CORRELATION OF PULMONARY EMBOLISM SEVERITY INDEX AND PULMONARY ARTERY INVOLVEMENT IN CT PULMONARY ANGIOGRAM- EXPERIENCE IN A TERTIARY CARE CENTRE

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ABSTRACT

BACKGROUND
Pulmonary embolism is a common and life-threatening condition. Most of the mortality due to pulmonary embolism occurs within the first few hours of the event. Despite improvement in diagnostic techniques, delays in diagnosis of pulmonary embolism are common. As an aetiology of sudden death, massive pulmonary embolism is second only to sudden cardiac death. In current scenario, it is underdiagnosed. Even though, the diagnosis is established, the choice of treatment decides the prognosis. So, using PESI (pulmonary embolism severity index), we can categorise patients into low-risk group and high-risk group and compared it with CTPA (computed tomography pulmonary angiogram) imaging for level of pulmonary artery involvement.

MATERIALS AND METHODS
This is a retrospective study for a period of 3 years from January 2013 to June 2016. Total of 50 patients were included in this study. In acute pulmonary embolism, patients who underwent CTPA, PESI clinical score was calculated and correlation was done in between these two.

RESULTS
Out of 50 patients, 38 are in high-risk group and 12 are in low-risk group. Main pulmonary artery, right/left pulmonary artery were involved in 70% of high-risk group patients, which shows a statistically significant association between risk group (class) and involvement of level of arteries by CT pulmonary angiography (p value 0.001).

CONCLUSION
- By simply using this, 11 variable PESI score, one can predict the patients who are at high risk in the emergency department itself.
- We can decide, which patient should undergo thrombolysis according to the risk score.
- Patients with high-risk score with immediate thrombolysis will have better results.

KEYWORDS
Computed Tomography Pulmonary Angiogram (CTPA), Pulmonary Embolism Severity Index (PESI), Pulmonary Artery (PA), Pulmonary Embolism (PE).

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BACKGROUND
Pulmonary Embolism (PE) is an acute and potentially fatal condition in which embolic material, usually thrombus originating from one of the deep veins of legs or pelvis, blocks one or more pulmonary arteries causing impaired blood flow and increased pressure to the right ventricle.

PE and deep vein thrombosis are considered to be two manifestations of the same condition, Venous Thromboembolism (VTE). PE is difficult to diagnose because symptoms are nonspecific and clinical presentation of patients with suspected PE varies widely from patient to patient who are asymptomatic to those in cardiogenic shock.

Symptomatic VTE occurs in 1-2 per 1,000 adults with about a third presenting with PE.

The incidence of PE increases exponentially to nearly 5-6 cases per 1,000 in older (>75 years) age.

PE-related mortality can be as high as 25%, if untreated. In the long-term due to comorbidities such as malignancy, congestive heart failure and chronic lung disease, mortality can reach up to 24-27%.

Venous thromboembolism is considered to be “provoked” in the presence of a temporary or reversible risk factor. Women of reproductive age have higher rates of PE related to pregnancy and by the use of oral contraceptives. Major trauma, surgery, lower limb fractures, joint
replacements, spinal cord injury, surgery for cancer and neurosurgery are strong provoking factors for VTE.\textsuperscript{3}

The highest risk for PE is conferred with history of previous VTE, immobility for more than 48 hours, infection and cancer.\textsuperscript{4} In the Prospective Investigative Study of Acute Pulmonary Embolism Diagnosis (PISA-PED),\textsuperscript{5} at least one of these risk factors was present in more than 80% of patients with established PE and in about 70% of those without PE.

Other medical disorders associated with increased risk for PE include heart failure, ischaemic stroke, acute respiratory failure or intubation, sepsis, acute rheumatic disease, CKD and inflammatory bowel disease.\textsuperscript{6}

Unprovoked risk factors are inherited. These manifest as prothrombotic conditions associated with either reduced levels or activity of anticoagulant proteins or maybe associated with increased levels or function of coagulation proteins. But, these deficiencies are rare and only account for 1% of all cases of PE.

Acute PE effects both the pulmonary circulation and gas exchange. Right Ventricular (RV) failure due to pressure overload is considered the primary cause of death in severe PE. Pulmonary artery pressure increases once more than 35-50% of the total cross-sectional area of the pulmonary arterial bed is occluded by thromboemboli.

PE-induced vasoconstriction contributes to the initial increase in pulmonary vascular resistance after PE.

Anatomical obstruction and vasoconstriction lead to an increase in pulmonary vascular resistance. The abrupt increase in pulmonary vascular resistance results in dilation of RV, which in turn alters the contractile properties of the right ventricle myocardium. The prolongation of RV contraction time into early diastole in the left ventricle leads to leftward bowing of the interventricular septum. As a result, Left Ventricular (LV) filling is impeded in early diastole and it leads to a reduction of the cardiac output and contribute to systemic hypotension and haemodynamic instability.

Pulmonary embolism is a serious and potentially fatal disorder.\textsuperscript{7} Pulmonary embolism risk stratification may allow early hospital discharge after treatment as an outpatient for low-risk patients. It also allows identification and in-hospital treatment of high-risk patients.

Pulmonary Embolism (PE) often provides not only a diagnostic challenge, but a prognostic one.

The PESI produces a score for patients based on 11 variables,\textsuperscript{8} including age, sex, history of cancer, basic observations and mental status. The score can be used to stratify patients into five different groups from I (very low risk of death within the next 30 days) to V (very high risk of death within the next 30 days).

Other prognostic indicators like CURB-65 score has got widespread acceptance in community-acquired pneumonia. However, for some strange reason, the PESI has not enjoyed the same success. One major factor for this is, its complexity as it requires the collection and analysis of 11 different variables.\textsuperscript{9}

The short-term mortality in shock patients is at the rate of 25-50%, whereas those with preserved blood pressure at presentation experience only a 2% to 5% risk of death.

An understanding of the pathophysiology of acute PE is essential to risk stratification. Outcomes clearly rests on the pre-existing comorbidities as well as the haemodynamic compromise. Especially in the setting of underlying cardiopulmonary disease, the capability of the Right Ventricle (RV) to compensate for an increase in pulmonary vascular resistance alters survival. The resistance to flow from the RV in acute PE is determined by both mechanical obstruction of the proximal pulmonary arteries by thrombus and also the effect of humoral factors that are released from the clot resulting in pulmonary vasoconstriction. In addition, the hypoxaemia due to impaired ventilation/perfusion matching contributes further to increase in pulmonary vascular resistance.

Risk stratification in acute PE has been investigated by a number of techniques including clinical scoring systems, laboratory measurements (biomarkers) and imaging studies.

In the task of stratifying those with acute PE into low-risk and high-risk categories, the PESI has better negative predictive value than positive predictive value in the setting of acute PE. This means that it excels in identifying those at low risk, however, lacks specificity in identifying those at high risk of adverse events.\textsuperscript{10}

In addition, although very useful in identifying those at low risk of 30-day mortality, the PESI is not as useful in the triage of patients with acute PE. To put in proper perspective, in one study those with a low-risk PESI score (groups I-II) experienced a 14% incidence of significant adverse events (not necessarily fatal), however, requiring inpatient care including increased oxygen requirement, need for vasopressor therapy or new arrhythmia.

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Points Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, per year</td>
<td>Age, in years</td>
</tr>
<tr>
<td>Male gender</td>
<td>+10</td>
</tr>
<tr>
<td>Cancer</td>
<td>+30</td>
</tr>
<tr>
<td>Heart failure</td>
<td>+10</td>
</tr>
<tr>
<td>Chronic lung disease</td>
<td>+10</td>
</tr>
<tr>
<td>Pulse ≥110 per minute</td>
<td>+20</td>
</tr>
<tr>
<td>Systolic blood pressure &lt;100 mmHg</td>
<td>+30</td>
</tr>
<tr>
<td>Respiratory rate ≥30 per minute</td>
<td>+20</td>
</tr>
<tr>
<td>Temperature &lt;36°C</td>
<td>+20</td>
</tr>
<tr>
<td>Altered mental status</td>
<td>+60</td>
</tr>
<tr>
<td>Arterial oxygen saturation &lt;90%</td>
<td>+20</td>
</tr>
</tbody>
</table>

Points correspond to the following risk classes- class I ≤65, class II 66-85, class III 86-105, class IV 106-125, class V >125.
In a large independent cohort, the PESI classified 36% of patients as low-risk (class I-II) in whom only 1% died within 30 days.

The mortality 10.7% for high-risk PESI (class III-V).

In recent years, the contribution of computed tomographic angiography (CTA) to the diagnosis of PE has greatly increased.

The most widely used technique for the diagnosis or exclusion of PE currently is multidetector CTA, which outlines thrombi in the pulmonary arteries with intravenous contrast medium and has almost replaced lung scanning as a screening test and conventional pulmonary angiography as the reference standard for the diagnosis of acute PE.

The predictive value of CTA is high with a concordant clinical assessment, but additional testing is necessary when clinical probability is inconsistent with the imaging results.

Positive predictive value of CTA varies with the extent of PE being 97% with main or lobar pulmonary artery abnormalities, 68% with segmental, but only 25% with isolated subsegmental pulmonary artery abnormalities.

The strengths of CTPA for acute PE risk assessment include the combination of both diagnostic and prognostic elements into a single study and wide availability. The disadvantages of CTPA include radiation exposure and requirement for intravenous contrast dye, both of which exclude certain patient populations.

Multiple CTPA measurements have been evaluated as potential prognostic tools in acute PE. These include the severity of pulmonary artery obstruction (clot burden), degree of RV strain, estimation of pulmonary artery pressure via main pulmonary artery diameter and indirect signs of elevated pulmonary vascular resistance such as reflux of contrast media into the inferior vena cava. Some other parameters, which have been studied including pulmonary artery size and contrast reflux have not been found to be reliable criteria for PE severity.

The proposed algorithm attempts to fulfill both these requirements with the usage of clinical risk prediction scores and a stepwise approach to assessing RV function that avoids unnecessary testing.

Patients who present in shock or with high-risk features such as hypotension or altered mental status are at significant risk of death and should be considered for intensive care unit admission and possible thrombolytic therapy. Patients in the low-risk group, those with benign clinical risk scores and no evidence by screening natriuretic peptide of RV dysfunction are unlikely to suffer short-term complications and maybe treated with conventional anticoagulation.

Source
Patients attended to Emergency Department/OPD/inpatients NRI Medical College and Hospital from January 2013 to June 2016.

Inclusion Criteria
All acute pulmonary thromboembolism patients with duration of less than 2 weeks.

Both males and females age >18 years.

Exclusion Criteria
Known pulmonary embolism patients.
Chronic pulmonary thromboembolic patients.

MATERIALS AND METHODS
Patients with acute PTE was subjected to CTPA and clinically PESI score was calculated. Correlation was done with PESI risk group and thrombus burden involved arteries in CTPA.

Correlation between PESI risk group and pulmonary artery level involvement in CTPA.

Statistical Analysis
Descriptive statistics are mainly used to present the findings. Chi-square test of association is used to find out association between PESI and involvement of pulmonary artery branches in CT pulmonary angiogram.

Study Design
Retrospective study.

<table>
<thead>
<tr>
<th>Age</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-34</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>35-39</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>45-49</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>50-54</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>55-59</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>60-64</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
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Table 1. Cases Distributed According to Age

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>27</td>
<td>54</td>
</tr>
<tr>
<td>Male</td>
<td>23</td>
<td>46</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 2. Distribution According to Gender

Figure 1. Distributed According to Age
Figure 2. Distribution According to Gender

<table>
<thead>
<tr>
<th>Cause</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKD</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>DVT</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>Idiopathic</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Polycythemia</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>RA clot</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>50</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Table 3. Distribution According to Aetiology

Table 4. Drugs Used for Treatment

<table>
<thead>
<tr>
<th>Class</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>High risk</td>
<td>38</td>
<td>76</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>50</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Table 5. Classified According to Risk Group

Table 6. Low-Risk and High-Risk Group Distributed According to Age
Figure 6. Low-Risk and High-Risk Group Distributed According to Age (Years)

### Table 7. Involved Pulmonary Artery and its Branches According to Risk Profile

<table>
<thead>
<tr>
<th>Class</th>
<th>Main PA</th>
<th>Left/right PA</th>
<th>Lobar/segmental</th>
<th>Total</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk</td>
<td>2</td>
<td>3</td>
<td>7</td>
<td>12</td>
<td>χ² value - 14.5, p value 0.001</td>
</tr>
<tr>
<td>High risk</td>
<td>16</td>
<td>19</td>
<td>3</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>22</td>
<td>10</td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>

**RESULTS**

- In this retrospective study, we noted Pulmonary Thromboembolism (PTE) is more in the age group of >45 years as 70% of the people in this group are affected.
- More common in female gender than male in our study.
- Most common cause for PTE is deep vein thrombosis, which accounts for 54% of all PTE patients and CKD (chronic kidney disease) is the second most common cause.
- 24% of the people are in low-risk group (class 1 and 2) and 75% are in high-risk group (class 3 to 5).
- Age group >45 years are in high-risk group, i.e. 95% of the people age >45 are in high-risk group.
- All patients of age group <40 years are in low-risk group.
- In high-risk group patients - main pulmonary artery, right PA, left PA are involved in 70% of the patients, which show a statistically significant association between risk group (class) and involvement of level of arteries by CT pulmonary angiography (p value 0.001).
- While in low-risk group patients, main PA, RT PA, LT PA involved in only 10% of the patients. Remaining all low-risk group patients had lobar and segmental branch involvement.

**DISCUSSION**

- In most of the studies, simplified PESI is used as a risk stratification tool.
- In our study, 11 variables PESI was used, because sensitivity and specificity is more with this compared to simplified PESI.
- No previous correlation studies between PESI and CT pulmonary angiogram was done.
- In our study, we observed PESI risk score was directly proportional to the severity of the pulmonary embolism.
- High PESI risk score patients have high chance of involving main right or left pulmonary artery.
- As the age progresses, the severity also increases according to this study.
- As DVT is well-known established cause for pulmonary embolism in our study, also it was proved that DVT is the most common cause for PE.
- Most of the studies described CKD is a rare cause, but in our study, it is the second most common cause for PE.
• Out of 38 high-risk group patients, we thrombolysed 25 patients, remaining all patients received heparin. 13 high-risk group patients were not thrombolysed in view of less thrombus burden in CTPA and due to contraindication to thrombolytic therapy.

CONCLUSION

• Pulmonary embolism is a potentially life-threatening condition, difficult to diagnose in several patients.
• Clinical signs of PE are neither sensitive nor specific enough to rule in or out the diagnosis. The choice of a diagnostic strategy for PE depends on the pretest clinical probability of PE, the condition of the patient, the availability of the necessary test, the risks of testing and the risk of an inaccurate positive or negative diagnosis.
• Clinical evaluation makes it possible to classify patients into probability categories corresponding to an increasing prevalence of PE, whether assessed by clinical judgment or by a PESI.
• The current diagnostic tool of choice for imaging, the pulmonary arteries in suspected PE is CTA in routine clinical practice. However, it may be constrained due to non-availability of CT equipment, contrast load and radiation.
• We can predict the patients who are at risk in the emergency department itself by simply using this 11 variable PESI score.
• With this risk score, it can be decided as to which patient should undergo thrombolization according to the risk score.
• Patients with high-risk score with immediate thrombolysis will have better results.

REFERENCES