Pulmonary Embolism: Assessment, risk-stratification, and treatment plan for the outpatient management of low-risk patients

Presentation by
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Objectives

1) Compare and contrast the various validated tools for the identification of patients with pulmonary embolism

2) Distinguish between the different risk and mortality algorithms that exist and the merits of using multiple criteria for stratification

Background

What is a Pulmonary Embolism

Various thrombosis transported within circulation to pulmonary arterial circulation

Blocks arterial lumen

Compromises downstream perfusion

Resulting in cardiac and respiratory compromise

Presentation

May present as acute, sub-acute, or chronic

Location

Saddle, Lobar, Segmental, Sub-segmental

Background

Pulmonary Embolism (PE)

Second leading cause of sudden cardiac death, and third leading cause of cardiovascular death in the US

>100,000 deaths annually in the US

5-10% of hospital-related deaths

75-269 cases per 100,000 annually worldwide

Increased incidence of 700 per 100,000 after the age of 60

Increased testing

Higher rate of diagnosis

Increased morbidity and mortality

Renal failure, hemorrhage, and cancer

Co-Investigators

Jayme Hartzell, PharmD, MS, BCPS

Disclosure Statement

Financial

The investigators of this study have no financial conflicts of interest to disclose

Non-Financial

The primary investigator of this study has been provided published resources (including published articles, clinical pocket cards, and free trial vouchers) from Johnson and Johnson to aid in the development of the study.

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Renal failure, hemorrhage, and cancer
Background

- Traditionally required hospitalization due to treatment options
- Advent of low-molecular weight heparins (LMWH's) and direct oral anticoagulants (DOAC's) increased feasibility of outpatient therapy
- Outpatient treatment of "low-risk" patients has been shown in studies to be non-inferior to inpatient treatment
- Confirmed via validation studies with low adverse event rates in the first 3 months following diagnosis
- The American College of Chest Physician Guidelines indicate that risk tools may be utilized to identify patients at "low-risk" for adverse events and early mortality
- These patients may be discharged home for treatment
- Treatment options recommended in the 2016 guidelines include, DOAC's, Vitamin-K antagonists (warfarin), and LMWH

Methods

- Retrospective, single-center, quasi-experimental study
- Pre-intervention data collection (Complete)
- Intervention (Complete)
- Algorithm implementation and provider education
- Post-intervention data collection (In process)
- Data gathered utilizing electronic health record

Methods

- Inclusion criteria
  - Age ≥ 18 years old
  - Patients diagnosed with a PE and admitted/treated by the Emergency Department, or referred to the Emergency Department for confirmation of suspicion of PE
- Exclusion criteria
  - Patients admitted directly to the hospital from outlying facilities or clinics
  - Patients with previously confirmed or treated PE

Methods

- Primary outcome
  - Number of patients re-admitted within 30 days
- Secondary outcomes
  - Effectiveness of predictive tools in diagnosis of pulmonary embolism
  - Quantity of patients qualifying for outpatient treatment by Hestia Criteria
  - Recurrence rate of PE
  - All-cause mortality at 30 and 90 days
  - Rate of major bleeding events
  - Average length of stay

Intervention

- Assessment algorithm
  - Diagnostic strategy algorithm
  - Pretest probability assessment (Wells Score and PERC)
  - Additional risk stratification (D-Dimer age-adjusted, imaging studies)
  - Risk stratification algorithm
  - Severity and risk assessment (Hestia Criteria)
  - Morbidity risk assessment (Clinical Features Correlated for Mortality Risk)
  - Bleeding risk assessment (HAS-BLED Score)
  - List of Recommended outpatient treatment options
**Wells Score and Clinical Probability of PE Criteria**

- History of PE or DVT
- Heart rate > 100 beats/min
- Recent surgery or immobility
- Hemoptysis
- Active malignancy
- Signs of DVT
- Alternative diagnosis to PE less likely

**Three-Level Clinical Probability of PE**

- Low: 0 - 1
- Intermediate: 2 - 6
- High: ≥ 7

DVT = deep vein thrombosis; PE = pulmonary embolism

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**Pulmonary Embolism Ruleout Criteria**

- Age > 49
- Heart rate ≥ 99 beats/min
- Pulse oximetry < 95% on room air
- Hemoptysis
- Exogenous estrogen supplementation
- History of venous thromboembolism
- Surgery or trauma within 1 month which required hospitalization
- Unilateral leg swelling

- If Yes is answered for any question then PE cannot be ruled out of differential diagnosis

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**Hestia Criteria**

- 1. Hemodynamically unstable? *
- 2. Thrombolysis or embolectomy necessary?
- 3. Active bleeding or high risk of bleeding? ±
- 4. Oxygen supply to maintain oxygen saturation > 90% > 24 h?
- 5. Pulmonary embolism diagnosed during anticoagulant treatment?
- 6. Intravenous pain medication > 24 h?
- 7. Medical or social reason for treatment in the hospital > 24 h?
- 8. Creatinine clearance of less than 30 mL/min? ≠
- 9. Severe liver impairment?
- 10. Pregnant?
- 11. Documented history of heparin-induced thrombocytopenia?

- If one of the questions is answered with YES, the patient CANNOT be treated at home

* Include the following criteria, but leave these to the discretion of the clinician: systolic blood pressure < 100 mm Hg with heart rate > 100 beats/min; condition requiring admission to an intensive care unit ±

Gastrointestinal bleeding in the preceding 14 days, recent stroke (< 4 weeks ago), recent operation (< 2 weeks ago), bleeding disorder or thrombocytopenia (platelet count < 75 x 10⁹/L), uncontrolled hypertension (systolic blood pressure > 180 mm Hg or diastolic blood pressure > 110 mm Hg)

≠ Calculated creatinine clearance according to the Cockcroft-Gault formula

× Left to the discretion of the physician

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**Clinical Features of Acute PE Correlated for Mortality Risk**

- Low Risk
- Intermediate Risk (“submassive”)
- High Risk (“massive”)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Low Risk</th>
<th>Intermediate Risk</th>
<th>High Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemodynamic status</td>
<td>Normal</td>
<td>Normal</td>
<td>Unstable</td>
</tr>
<tr>
<td>Hypoxia</td>
<td>±</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Serum biomarkers</td>
<td>-</td>
<td>±</td>
<td>++</td>
</tr>
<tr>
<td>RV dysfunction</td>
<td>-</td>
<td>+</td>
<td>+++</td>
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</tbody>
</table>

**Key:**

- = normal; ± = may be present; ++ = likely present; +++ = present

- SBP < 90 mm Hg or decrease ≥ 40 mm Hg from baseline, or requires a vasopressor infusion

- RV dysfunction diagnostic criteria:
  - Echocardiography or CT: RV/LV diameter ratio ≥ 0.9 and/or RV systolic dysfunction
  - Elevated cardiac biomarkers: BNP, NT-proBNP, and/or cardiac troponin
  - ECG: New complete/incomplete right bundle branch block and/or anteroseptal ST-segment elevation/depression and/or anteroseptal T-wave inversion

- BNP = B-type natriuretic peptide; LV = left ventricle; PE = pulmonary embolism; RV = right ventricle

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**Treatment Options (including class, dosing regimen, precautions, and interactions)**

- No Bridge required
- Eliquis (apixaban)
- Xarelto (rivaroxaban)
- Bridge required
- Warfarin

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**Pre-intervention data**

- Study period January 1, 2017 - December 31, 2017
- Patients with diagnosis of PE identified by ICD 10 code = 198
- Patients fitting inclusion criteria = 89
- Age range = 19-89 years old
- Mean age = 65.8 years old
- Insurance
  - Insured = 85
  - Uninsured = 4
Pre-intervention data

- Pre-test probability
  - Wells Score
    - Positive = 47 (75.3%)
    - Negative = 15 (24.7%)
  - PERC
    - Positive = 18 (90.9%)
    - Negative = 1 (1.1%)
  - Additional risk stratification
    - D-Dimer performed = 30 (33.7%)
    - CT performed = 79 (89%)
    - VQ performed = 6 (6.7%)

- Severity and mortality risk assessment
  - Hestia
    - Qualify for outpatient treatment = Yes - 21 (33.4%), No - 68 (74.4%)
    - Recalculated outpatient treatment = B (39% of those eligible)
  - PERC
    - Qualify for outpatient treatment and Low-risk = 8 (35% of eligible)
    - 3 patients healed outpatient
    - Qualify for outpatient treatment with massive/sub-massive = 13 (62% of eligible)
    - 4 patients healed outpatient
  - Clinical features mortality risk
    - Low-risk = 26 (93.3%)
    - Massive/sub-massive = 6 (21.4%)

- Additional risk stratification
  - D-Dimer performed = 30 (33.7%)
  - CT performed = 79 (89%)
  - VQ performed = 6 (6.7%)

Pre-Intervention data

- Bleeding risk assessment
  - Average HAS-BLED for those that qualify for outpatient therapy = 1.23
  - Average HAS-BLED for those that do not qualify for outpatient therapy = 2.12
  - Length of stay
    - Average length of stay for those that qualify for outpatient therapy = 1.2 days
    - Average length of stay for those that do not qualify for outpatient therapy = 4.22 days

Discussion

- Analysis of pre-intervention data
  - Validated tools selected for pre-test probability
  - Identified numerous patients that may have qualified for outpatient therapy
  - Showed a decreased average length of stay in patients admitted that qualified for outpatient therapy
  - Identified 5 patients that would have qualified for outpatient therapy that suffered re-admission, recurrence, major bleed, or death, which is in line with other studies and current guidelines.

Conclusion

- Current treatment practices of PE patients identified in the emergency departments may not be aligned with best practices or guidelines,
  - Adherence to the proposed intervention will likely help to identify more PE's and improve clinical outcomes and mortality.
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- Limitations
  - This study is retrospective and only captures patients that have a confirmed diagnosis of PE by ICD-10 code, which may not be representative of all patients with PE.
  - As always when performing reviews within the electronic health record, incomplete documentation could skew data.
Future Directions

- Post-intervention data collection
- Continued reinforcement for use algorithm
- Continued education and resources as needed or as data becomes available
- If effective, pursue standardization process as approved protocol
- Possibly implement in outlying departments/clinics

References