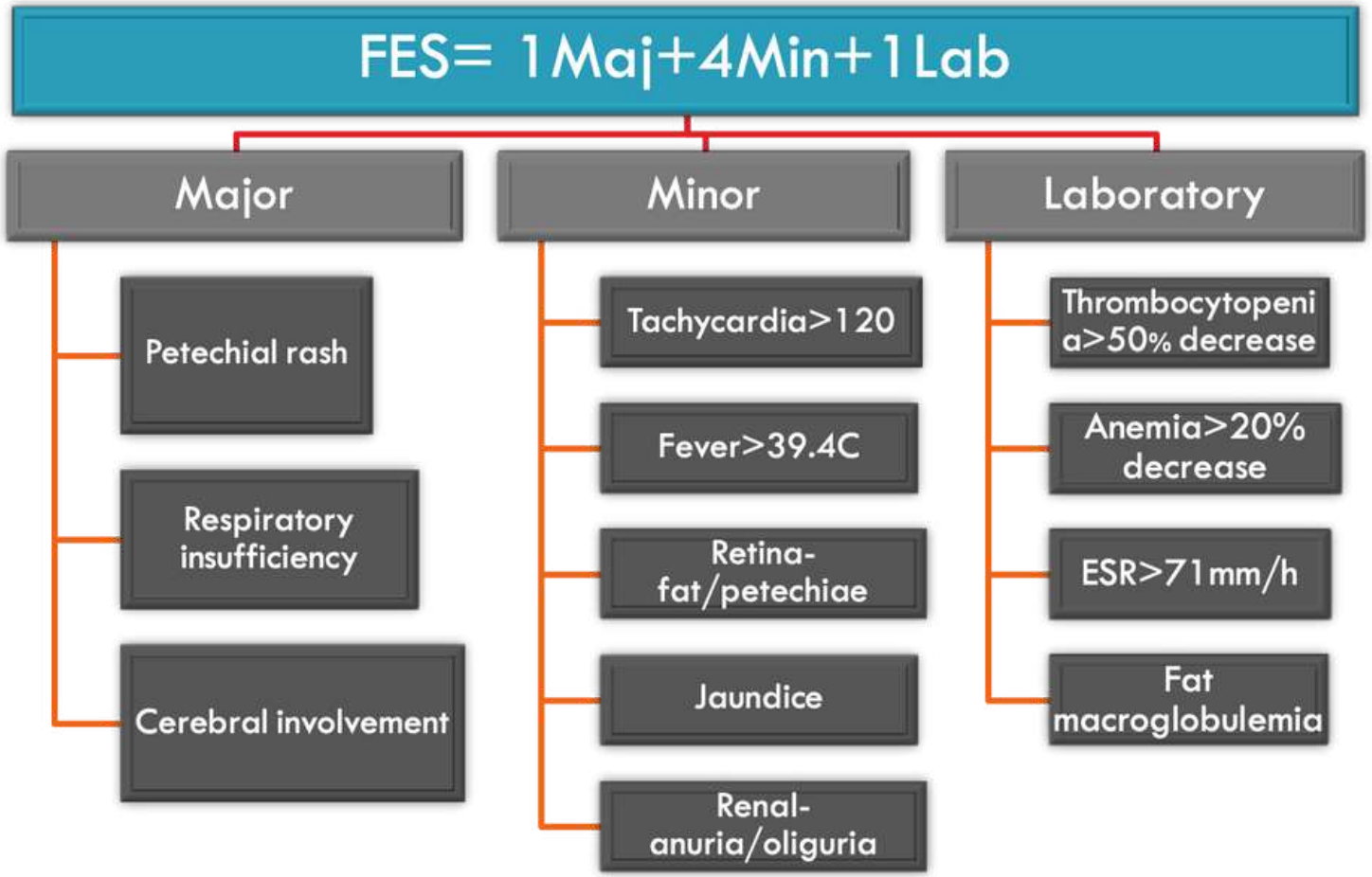
B. Petechiae

C. Hypoxia

D. Fever

Gurd – Wilson Criteria

Gurd's criteria (1970) later modified by Wilson



Schonfeld's Criteria

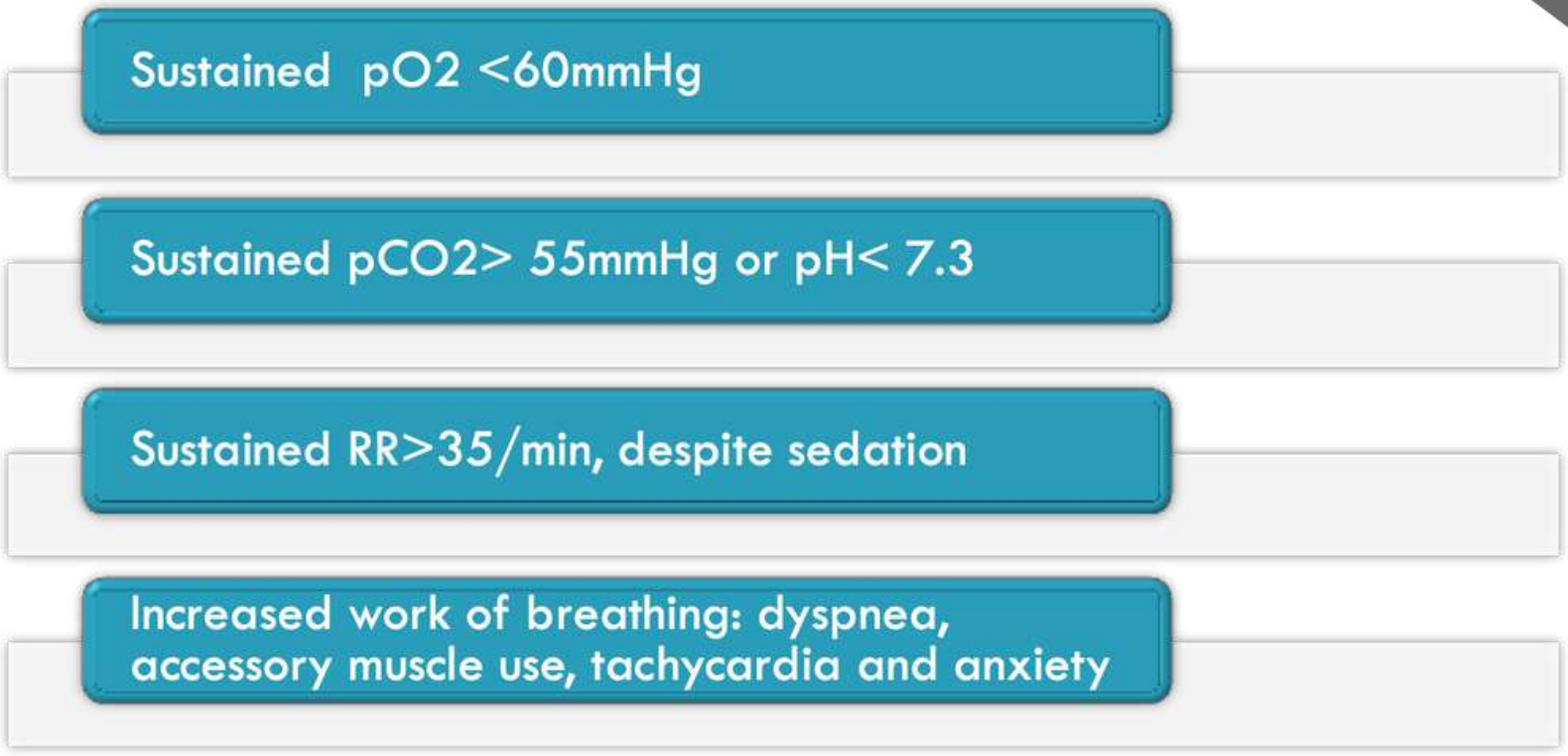
THE FAT EMBOLISM INDEX (FEI)

- Quantitative means to diagnosis
- >5 score (FEI score) required over first three days of hospitalization

Petechiae	5
CXR changes	4
Hypoxia	3
Fever	1
Tachycardia	1
Tachypnea	1
Confusion	1

Lindeque's Criteria

- Diagnosis based only on respiratory status



LAB

- Thrombocytopenia(>50% decrease)
- Anemia(>20% decrease)
- ESR>71 mm/h
- Fat microglobulinemia
- Hypofibrinogenemia
- S. Lipase & PLA2- increased
- S. Calcium- decreased
- Urine, Blood, CSF and Sputum- fat globules
- ABG: increased A-a O2 tension difference
- BAL: fat globules in Macrophages

A-a: Alveolar to Arterial

Q. For earliest diagnosis of FES, ideal would be

A. Check fat in urine and sputum

B. Get BAL done to look for fat in macrophages

C. Get eye evaluation

D. Check serum lipase and PLA-A2 levels for elevation

LAB

The most significant laboratory finding is a decrease in arterial oxygen tension.

Examination for fat in urine and sputum is earliest finding but of little value relative to more modern diagnostic measures as its highly non specific.

Recently, bronchoalveolar lavage for detection of fat-containing cells (macrophages) and retinal examination for cotton-wool spots and retinal hemorrhages have been reported to be helpful in early diagnosis.

Retinopathy has been reported in up to 50% of patients with FES. Typical lesions consist of cotton-wool spots and flame-like hemorrhages, and are attributed to microvascular injury and microinfarction of the retina. Retinal lesions may take at times a few weeks to disappear.

Imaging

Chest X-ray

- b/l infiltrates (*Snowstorm*), rt heart dilation

CT Head

- May be normal or diffuse edema and petechiae

V/P Scan

- Normal or subsegmental defects

MRI Head

- More sensitive than CT. Hypointense on T1, hyper- on T2 lesions along vascular boundary zones

Transcranial Doppler

- Trauma pts may be monitored even intra-op

TEE

Trans-Esophageal Echo: Fat extravasation into lung parenchyma during nailing can be seen!

Treatment - Supportive

Hemodynamic

- Adequate hydration, blood products
- Albumin- binds fatty acids

Prophylactic

- Deep venous thrombosis
- Stress ulcers
- Cachexia

pO_2 monitoring

- Continous pulse oximetry to detect early desaturation
- Decreases chances of hypoxic insult and systemic complications

Treatment - Drugs

Steroids

- May have role in prophylaxis, but not in rx
- Can benefit if there is cerebral edema
- Methylprednisolone used, with wide variation in dosages (2mg/kg q8h to 30mg/kg q4h)
- Overall data controversial

Heparin

- Stimulates lipase and clears lipemis
- NO clinical role

Others

- ASA- inhibits thromboxane, NO role
- IV alcohol- NO role
- Hypertonic Glucose- NO role

Treatment – Ventilation

Goal: maintain SpO2>90% at Fio2<0.6

Reverse I:E ratio, adequate PEEP, low tidal volume

Pressure Control Mode

- Seems to better prognosis in select pts

Prone positioning

- Improves oxygenation in half of pts, but no survival benefit

PEEP: positive end-expiratory pressure ventilation

Treatment - Surgical

Early immobilisation

- External fixation preferred in a borderline pt
- ORIF also better than conservative Mx

Intramedullary nailing?

- Concerns of reaming causing embolism
- Initial evidence seems to indicate no increased risk with femoral or tibial nailing

Treatment - Surgical

Intramedullary fixation of long bones (particularly diaphyseal fractures of the femur) is preferred because it reduces the risk of fat embolism syndrome. However, reaming for the nail can cause an increase in circulation and can potentially increase the risk of a fat embolism to the lung, so un reamed nailing should be preferred.

Q. During IM nailing in a high risk patient for FES, all of the following techniques can be useful to reduce IM pressure EXCEPT

A. Bone venting

B. Making drill holes in cortex

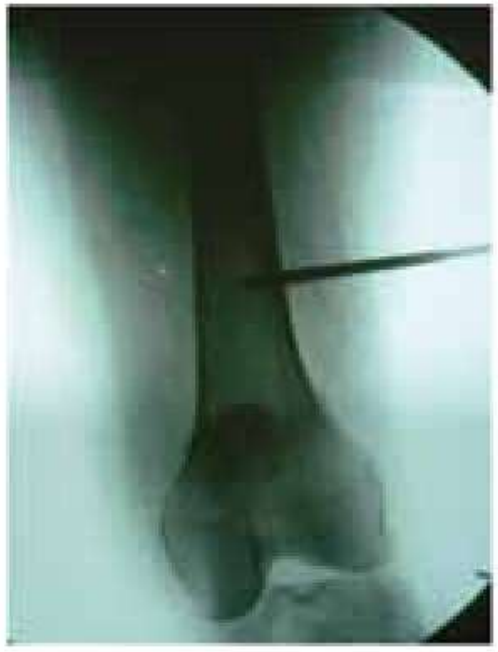
C. Corticosteroid administration before inserting nail

D. Lavage before bone fixation

Treatment - Surgical

Techniques to decrease incidence while internal fixation (nailing):

- Un-reamed nailing
- Make drill holes into bone cortex to decrease intramedullary pressure
- Lavage the bone before fixation
- Venting the bone- drilling a hole approximately 4.5 mm in diameter into the distal cortex of the femur to reduce IM pressure while nailing
- Use tourniquet to prevent embolisation



RISK FACTORS FOR SEVERE FES

- High velocity trauma
- Surgical delay > 10 hours
- Fixation of multiple fractures in same sitting
- Presence of a contused lung secondary to trauma

Prognosis

Mortality

- 10%; as compared to 50% for other forms of ARDS

Duration

- Mean 6 days ICU stay; 15 days hospital stay

Respiratory

- Changes usually reverse
- Small perfusion defects may persist

Neurological

- Subtle deficits to personality changes to focal deficits
- Global anoxic injury very rare

Summary