SPEED

« Suspected Pulmonary Embolism in Emergency Department »

- Description manual -

Sommaire

1) Introduction

Making the diagnostic of pulmonary embolism (PE) can be challenging for physicians because no single test is suitable in all cases. Routine diagnostic practices for suspected PE differ often from evidence-based guidelines whereas the appropriateness of the diagnostic criteria strongly correlate with patient outcomes.[1]
The software SPEED is a computerized decision support system intended to help physicians taking care of patients suspected of having PE. SPEED is based on the Bayes theorem that states that the posttest odds of a disease equal the pretest odds multiplied by the likelihood ratio of the test result. Applying this principle, SPEED calculates at each time of the diagnostic process the probability of PE using clinical probability estimation and the likelihood ratios of the diagnostic tests. It guides diagnostic decision making step by step until the risk of error is low enough to rule-out or to rule-in PE with confidence.[2] Its scientific bases have been validated by a Committee of international experts and its efficiency has been evaluated in a recently published multicentric randomized trial. SPEED improves diagnostic decision making more than paper-based educational material.[3]

However, SPEED does not substitute the personal judgment of the physician. The physician is always responsible of his decisions.

SPEED 2009 operates on all Palm OS (Palm, Sunnyvale, California) devices and on emulator of palm OS devices for desktop computers. Versions for other devices are under construction.

SPEED 2009 can be downloaded free of charge after registration at www.thrombus.fr

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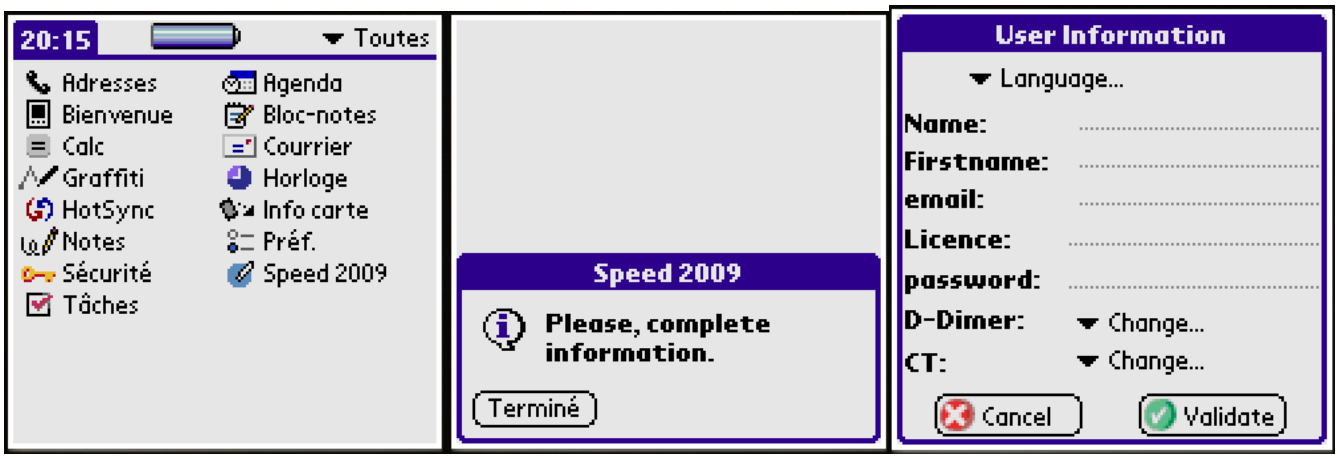
References:

[1] Roy PM, Meyer G, Vielle B, Le Gall C, Verschuren F, Carpentier F, et al; EMDEPU Study Group. Appropriateness of diagnostic management and outcomes of suspected pulmonary embolism. Ann Intern Med. 2006;144:157-64.

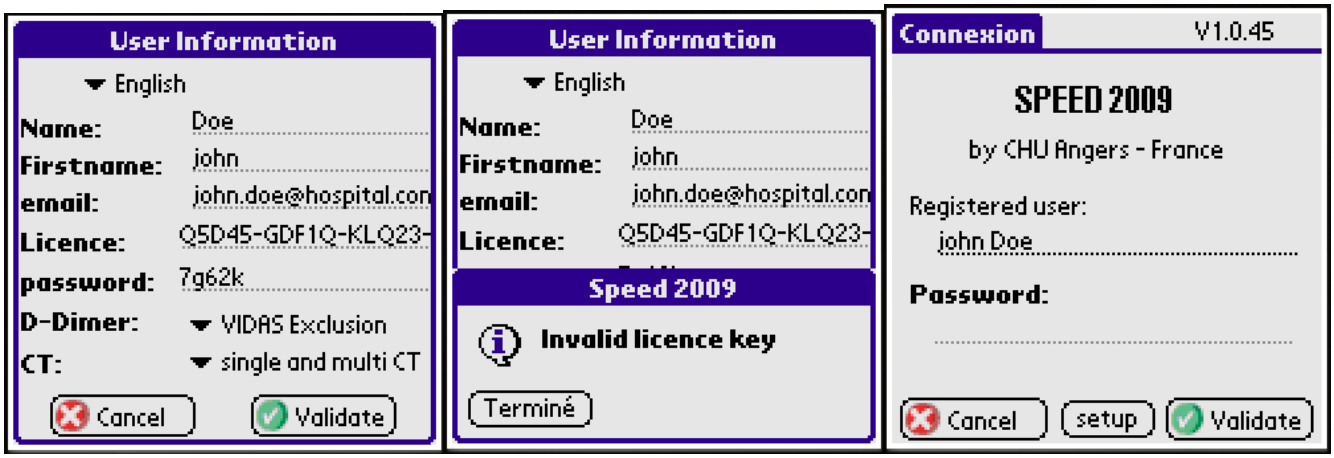
[2] Roy PM, Colombet I, Durieux P, Chatellier G, Sors H, Meyer G. Systematic review and meta-analysis of strategies for the diagnosis of suspected pulmonary embolism. Bmj. 2005;331(7511):259.

[3] Roy PM, Durieux P, Gillaizeau F, Legall C, Armand-Perroux A, Martino L, et al. A computerized handheld decision-support system to improve pulmonary embolism diagnosis. A randomized trial. Ann Intern Med. 2009;151:677-86.

2) SPEED initialization



The first time you want to use SPEED, you have to complete user information.



The same email address used during registration must be mentioned as well as the license key you have received by email after registration (cf. installation manual). You have to choose a password. You can specify the D-dimer test and the CT (single or multirow) you currently used.

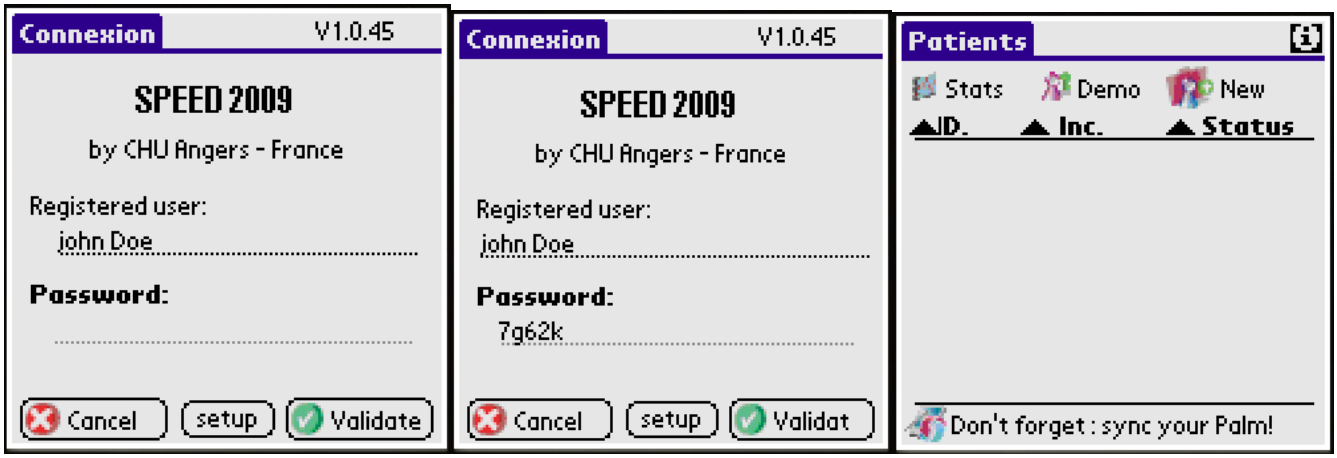
The next time, you will have just to mention your password in order to use SPEED.

3) SPEED utilization step by step

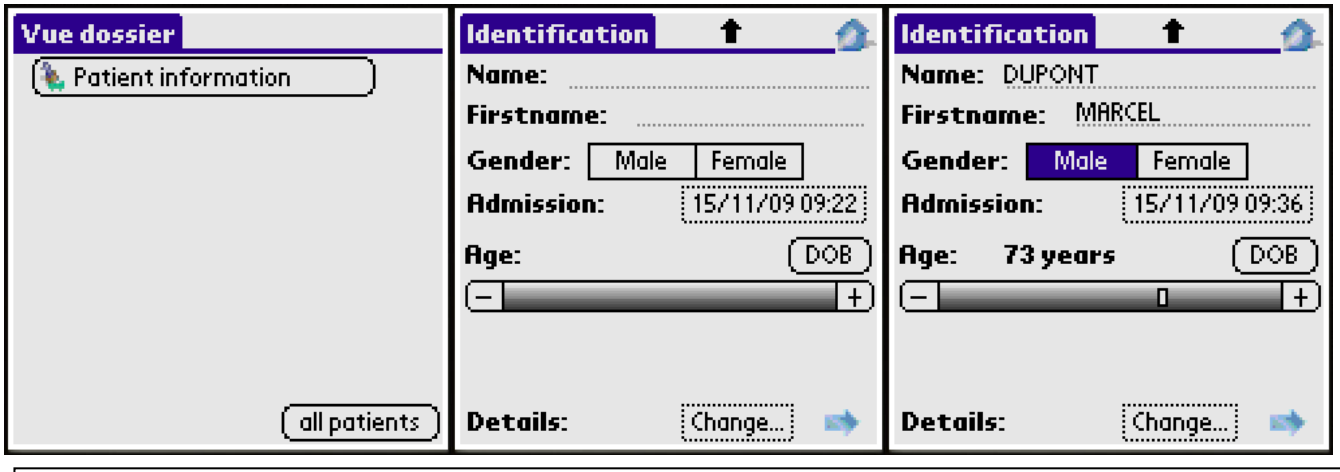
1) Summary

A physician who uses the program, after login, is first asked for the clinical variables necessary to generate a revised Geneva score that predicts the probability of pulmonary embolism. The physician is then asked to enter an estimate of the probability of pulmonary embolism, which could be the revised Geneva score estimate or a different probability from another source. SPEED then lists all available diagnostic tests, and uses the pretest probability to identify tests that could result in a posttest probability less than 5% or greater than 85% as "appropriate" and those that could not as "inappropriate". SPEED identifies the least invasive of the appropriate tests as "recommended". The physician is asked to enter the test chosen and its result. SPEED calculates the posttest probability and if it is low enough to rule-out PE or high enough to rule-in PE, SPEED recommends stopping investigations. If not, it lists a new set of appropriate tests and recommends the less invasive one. The same process is resumed until the probability threshold is obtained allowing a diagnostic decision with confidence.

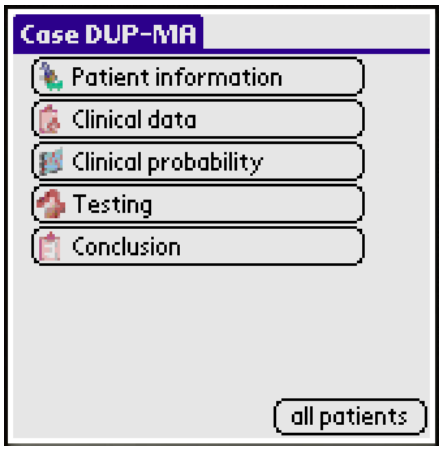
2) Login and patient information



You have to mention your password and will arrive to the summary screen "all patients". In order to use SPEED for a patient suspected of PE, choose "new". If you just want to test SPEED software or to perform demonstration, for example for students, chose "demo". Finally, if you want to have information about the appropriateness of your personal practice, choose "stats".

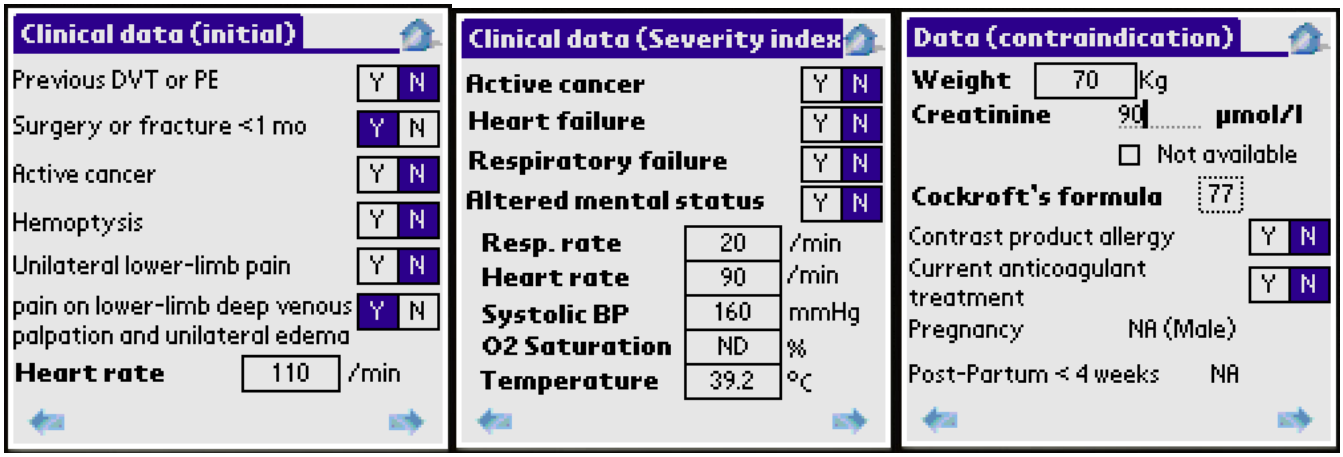


For a new patient, you have to mention his family name and first name or their initials, his gender and his age (click on the bar line or use the "date of birth" button).

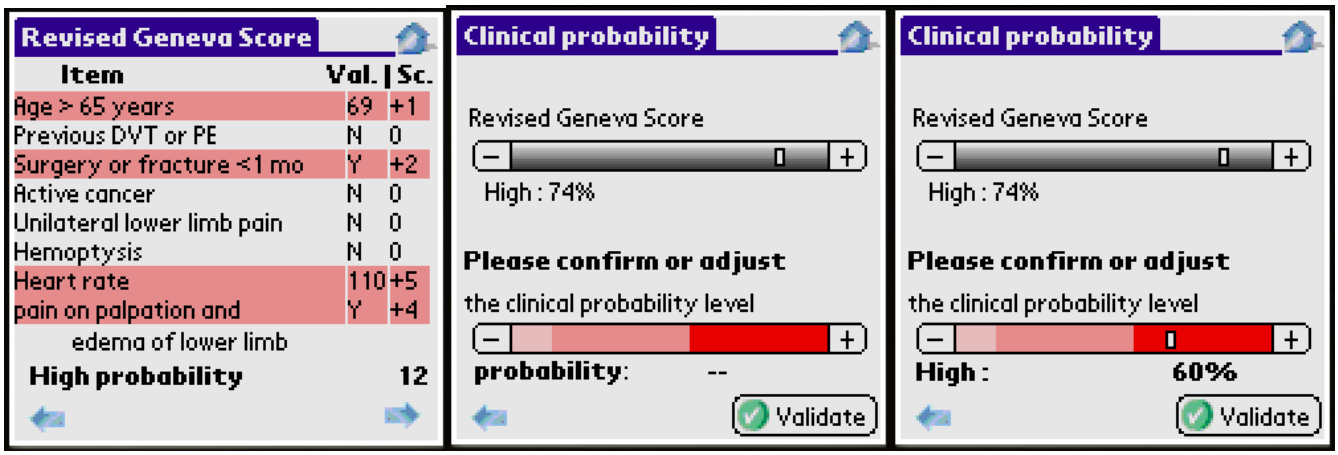


You have then to enter clinical data at least those used in the calculation of the revised Geneva score.
Click on “Clinical data” or directly on “Clinical probability”.

3) Clinical data input and clinical probability assessment

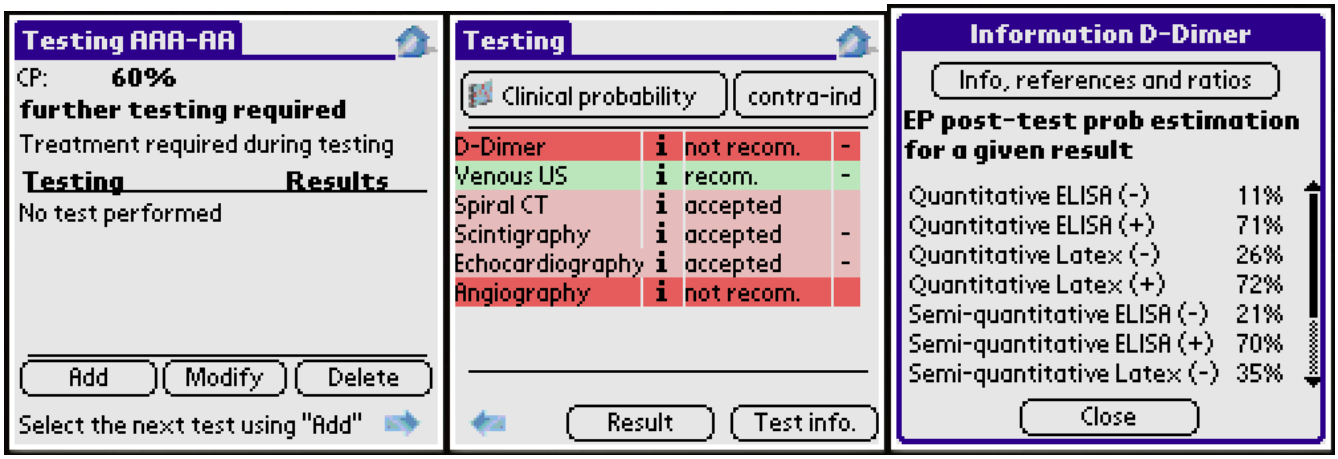


Clinical data include items of the revised Geneva score (panel 1), items used in the Pulmonary Embolism Severity Index (panel 2) and data that may contraindicate one or several diagnostic tests (panel 3). Just the first ones (panel 1) are required in order to estimate the clinical probability of PE.

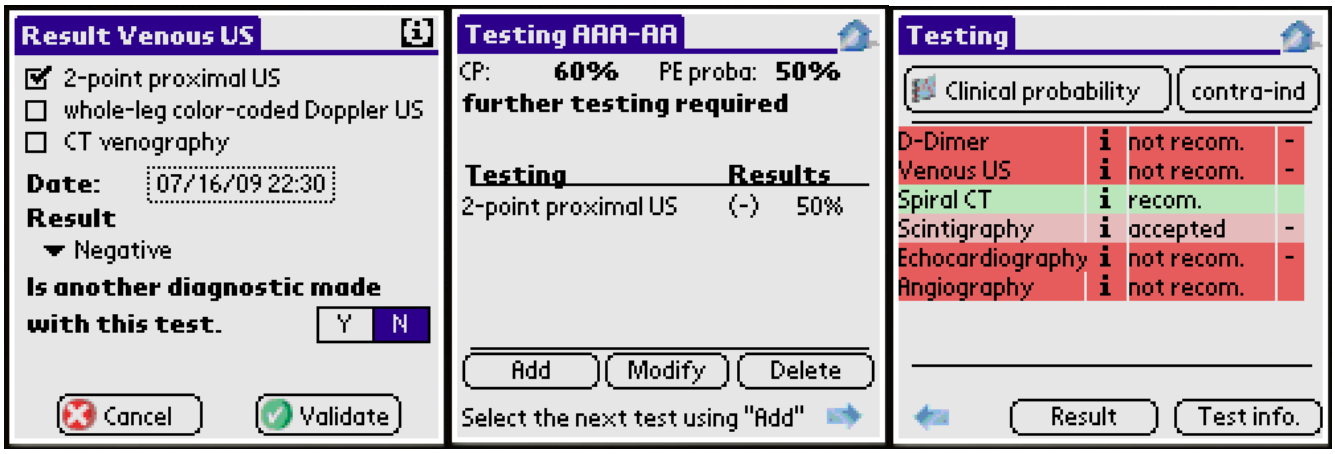


SPEED calculates the revised Geneva score (panel 1) and mentions the corresponding clinical probability (high, 74%; medium, 28%; low, 8%) (panel 2). You have then to confirm or to adjust the level of clinical probability using another rule or your implicit judgment (panel 3).

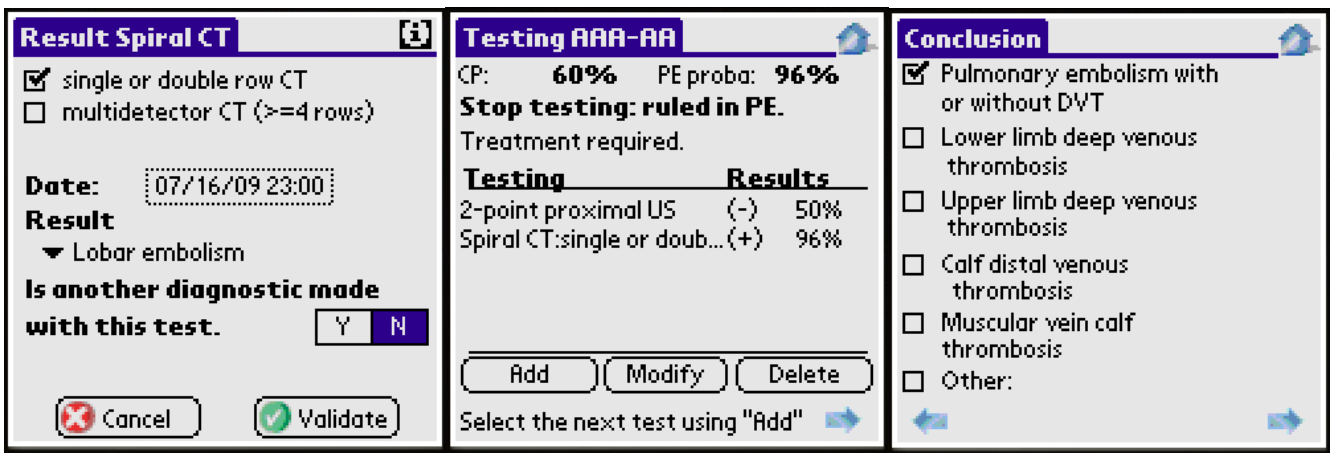
4) Testing and conclusion



To have information about appropriate testing, click “add” (panel 1). SPEED presents a list of possible test. Those that could result in a posttest probability less than 5% or greater than 85% are considered as appropriate and those that could not as inappropriate or “not recommended”. The less invasive appropriate test is mentioned as “recommended” and the others as “accepted” (panel 2). For each test, information about the PE posttest probabilities estimation is available when clicking on “i” button (panel 3).



When the test chosen and its result of the test are mentioned, SPEED calculates the posttest probability of PE (panel 1). If the probability is between 5% and 85%, SPEED recommends pursuing the investigation (panel 2). If you choose to add a test, SPEED lists a new set of appropriate tests and recommends the less invasive one (panel 3).



When the posttest probability becomes lower than 5% or greater than 85%, the software recommends stopping the investigations. Then you can enter your diagnostic conclusion.

4) Diagnostic process and probability thresholds

Using Bayesian theory, the diagnostic decision is never an absolute certainty but a probabilistic approach. When the probability of PE is enough low, below the test threshold, PE can be ruled-out and the testing stopped; when the probability is enough high, upper the treatment threshold, PE can be ruled-in and a treatment initiated [1,2]. The probability of PE (i.e. posttest probability) depends on the pretest probability (i.e. clinical probability) and the result of the diagnostic test(s) performed (i.e. its likelihood ratio). The likelihood ratio of a test result (LR) allows calculation of the posttest probability of PE as a function of the pretest probability of the disease (Pp), using the Fagan's diagram or the following formula: posttest probability = (Pp x LR) / (1-Pp x (1-LR)) [3].

The probability below which the clinician decides a diagnosis warrants no further consideration defines the test threshold. The more serious a missed diagnosis, the lower we will set our test threshold. Since a missed diagnosis of a pulmonary embolus could be fatal, we would be inclined to set our diagnostic threshold low. The invasiveness of the test we are considering will also impact our threshold.
The probability above which the diagnosis is sufficiently likely to warrant therapy defines the treatment threshold. The greater the adverse effects of treating (as long-term anticoagulant treatment), the more we will be inclined to choose a high treatment threshold. However, this is again counterbalanced by the risks associated with the test we are considering.

SPEED considers the probability thresholds (less than) 5% and (greater than) 85% as accurate for excluding or diagnosing pulmonary embolism [4,5]. However, as SPEED does a dynamic calculation of the PE probability, the physician is always aware of the risk of misdiagnosis and can decide to pursue investigations even if the preconfigured in the software probability threshold is obtained.

References:

[1] Richardson S, Wilson M, Guyatt G. The process of diagnosis. In: Guyatt G, Rennie D, eds. Users' guides to the medical literature. A manual for evidence-based clinical practice. Chicago: AMA Press, 2002.

[2] Chunilal SD, Eikelboom JW, Attia J, et al. Does this patient have pulmonary embolism? JAMA 2003; 290:2849-58

[3] Fagan TJ. N Engl J Med 1975; 293: 275

[4] Kearon C. Diagnosis of pulmonary embolism. Cmaj 2003;168(2):183-94

[5] Roy PM, Colombet I, Durieux P, Chatellier G, Sors H, Meyer G. Systematic review and meta-analysis of strategies for the diagnosis of suspected pulmonary embolism. Bmj. 2005;331(7511):259.

5) Clinical probability – The revised Geneva score

The assessment of the clinical probability is the first step of the diagnostic workup. SPEED calculates the revised Geneva score [1,2]. The revised Geneva rule is based on clinical variables without requiring test as arterial blood gas measurement (conversely to the first Geneva rule) or subjective diagnostic judgment (conversely to Wells' rules) [3-5]. However, the physician using SPEED can use another rule or his implicit judgment to override the revised Geneva score.

Variables	Points
Age	
> 65 y	+1
Medical history	
Previous deep venous thrombosis or PE	+3
Surgery (under general anesthesia) or fracture (of the lower limbs) within 1 mo	+2
Active malignant condition (solid or hematologic malignant condition, currently active or considered cured since < 1 y)	+2
Symptoms	
Unilateral lower-limb pain	+3
Hemoptysis	+2
Clinical signs	
Heart rate between 75 and 94 beats/min	+3
Heart rate ≥ 95 beats/min	+5
Pain on lower-limb deep venous palpation and unilateral edema	+4
The clinical probability is low when the total is ≤ 3: prevalence 8%.	
The clinical probability is intermediate when the total is between 4 and 10: prevalence 27%.	
The clinical probability is high when the total is ≥ 11: prevalence 73%.	

References:

[1] Le Gal G, Righini M, Roy PM, Sanchez O, Aujesky D, Bounameaux H, Perrier A. Prediction of pulmonary embolism in the emergency department: the revised geneva score. Ann Intern Med. 2006;144:165-71.

[2] Righini M, Le Gal G, Aujesky D, Roy PM, Sanchez O, Verschuren F et al. Diagnosis of pulmonary embolism alone or comined with venous ultrasonography of the leg : a randomised non-inferiority trial. Lancet. 2008;371:1343-52.

[3] Wells PS, Ginsberg JS, Anderson DR, Kearon C, Gent M, Turpie AG, et al. Use of a clinical model for safe management of patients with suspected pulmonary embolism. Ann Intern Med. 1998;129:997-1005.

[4] Wells PS, Anderson DR, Rodger M, Stiell I, Dreyer JF, Barnes D, et al. Excluding pulmonary embolism at the bedside without diagnostic imaging: management of patients with suspected pulmonary embolism presenting to the emergency department by using a simple clinical model and d-dimer. Ann Intern Med. 2001;135:98-107.

[5] Wicki J, Perneger TV, Junod AF, Bounameaux H, Perrier A. Assessing clinical probability of pulmonary embolism in the emergency ward: a simple score. Arch Intern Med. 2001;161:92-7.

6) Diagnostic tests

The diagnostic performances of the tests are described by the likelihood ratios of the different test results: for a dichotomic test, the positive likelihood ratio and the negative likelihood ratio. SPEED uses the likelihood ratio of a test result to calculate the posttest probability of PE as a function of the pretest probability of the disease.

1) D-dimer tests

Likelihood ratios:

- quantitative ELISA D-dimer test, < 500 µg/L: 0.08 ; ≥ 500 µg/L: 1.64
- quantitative latex D-dimer test, < 500 µg/L: 0.23 ; ≥ 500 µg/L: 1.65
- semiquantitative ELISA, negative: 0.18 ; positive: 1.55
- semiquantitative Latex D-dimer test, negative: 0.36 ; positive : 1.81
- qualitative D-dimer test, negative: 0.27 ; positive: 1.32

The diagnostic value of D-Dimer tests has not been studied in patients receiving long term anticoagulant treatment.

References:

Stein PD, Hull RD, Patel KC, et al. D-dimer for the exclusion of acute venous thrombosis and pulmonary embolism: a systematic review. Ann Intern Med. 2004;140(8):589-602.

Roy PM, Colombet I, Durieux P, Chatellier G, Sors H, Meyer G. Systematic review and meta-analysis of strategies for the diagnosis of suspected pulmonary embolism. Bmj. 2005;331(7511):259.

2) Radioisotopic lung scan (scintigraphy)

Likelihood ratio:

- Normal or near normal lung scan: 0.05
- Low probability ventilation perfusion lung scan: 0.36
- Intermediate probability ventilation perfusion lung scan: 1.20
- High probability ventilation perfusion lung scan: 18.3

- Perfusion lung scan not compatible with PE: 0.09*
- Perfusion lung scan compatible with PE: 7.1*

** Data not take into account in SPEED study (Roy PM et al. Ann Intern Med. 2009;151:677-86.)*

References:

Roy PM, Colombet I, Durieux P, Chatellier G, Sors H, Meyer G. Systematic review and meta-analysis of strategies for the diagnosis of suspected pulmonary embolism. Bmj 2005;331(7511):259.

Value of the ventilation/perfusion scan in acute pulmonary embolism. Results of the prospective investigation of pulmonary embolism diagnosis (PIOPED). JAMA 1990;263(20): 2753-9.

Miniati M, Pistolesi M, Marini C, Di Ricco G, Formichi B, Prediletto R et al. Value of perfusion lung scan in the diagnosis of pulmonary embolism : results of the prospective investigative study of acute pulmonary embolism (PISA-PED). Am J Respir Crit Care Med 1996;154:1387-93.*

3) Computed tomography lung scan

Likelihood ratio:

- Simple or double row CT, negative: 0.11; positive: 24.1
- Simple or double row CT and proximal leg vein ultrasonography, both negative: 0.04
- Multirow CT, negative: 0.04*; positive: 24.1
  (the negative likelihood ratio is assumed to be the same as simple row CT and proximal leg vein ultrasonography, both negative and the positive likelihood ratio is assumed to be the same as positive simple or double row CT apart from isolated subsegmental thrombus considered as an indeterminate result)

** Data not take into account in SPEED study (Roy PM et al. Ann Intern Med. 2009;151:677-86.)*

References:

Roy PM, Colombet I, Durieux P, Chatellier G, Sors H, Meyer G. Systematic review and meta-analysis of strategies for the diagnosis of suspected pulmonary embolism. Bmj. 2005;331(7511):259.

Stein PD, Fowler SE, Goodman LR, et al. Multidetector computed tomography for acute pulmonary embolism. N Engl J Med. 2006;354(22):2317-27.*

van Belle A, Büller HR, Huisman MV, Huisman PM, Kaasjager K, Kamphuisen PW et al. Effectiveness of managing suspected pulmonary embolism using an algorithm combining clinical probability, D-dimer testing, and computed tomography. JAMA 2006;295(2):172-9.*

Righini M, Le Gal G, Aujesky D, Roy PM, Sanchez O, Verschuren F et al. Diagnosis of pulmonary embolism by multidetector CT alone or combined with venous ultrasonography of the leg: a randomised non-inferiority trial. Lancet 2008;371(9621):1343-52.*

4) Leg vein ultrasonography and leg vein computed tomography

Likelihood ratio:

- Proximal leg vein compression ultrasonography, negative: 0.67;
  positive (popliteal or supra popliteal deep vein thrombosis): 16.2
- Distal leg vein ultrasonography, positive (infrapopliteal deep vein thrombosis): 3.9*
- Simple or double row CT and proximal leg vein ultrasonography, both negative: 0.04
- Leg vein computed tomography, negative: 0.67;
  positive (popliteal or supra popliteal deep vein thrombosis): 16.2
  (the diagnostic value of proximal CT venography is assumed to be the same as proximal leg vein ultrasonography)

** Data not take into account in SPEED study (Roy PM et al. Ann Intern Med. 2009;151:677-86.)*

References:

Roy PM, Colombet I, Durieux P, Chatellier G, Sors H, Meyer G. Systematic review and meta-analysis of strategies for the diagnosis of suspected pulmonary embolism. Bmj. 2005;331(7511):259.

Le Gal G, Righini M, Sanchez O, et al. A positive compression ultrasonography of the lower limb veins is highly predictive of pulmonary embolism on computed tomography in suspected patients. Thromb Haemost. 2006;95(6):963-6.

Righini M, Le Gal G, Aujesky D, Roy PM, Sanchez O, Verschuren F et al. Complete venous ultrasound in outpatients with suspected pulmonary embolism. J Thromb Haemost. 2009;7(3):406-12*

Stein PD, Fowler SE, Goodman LR, et al. Multidetector computed tomography for acute pulmonary embolism. N Engl J Med. 2006;354(22):2317-27.*

5) Echocardiography

Likelihood ratio:

- Right ventricular dilatation research, negative: 0.59 ; positive: 5.0

References:

Roy PM, Colombet I, Durieux P, Chatellier G, Sors H, Meyer G. Systematic review and meta-analysis of strategies for the diagnosis of suspected pulmonary embolism. Bmj. 2005;331(7511):259.

6) Pulmonary angiography

Pulmonary angiography is assumed to be the gold standard test for PE, a negative test excluding PE (negative likelihood ratio: 0), a positive test confirming PE (positive likelihood ratio: ∞)

7) SPEED contacts and scientific committee

- Address:
    - SPEED, ADMSU, Service des Urgences, Centre Hospitalier Universitaire, 4 rue Larrey, F-49933 cedex, Angers, France.
      e-mail: SPEED@chu-angers.fr

- Steering committee:
    - Pierre-Marie Roy, University Hospital of Angers, France (pmroy@chu-angers.fr)
    - Jean-Marie Chrétien, University Hospital of Angers, France (jmchretien@chu-angers.fr)

Scientific committee:

- Pierre Durieux, Hôpital Européen Georges Pompidou,Paris, France.
- Guy Meyer, Hôpital Européen Georges Pompidou, Paris, France.
- Arnaud Perrier, Geneva University Hospital, Geneva, Switzerland.
- Pierre-Marie Roy, University Hospital of Angers, France
- Franck Verschuren, University Hospital Saint Luc, Brussells, Belgium

Scientific partnerships:

- LIVE: Ligue Française contre la maladie veineuse thrombo-embolique, Paris, France (http://www.live-mvte.org)
- SFMU: Société Française de Médecine d'Urgence, Paris, F-75019, France (http://www.sfmu.org)

8) SPEED efficiency evaluation

SUMMARY – The full text is available on the Website of Annals of Internal Medicine (http://www.annals.org/)

A Computerized Handheld Decision Support System to Improve Pulmonary Embolism Diagnosis - A Randomized Trial

Pierre-Marie Roy, MD, PhD; Pierre Durieux, MD; Florence Gillaizeau, MS; Catherine Legall, MD; Aurore Armand-Perroux, MD; Ludovic Martino, MD; Mohamed Hachelaf, MD; Alain-Eric Dubart, MD; Jeannot Schmidt, MD, PhD; Mirko Cristiano, MD; Jean-Marie Chretien, MS; Arnaud Perrier, MD; and Guy Meyer, MD

Background: Testing for pulmonary embolism often differs from that recommended by evidence-based guidelines.

Objective: To assess the effectiveness of a handheld clinical decision support system to improve the diagnostic work-up of suspected pulmonary embolism among patients in the emergency department.

Design: Cluster-randomized trial. Assignment was by random number table, providers were not blinded, and outcome assessment was automated. (ClinicalTrials.gov registration number: NCT00188032)

Setting: 20 emergency departments in France.

Patients: 1103 and 1788 consecutive outpatients with suspected pulmonary embolism.

Intervention: After a pre-intervention period involving 20 centers and 1103 patients, in which providers grew accustomed to inputting clinical data into handheld devices and investigators assessed baseline testing, emergency departments were randomized to activation of a decision-support system on the devices (10 centers, 753 patients) or posters and pocket cards that showed validated diagnostic strategies (10 centers, 1015 patients).

Measurement: Appropriateness of diagnostic work-up, defined as any sequence of tests that yielded a posttest probability of less than 5% or greater than 85% (primary outcome) or as strict adherence to guideline recommendations (secondary outcome); number of tests per patient (secondary outcome).

Results: The proportion of patients who received appropriate diagnostic work-ups was greater during the trial than in the pre-intervention period in both groups, but the increase was greater in the computer-based guidelines group (adjusted mean difference in increase, 19.3% favoring computer guidelines [95% CI, 2.9% to 35.6%]; $P = 0.023$). Among patients with appropriate work-ups, those in the computer-based guidelines group received slightly fewer tests than did patients in the paper guidelines group (mean tests per patient, 1.76 [SD, 0.98] vs. 2.25 [SD, 1.04]; $P < 0.001$).

Limitation: The study was not designed to show a difference in the clinical outcomes of patients during follow-up.

Conclusion: A handheld decision support system improved diagnostic decision making for patients with suspected pulmonary embolism in the emergency department.

References

Roy PM, Durieux P, Gillaizeau F, Legall C, Armand-Perroux A, Martino L, et al. A computerized handheld decision-support system to improve pulmonary embolism diagnosis. A randomized trial. Ann Intern Med. 2009;151:677-86.