Pulmonary Embolism in the ICU

Nabil Abouchala, MD, FCCP, FACP
Consultant, Pulmonary & ICU
Medical Director, MSICU
Department of Adult Critical care Medicine
King Faisal Hospital & Research Center

abouhani@yahoo.com
Outline

- Epidemiology of VTE
- DVT-ICU patients
- Clinical Manifestations
  - Clinical
  - Biomarkers
  - EKG
  - ECHO
- Management
Pathophysiology of Pulmonary Embolism

Cases/Mortality 2002

in thousands

CVA
158/700

MI
171/865

PE
296/910
Silent DVT in ICU

Deep venous thrombosis: clinically silent in the intensive care unit

Mark A. Crowther MD, MSc(Epi)\textsuperscript{a,*,1}, Deborah J. Cook MD\textsuperscript{a,b,2}, Lauren E. Griffith MSc\textsuperscript{b}, Phillip J. Devereaux MD\textsuperscript{a,b,3}, Christian G. Rabbat MD, MSc(Epi)\textsuperscript{a}, France J. Clarke RRT\textsuperscript{b}, Neala Hoad RN\textsuperscript{c}, Ellen McDonald RN\textsuperscript{b}, Maureen O. Meade MD, MSc(Epi)\textsuperscript{a,b,4}, Gordon H. Guyatt MD, MSc(Epi)\textsuperscript{a,b}, William H. Geerts MD\textsuperscript{d}, Phillip S. Wells MD, MSc(Epi)\textsuperscript{e,2}

\begin{itemize}
  \item \textbf{N= 261 patients}
  \item \textbf{Bilateral LE CUS + Physical exam x wkly}
\end{itemize}

Silent DVT in ICU

Total DVT 35/261 = 13%
- 7 early DVT
- 25 late DVT
- 3 late CVC-related upper DVT

Symptomatic 6/35 = 17%
- 3 LE DVT
- 3 UE DVT

Silent DVT 83%

Silent DVT in ICU

- NO DVT: 87%
- DVT: 13%

- Asymptomatic: 88%
- Symptomatic: 12%

Spectrum of VTE
The Spectrum of Pulmonary Embolism

Stable hemodynamics and cardiac function

RV Dysfunction

Hemodynamic Instability
Case presentation

March 15, 2008:
- Patient is admitted to hospital with GI obstructive symptoms secondary to circumferential rectal cancer staged at T3N3M0. Patient is known to have hypertension.

March 17, 2008:
- Patient underwent colostomy creation surgery.

On the morning of March 21:
- Patient described feeling of dizziness after walking associated with SOB. BP of 99/65, saturation 97% on room air, patient was given fluid bolus.

March 22 at 7:30 a.m.
- Patient complained of SOB with no chest pain. BP 100/55, pulse 100 and regular.
- Patient was thought to have hypoxia due to fluid overload
Case presentation

- March 15:
  - Patient is admitted to hospital

- March 17:
  - Colostomy creation surgery

- March 21:
  - Dizziness

- March 22
  - at 7:30 a.m. SOB with no chest pain.
  - At 9:30 p.m. increasing SOB with minimal exertion, he appeared quite dyspneic
    - Sat 92%. **BP 103/75** pulse 100 RR 26 and T 36.3.
    - Feet were cold!
"In acute diseases, coldness of the extremities is a very bad sign..."

Hippocrates 400 BC
Case presentation

Investigation:
- Na 140, K 3.6, Cl 103, HCO3 18
- Lactic acid 5.8
- WBC 13.3, Hgb 126, Plat 156
- D-Dimer 1660
- Cardiac troponin 0.10
- ABGs: pH 7.43, PCO2 17, PO2 52, Sat 92%
- VBGs: pH 7.26, PCO2 43, PO2 21, Sat 24%
S1 Q3 T3

- Frequency 27%
- Mortality 76%

25mm/s 10.0mm/mV 100Hz
CXR Pre-Op
CXR Transfer to ICU
CT Chest
Septal bowing
## Table 3. Echocardiographic Findings in Major Pulmonary Embolism.

- Right ventricular dilatation and hypokinesis
- Interventricular septal flattening and paradoxic septal motion
- Reduced left ventricular distensibility during diastole, which results in increased left atrial contribution to left ventricular filling and an A wave that is greater than the E wave
- Pulmonary-artery hypertension on Doppler imaging
- Direct visualization of the embolus in rare cases
Echocardiography

RV
LV
RA
Clinical Syndromes of PE in PIOPED II

- Hemoptysis or pleuritic pain: 44%
  *
  *Pulmonary hemorrhage/infarction*

- Isolated dyspnea: 36%

- Circulatory Collapse: 8%
  *(acute cor pulmonale)*

- Different presentation: 12%
Clinical Characteristics According to Location of PE

*PIOPED II*

Central & Lobar
- 94%

Segmental
- 72%

Typical syndromes:
- Hemoptysis
- Pleuritic pain syndrome
- Uncomplicated dyspnea syndrome
- Circulatory collapse syndrome
Cardiac effects of APE

Obstruction of > 30% of the pulmonary circulation

Elevation of the pulmonary vascular resistance

Pulmonary hypertension

RV dilatation
Stable RV

RV dysfunction

Sudden Death
Cardiac Arrest
Shock

Mortality

0%
10%
30%
70%
100%

Severity

Embolism Size
Cardiopulmonary Status
In-Hospital Mortality According to the Degree of Hemodynamic Compromise

(1001 Patients with Acute PE)

Mortality

- RV dysfunction: 8.1%
- Hypotension: 15.2%
- Cardiogenic shock: 24.5%
- CPR: 64.8%

## Risk stratification in the presence of normal SBP

| Clinical evaluation | • General appearance  
|                     | • VS: BP, HR, RR, Temp, SpO2 |
| Assessment of RV dysfunction | • Distended jugular veins  
|                     | • Systolic murmur of TR  
|                     | • Accentuated P2 |
| EKG | • S1Q3T3  
|     | • T-wave inversion in leads V1-4 |
| Cardiac biomarkers | • Cardiac Troponin (RV micro infarction) |
| Echo | • RV dysfunction |
| Helical CT scan | • RV size |
Biomarker-based risk assessment model in acute pulmonary embolism

Maciej Kostrubiec¹, Piotr Pruszczyk¹*, Anna Bochowicz¹, Ryszard Pacho², Marcin Szulc¹,

N = 110 patient with Acute PE

10 patients with Massive PE SBP < 90 (3 APE death)

100 Patients SBP > 90

Mortality
15 Deaths (8 APE death)

On Admission
• Troponin
• BNP
• Echo
Consecutive Pulmonary Embolism Cases (#110)
10% APE Mortality

BP > 90 mmHg (#100)
8% APE Mortality

BP ≤ 90 mmHg (#10)
30% APE Mortality

High Risk
Risk Assessment Algorithm APE

SBP < 90
30%

SBP > 90

Pro-BNP > 600

Troponin > 0.07

33%
BNP & Troponin

Complimentary Biomarkers for Risk Stratification

- BNP:
  - Stretch
  - RV Dysfxn
  - BNP < 50 detects low risk

- And

- Troponin:
  - Ischemia
  - RV damage
  - TnT > 0.01 detects high risk
BNP & Troponin
Complimentary Biomarkers for Risk Stratification

Hemodynamically Stable PE

- BNP
  - Stretch
  - RV Dysfxn
  - BNP < 50 detects low risk

And

- Troponin
  - Ischemia
  - RV damage
  - TnT > 0.01 detects high risk
BNP & Troponin
Complimentary Biomarkers for Risk Stratification

Hemodynamically Stable PE

- BNP
  - Stretch
  - RV Dysfxn
  - BNP < 50 detects low risk
- Troponin
  - Ischemia
  - RV damage
  - TnT > 0.01 detects high risk

BNP/TnT Normal

- Lower risk
- Heparin
- Floor
- Outpatient
BNP & Troponin

Complimentary Biomarkers for Risk Stratification

Hemodynamically Stable PE

- BNP
  - Stretch
  - RV Dysfxn
  - BNP < 50 detects low risk
- Troponin
  - Ischemia
  - RV damage
  - TnT > 0.01 detects high risk

BNP/TnT Elevated

Higher risk

Echocardiogram

- RV Normal
  - Heparin
- RV Dysfunction
  - Heparin vs. Lysis?
initially maintain systemic arterial pressure. Consequently, in distinction to the last version of these guidelines that generally discouraged treatment of PE with thrombolytic therapy unless there was hemodynamic compromise, we suggest administration of thrombolytic therapy in selected high-risk patients without hypotension who are judged to have a low risk of bleeding.

Assessment of bleeding risk with thrombolytic therapy is similar in patients with PE and with acute ST-segment elevation myocardial infarction. Major contraindications to thrombolytic therapy include intracranial disease, uncontrolled hypertension at presentation, and recent major surgery or trauma.
Thrombolytic Regimens for PE

- **tPA** – 100 mg IV over two hours.

- **Streptokinase** – 250,000 units IV over the initial 30 minutes, then 100,000 units/hour for 24 hours.

- **Urokinase** – 4400 units/kg IV over the initial 10 minutes, then 2200 units/kg per hour for 12 hours.
Case presentation

- Pre TPA:
  - Lactic acid 5.8
  - VBG: pH 7.26, PCO2 43, PO2 21, Sat 24%

- Post TPA:
  - Lactic acid 2.4
  - VBG: pH 7.37, PCO2 37, PO2 52, Sat 69%
Massive PE

- **Diagnosis:** Spiral CT or echocardiography

- **Thrombolysis** is the **first** line treatment for massive PE [B] and may be instituted on clinical grounds alone if cardiac arrest is imminent [B]
An Integrated Approach to the Risk Stratification of Patients with Acute PE
An Integrated Approach to the Risk Stratification of Patients with Acute PE

- **No shock**: Anticoagulation alone
- **Shock**: Consider fibrinolysis or embolectomy
An Integrated Approach to the Risk Stratification of Patients with Acute PE
PLEASE STOP DVT
SO MY DAD
WILL NOT HAVE TO TREAT PE