

The Simplified Geneva Score and the Utilization of the D-Dimer and Computerized Tomography for Assessing Pulmonary Embolism

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Abstract

Background. Pulmonary embolism (PE) is clinically suspected in many patients who complain of shortness of breath or chest pain due to its nonspecific nature. The prevalence of PE, however, is low in this population. To assist physicians in diagnostic decision making, several clinical decision rules (CDR) have been developed. The appropriate use of these CDRs has been proven to decrease the need for expensive, time consuming, and invasive diagnostic imaging procedures. In this study, the appropriateness of D-dimer and CT usage was investigated to rule out pulmonary emboli based on the simplified Geneva score.

Methods. A retrospective review was performed on 74 patients with a CT scan ordered through a pulmonary embolism (PE) protocol. Using clinical data, the patients were stratified into “unlikely” and “likely” groups for the presence of PE based on the simplification of the revised Geneva score. Scores of 0-2 were graded as “unlikely” and scores of 3 or greater were “likely.”

Results. There were 45/74 (60.8%) patients in the “unlikely” group. Of these, 14/45 (31.1%) received a D-dimer; eight were normal and six elevated. Only one patient in the elevated group had evidence of a PE. Of the remaining 31(39.2%) patients in the “unlikely” group that did not receive a D-dimer, only one had a PE. The “likely” group consisted of 29 (39.2%) patients of whom six received a D-dimer. Three patients had a normal D-dimer and three had an elevated level. Neither of these two groups had a PE. Of the remaining 23 (60.8%) in the “likely” group who did not receive a D-dimer, six had a PE.

Conclusions. Diagnosing pulmonary emboli using D-dimer levels and CT scans may be aided by clinical decision rules such as the simplified Geneva system. This process may lead to more effective use of medical resources.

KJM 2011; 4(4):99-104.

Introduction

Pulmonary embolism (PE) is clinically suspected in many patients who complain of shortness of breath or chest pain due to its nonspecific nature. The prevalence of PE, however, is low in those patients with these symptoms. To assist physicians in diagnostic decision making, several clinical decision rules (CDR) have been devel-

oped.¹ The appropriate use of these CDRs have been proven to decrease the need for expensive, time consuming, and invasive diagnostic imaging procedures.

Two CDRs that have been studied extensively with proven validity are the Well's rule² and the Geneva score³. The Well's rule lacks full standardization, as one

criterion includes the physician's judgment whether an alternative diagnosis is more likely than PE. The predictive value of the Well's rule may be from this subjective component.¹ The Geneva score also has weaknesses, as it has eight variables, all with different individual scores, which can make it apt to errors and less likely to be used.

A simplified Geneva score has been developed, by assigning each of the 8 variables a value of 1.¹ This simplified score was found to be equivalent to the revised Geneva score with regards to diagnosing pulmonary embolism correctly in a sample of 1049 patients. The authors concluded that the simplified Geneva scoring did not lead to a decrease in diagnostic accuracy or clinical utility.¹ Furthermore, the study also used a highly sensitive D-dimer assay to categorize people into different probability groups. The study suggested that the use of the D-dimer was important and very sensitive in ruling out PE and that its use should be limited to the group "unlikely" to have PE. It also supported the notion that the immediate use of computerized tomography (CT) should be reserved only for those in the "likely" to have PE (i.e., high probability) group.

Methods

A retrospective review was performed on CT scans (Spiral CT chest with IV contrast using 1.25 mm slices) ordered through a PE protocol from 1/5/09 to 4/7/09 at the University of Kansas Medical Center (KUMC). Patients with charts that did not contain enough data to obtain a simplified Geneva score and those who received a CT scan for any other reason besides ruling out PE were excluded. All records, laboratory, and imaging results were accessed via KUMC's electronic medical record (O₂[®] and CHARTMAXX[®]). Data collected included clinical risk factors, location of the

encounter, D-dimer levels, and CT results. The D-dimer was considered as having been done only if results were obtained within 24 hours prior to the CT. Two different D-dimer tests were used and cutoffs for a normal D-dimer were 230 mg/L⁴ or 1.0 g/L (manufacturer's cutoff), depending on the assay.

Patients were scored as "likely" or "unlikely" to have pulmonary embolus using the simplified Geneva scoring protocol³ (see Table 1). Scores of 0-2 were graded as "unlikely" and scores of 3 or greater were "likely." Scoring was completed using the data closest to, but prior to the time of the CT being ordered.

Table 1. Simplified Geneva scoring to determine patients likely or unlikely to have a PE.

Variable	Score
Age > 65	1
Previous PE or DVT	1
Active cancer or cured < 1 year	1
Surgery within 1 month (under general anesthesia or lower extremity fracture)	1
Unilateral lower limb pain	1
Hemoptysis	1
Heart rate 75-94 beats per minutes	1
Heart rate > 94 beats per minute*	1
Unilateral lower limb swelling and pain with palpation	1

*Patients with a heart rate of > 95 receive one point for heart rate between 75-94 and one point for > 94, for a total of 2 points.

Results

A total of 74 patients met the eligibility criteria. The population demographics are shown in Table 2. Thirty-two (43.2%) CT scans were ordered from a non-intensive care unit (ICU) inpatient admission, 24 (32.4%) from the emergency department, 16

(21.6%) from the ICU (medical, surgical, or neurologic), and only two (2.7%) from the outpatient clinics.

Table 2. Population demographics.

Characteristic	Total (Percentage)
Over age 65	23 (31.1%)
Male	33 (35.0%)
Female	41 (55.0%)
Cancer (active or cured < 1 year)	23 (31.1%)
History of DVT or PE	11 (14.9%)

The group “unlikely” to have a PE according to the simplified Geneva score consisted of 45 (60.8%) patients. Of those, 14 (31.1%) received a D-dimer; eight were normal and none had evidence of PE. Six D-dimer levels were elevated and 1 patient

in this group had a PE. Out of the remaining 31(39.2%) patients in the unlikely group who did not receive a D-dimer, only one had a PE (see Figure 1).

The “likely” group consisted of 29 (39.2%) patients of which six (20.7%) received a D-dimer. Three patients had a normal D-dimer and the other three had an elevated level. None had any evidence of PE. Of the remaining 23 (60.8%) likely patients who did not receive a D-dimer, six were found to have a PE (see Figure 1).

The D-dimer ordering status was analyzed by department (see Table 3). In the emergency department 26.7% (4/15) of the “unlikely” and none (0/9) of the “likely” patients received a D-dimer. On the hospital inpatient ward, 33.3% (7/21) of the “unlikely” and 33.3% (3/9) of the “likely” patients received a D-dimer. In the Intensive Care Unit (ICU), 37.5% (3/8) of the “unlikely” and 37.5% (3/8) of the “likely” patients received a D-dimer. In the outpatient clinics, no patients in either group received a D-dimer.

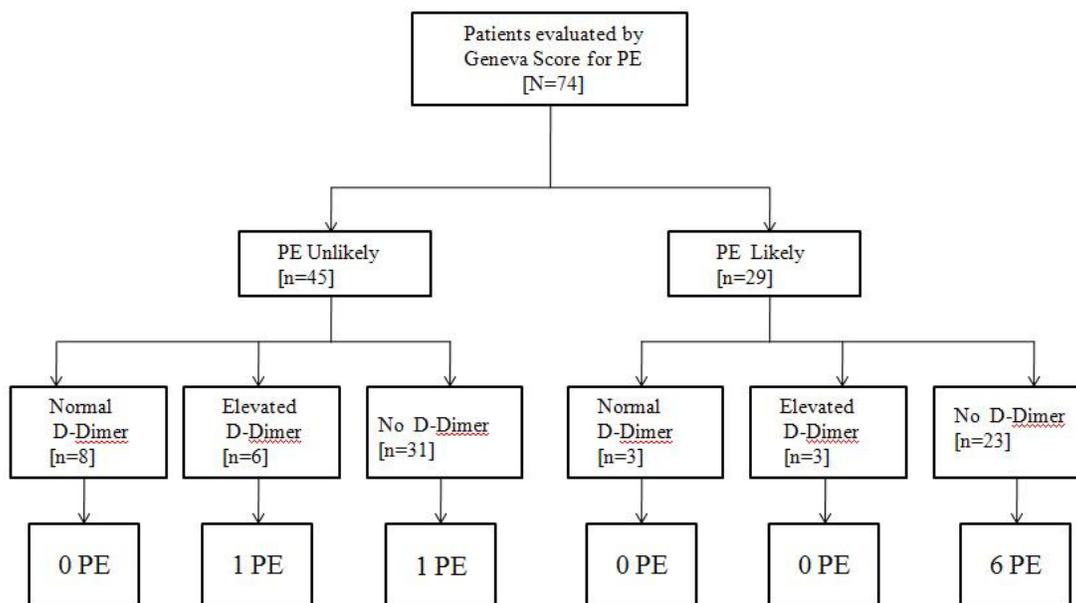


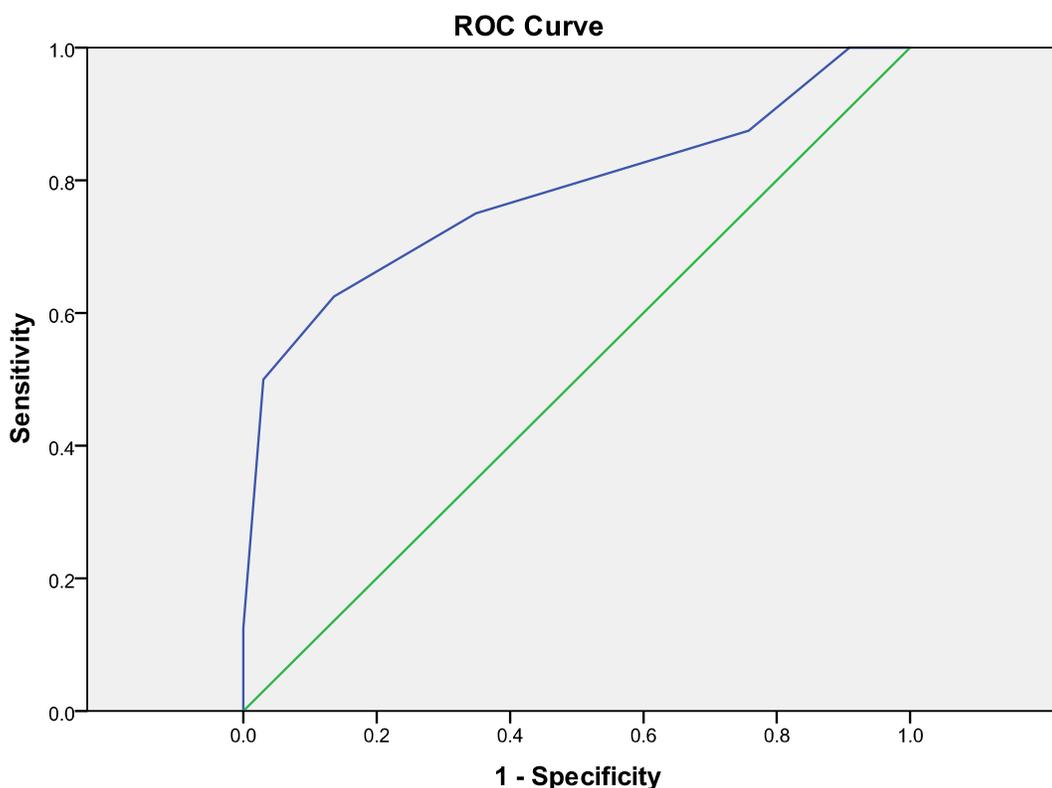
Figure 1. Stratification of patients based on the simplified Geneva score and D-dimer status. (Diagnosis was confirmed by CT scan using a PE protocol which is the gold standard investigation for PE.)

Table 3. Location of D-dimer ordering for patients who were likely or unlikely to have PE based on simplified Geneva score.

Location	“Unlikely” with D-dimer Percent (number)	“Likely” with D-dimer Percent (number)
Emergency Department	26.7% (4/15)	0% (0/9)
Hospital (Inpatient Ward)	33.3% (7/21)	27.3% (3/11)
Intensive Care Unit (Neurological, medical, surgical)	37.5% (3/8)	37.5% (3/8)
Outpatient Clinics	0% (0/1)	0% (0/1)

Statistical analysis comparing the accuracy of the simplified Geneva score against the PE protocol CT scans (the gold standard investigation) determined the sensitivity of the Geneva score to be 0.75 and specificity of 0.65. This correlated with a positive predictive value of 0.21 and negative predictive value of 0.96. The

continuous receiver operating characteristic (ROC) curve was plotted (see Figure 2). The area under the curve was 0.78 +/- 0.1 [95% CI: 0.571, 0.990]. These data were comparable to those reported by Klok et al.¹ that found an area under the curve (AUC) of 0.74 [95% CI: 0.70, 0.77].



Diagonal segments are produced by ties.

Figure 2. Continuous receiver operating characteristic curve of the Simplified Geneva Score.

Discussion

In the current healthcare climate, the allocation of limited medical resources is becoming increasingly more important. At KUMC, the charge for a CT scan ordered from a PE protocol was \$2,487. In comparison, the charge for a D-dimer test was \$278. In this study, the “unlikely” group may have received too many CT scans as only 2/45 (4.4%) patients had a PE. The D-dimer also seemed to be underutilized as 31/45 (68.9%) patients did not have one ordered. For the “likely” group, 6/29 (20.7%) patients had a pulmonary embolism, representing a 4.7 fold increase as compared to the “unlikely” group. In contrast to the underutilization of the D-dimer test in the “unlikely” group, there was an overutilization in the “likely” group. The D-dimer was ordered in 6/29 (20.7%) patients. These were considered unnecessary as a CT scan ordered from the PE protocol (i.e., the diagnostic gold standard) was ordered already. Of note, all 11 patients with a normal D-dimer did not have a PE. This result was consistent with the study by Klok et al.¹ who had a total of 330 patients in the “unlikely” group with normal D-dimers and had zero incidence of PE.

The utility of CDRs has been shown in multiple studies. However, if they are not used routinely, their efficiency and reliability becomes futile. When they are used judiciously, clinical judgment still must be taken before applying them to patient care. Clinical symptoms alone (as evaluated from the simplified Geneva score) did not reliably predict the presence of PE as only 20.7% (6/23) of “likely” groups had a PE.

Clinicians in a previous study⁵ did not document all the elements of a CDR properly and suggested the need for paper or electronic aids in conjunction with their use. In addition, CDRs and D-dimer levels had a lower specificity in cancer patients, hinting

at the need to modify established CDRs further and changing the D-dimer cut-off levels in special patient populations.⁶ In our series, we had 23 cancer patients of which 3 had a PE. All 3 patients were in the “likely” group and had a negative D-dimer showing that the specificity of D-dimer in our study was not adequate, and that a different D-dimer threshold for these patients may be warranted in this population. Other strategies to reduce CT utilization are also underway, as a more sensitive D-dimer test using the Tina-quant assay reduces the number of scans by 16%⁷, and a new diagnostic strategy combining clinical assessment, the D-dimer, ultrasonography, and lung perfusion scans required only 11% of patients to receive a CT scan.⁸

Our study is limited, in part, because it is a retrospective review. The clinical data were obtained through review of charts and not actual assessment of patients. The chart reviewers were not blinded to CT results. In addition, only patients who received CT scans were studied and those who were “ruled out” in other ways were excluded. Given these caveats, this study showed that stratification according to the simplified Geneva score produced a 4.7 fold (20.7% vs 4.4%) increase in the diagnosis of PE in the “likely” vs “unlikely” groups. These results provide further support for the ability of the simplified Geneva score to stratify patients according to risk. In addition, the stratification with the Geneva score and D-dimer also highlighted the fact D-dimers were underutilized in the “likely” group and given the negative predictive value of 0.96 in our study, unnecessarily ordered in the “unlikely” group.

In conclusion, diagnosing pulmonary emboli using D-dimer levels and CT scans may be aided by a CDR such as the simplified Geneva system. In those patients who are in the “unlikely” group with a

normal D-dimer, given the NPV of 0.96, a PE may be ruled out safely even without a CT scan. This process may lead to more effective usage of D-dimer levels and CT scans obviating the need for extra medical resources.

Acknowledgements

We would like to thank Dr. Mark Cunningham for his help with the technical aspects of D-dimer utilization.

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Keywords: pulmonary embolism, D-dimer, x-ray computerized tomography, diagnosis