Diagnosis of suspected venous thromboembolism

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The primary goal of diagnostic testing for venous thromboembolism (VTE) is to identify all patients who could benefit from anticoagulant therapy. Test results that identify patients as having a ≤2% risk of VTE in the next 3 months are judged to exclude deep vein thrombosis (DVT) or pulmonary embolism (PE). Clinical evaluation, with assessment of: (1) clinical pretest probability (CPTP) for VTE; (2) likelihood of important alternative diagnoses; and (3) the probable yield of D-dimer and various imaging tests, guide which tests should be performed. The combination of nonhigh CPTP and negative D-dimer testing excludes DVT or PE in one-third to a half of outpatients. Venous ultrasound of the proximal veins, with or without examination of the distal veins, is the primary imaging test for leg and upper-extremity DVT. If a previous test is not available for comparison, the positive predictive value of ultrasound is low in patients with previous DVT. Computed tomography pulmonary angiography (CTPA) is the primary imaging test for PE and often yields an alternative diagnosis when there is no PE. Ventilation-perfusion scanning is associated with less radiation exposure than CTPA and is preferred in younger patients, particularly during pregnancy. If DVT or PE cannot be "ruled-in" or "ruled-out" by initial diagnostic testing, patients can usually be managed safely by: (1) withholding anticoagulant therapy; and (2) doing serial ultrasound examinations to detect new or extending DVT.

Learning Objectives

- Understand what testing for VTE needs, and does not need, to achieve
- Understand the strengths and limitations of diagnostic tests for VTE, singly and in combination
- Know what combinations of test results rule-out and rule-in DVT and PE
- Be able to select the optimal testing strategy for individual patients

Venous thromboembolism (VTE) is diagnosed in ~1.5 per 1000 persons each year. For each patient who is diagnosed with VTE, the diagnosis is excluded in ~9 others. Therefore, in the United States and Canada, with their combined population of about 350 million, over 5 million patients are tested for VTE each year. About two-thirds of patients with VTE present with suspected deep vein thrombosis (DVT) only and one-third present with suspected pulmonary embolism (PE) (with or without symptoms of DVT). Of the cases with DVT, ~90% involve the legs, 5% involve the arms (or more central veins), and 5% involve unusual deep venous sites (eg, visceral or cerebral veins). Three-quarters of VTEs are first episodes and one-quarter are recurrences. Some diagnoses of VTE are made incidentally on imaging that has been done for other reasons; often, these are PEs seen on computed tomography (CT) scans in patients with cancer.

This review addresses the diagnosis of first and recurrent episodes of DVT or the leg, upper-extremity DVT, and PE. It does not address the diagnosis of DVT in usual sites, or superficial vein thrombosis. It refers to, but does not consider in depth, the diagnosis of VTE during pregnancy.[1-5]

Goals of diagnostic testing for VTE

The primary goal of testing for VTE is to identify patients who should be treated with anticoagulants. It is acceptable for diagnostic testing not to detect VTE that are very unlikely to progress and, therefore, the patient would not benefit from anticoagulant therapy. Evidence that diagnostic testing has not missed important VTE usually comes from management studies that have shown a very low frequency of progressive VTE during follow-up in patients who have those diagnostic test results and have not been treated with anticoagulants. Similarly, not all detected VTE need to be treated. In some cases, it is preferable just to monitor closely, with or without repeat thrombus imaging (usually venous ultrasonography [US]), and only treat if thrombus extends.

Narrowing the differential diagnosis may be another important goal of diagnostic testing. In some patients, it is enough to exclude VTE. In others, because symptoms or signs are severe or are compatible with another serious condition, it is important to look for an alternative diagnosis if the patient does not have VTE. Some VTE diagnostic tests can identify an alternative diagnosis (eg, CT pulmonary angiography [CTPA] or leg US), whereas others do not (eg, D-dimer testing or perfusion scanning).

What posttest probability "rules-in" or "rules-out" DVT or PE

Ruling-in VTE

In general, a high level of certainty is required if a diagnosis will result in an aggressive and potentially harmful treatment, or is associated with a major psychological burden to the patient. Anticoagulant therapy causes bleeding and many patients find it burdensome. Also, a diagnosis of VTE is a major psychological burden for some patients. For these reasons, a high level of certainty is required before patients are

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judged to have VTE. When ventilation-perfusion (V/Q) scanning was the primary diagnostic test for PE, a posttest probability of ≥85% was considered diagnostic and grounds for long-term anticoagulant therapy (ie, corresponding to a "high probability" scan). Consequently, a posttest probability for proximal DVT or PE of ≥85% usually justifies a diagnosis of VTE and anticoagulant therapy.

Ruling-out VTE

In general, a high level of certainty is required to decide that a condition is not present if a "missed diagnosis" is likely to have serious consequences. This applies to VTE, because progressive VTE may be fatal and anticoagulant therapy is very effective. The level of certainty that excludes VTE, and justifies both withholding anticoagulant therapy and further diagnostic testing, is generally accepted as a ≤2% probability of progressive of VTE in the next 3 months. A ≤2% probability of VTE during follow-up is: (1) similar to what is observed after a negative venogram or pulmonary angiogram; (2) acceptable to most patients and physicians; and (3) low enough that further diagnostic testing has little chance of establishing a diagnosis of VTE, either because further testing will be negative or has a high risk of being falsely positive.[1] As previously noted, it is acceptable to consider VTE excluded despite a >2% prevalence of thrombosis, provided those thrombi do not need treatment because they will not extend.

Nondiagnostic for VTE

If the posttest probability of VTE lies between the ruling-out and ruling-in thresholds (ie, 3% to 84%), the patient requires further testing. If, despite further testing, the probability of VTE remains between these thresholds, the options are to: (1) withhold treatment while performing serial US of the proximal leg veins (eg, over 2 weeks) and only treat if (new) proximal DVT develops (usually the preferred option)[6]; or (2) treat despite having a nondiagnostic posttest probability for VTE. The level of certainty required to rule-out or rule-in VTE may also be influenced by the patient's risk of bleeding and treatment preference.

Clinical pretest probability (CPTP) for DVT and PE

Diagnosis of VTE starts with an assessment of CPTP. CPTP is higher if: (1) symptoms and signs are typical for DVT or PE; (2) there are risk factors for VTE; (3) VTE is thought to be the most likely diagnosis; and (4) symptoms and signs are more severe. CPTP assessment is facilitated by use of clinical prediction rules, of which the Wells DVT score (Table 1), the Wells PE score (Table 2), and the Geneva PE score are the most widely used and best validated.[3,7-10] The Wells PE and Geneva PE scores, and a modified version of the Wells DVT score are suitable for suspected first or recurrent PE.[11,12] CPTP prediction rules are also available for DVT in pregnancy and upper-extremity DVT.[2,13,14] CPTP is usually categorized as low, intermediate, or high (ie, 3 categories), or as unlikely or likely (ie, 2 categories). Although CPTP alone cannot rule-in VTE and generally does not rule-out VTE, it: (1) guides the selection of further testing (eg, confirmatory test if high CPTP; exclusionary test if low CPTP); and (2) is often rules-out or rules-in VTE when combined with other test results (Tables 3-5). Not using CPTP as part of the diagnostic process "wastes" information and, therefore, reduces the accuracy of diagnostic testing (ie, increases false-positives and false-negatives).

PE rule-out criteria (PERC)

The PERC criteria are a clinical prediction rule that are designed to identify patients with suspected PE who do not require any diagnostic testing, including D-dimer.[9,15,16] Having first decided that there is a low CPTP based on gestalt, the following 8 clinical findings must be satisfied: age <50; initial heart rate <100; initial oxygen saturation on room air >94%; no unilateral leg swelling; no hemoptysis; no surgery or trauma within 4 weeks; no history of VTE; and no estrogen uses. The prevalence of PE in PERC-negative patients, who make up ~30% of low CPTP outpatients is ~1%. However, the safety of using PERC to withhold diagnostic testing has yet to be tested in a large management study.[16,17]

D-dimer testing for DVT and PE

D-dimer is formed when crosslinked fibrin is broken down by plasmin. Levels are almost always increased in VTE and, consequently, a normal D-dimer level helps to exclude DVT and PE.[1,3,7,9,12,18-20] However, because D-dimer levels are commonly increased by other conditions, an abnormal result is of little help for confirming VTE. D-dimer tests vary in terms of the measurement method and the D-dimer level that is used to categorize a test as positive or negative. D-dimer tests can be divided into those that are highly or only moderately sensitive for VTE.

Highly sensitive tests

These have sensitivity ≥95% but specificity is only ~40% in outpatients (and lower in inpatients). A negative highly sensitive test rules-out DVT or PE in patients with low or moderate CPTP (Tables 3 and 5); however, a negative test is obtained in only ~30% of outpatients because of the very low specificity associated with the test's low D-dimer threshold.

Moderately sensitive tests

These have a sensitivity of 80% to 94% and a specificity of up to 70% in outpatients. In order to exclude DVT or PE, a negative test needs to be combined with another assessment or test result that identifies patients as having a lower prevalence of VTE. For patients with suspected DVT, this includes: (1) a low CPTP; or (2) negative proximal US (Table 3). For patients with suspected PE, this includes: (1) a low CPTP; or (2) a nondiagnostic V/Q scan and negative bilateral proximal US examinations (Table 5). Compared with a highly sensitive test, the lower negative predictive value of a moderately sensitive D-dimer test is offset by about twice as many negative test results obtained.

New ways of interpreting D-dimer results that will increase diagnostic yield

Traditionally, a single cutoff has been used to define a negative D-dimer assay. Recently, it has been proposed that the specificity of D-dimer testing can be increased without unduly compromising negative predictive by using D-dimer <1000 μg/L to exclude VTE in patients with a low CPTP because they have a low prevalence of disease, while continuing to use D-dimer <500 μg/L in patients with moderate CPTP.[21-23] This "CPTP-adjusted" approach to D-dimer interpretation has been prospectively validated in patients with suspected DVT.[23] It has also been proposed that using a D-dimer threshold of <500 μg/L to exclude VTE in patients 50 years or younger, and a threshold equal to 10× the patient's age (eg, <750 μg/L at 75 years) in those over 50 years, will increase the specificity of D-dimer testing without compromising sensitivity.[19,24-27] This "age-adjusted" approach to D-dimer interpretation has been prospectively validated in patients with suspected PE.[28]

Table 1. Wells score for DVT clinical pretest probability

	Number of points	Proportion of patients	Prevalence of PE
Variables			
Active cancer (treatment ongoing or within previous 6 mo or palliative)	1		
Paralysis, paresis, or recent plaster immobilization of the lower extremities	1		
Recently bedridden >3 d or major surgery within 4 wks	1		
Localized tenderness along the distribution of the deep venous system	1		
Entire leg swollen	1		
Calf swelling 3 cm greater than on asymptomatic side (measured 10 cm below tibial tuberosity)	1		
Pitting edema confined to the symptomatic leg	1		
Dilated superficial veins (nonvaricose)	1		
Previous documented DVT (or PE)	1		
Alternative diagnosis as likely or greater than that of DVT	−2		
Score interpretation			
High probability*	≥3	10%	60%
Moderate probability*	1 or 2	30%	25%
Low probability†	≤0	60%	5%

*A score of ≥2 has been termed "DVT likely." This group makes up ~40% of patients and has a prevalence of DVT of ~33%.
†A score of ≤1 has been termed "DVT unlikely." This group makes up ~75% of patients and has a prevalence of DVT of ~10%. The original Wells DVT model was for a first suspected DVT and, therefore, did not include a score for previous VTE.

Recurrent DVT or PE

D-dimer has been less well evaluated in patients who are suspected of having recurrent VTE.[1,3,19,20] Specificity is lower than in patients with a first suspected VTE, presumably because of a higher prevalence of comorbid conditions that increase D-dimer. However, D-dimer still has a high negative predictive value for recurrent VTE. D-dimer has been even less well evaluated in patients who are suspected of having recurrent VTE while on anticoagulants, but is still expected to have a high negative predictive value.

Upper-extremity DVT

D-dimer is also less well evaluated in patients with suspected upper-extremity DVT. Sensitivity and specificity may be lower because of smaller thrombi and a higher prevalence of comorbidity. However, a negative D-dimer appears to retain its high negative predictive value (Table 4).[29]

Cautionary notes

Specificity of D-dimer testing decreases with age, pregnancy, inflammatory conditions, cancer, trauma, recent surgery, and being an inpatient.[19] If a patient is expected to have a positive D-dimer test in the absence of VTE, such as after major surgery, D-dimer testing should not be performed. D-dimer testing is also of limited value in patients with high CPTP because about 60% will have a positive test due to VTE and, if a negative test is obtained, its negative predictive value is reduced by the high prevalence of disease. D-dimer testing should not be ordered to "screen out" DVT or PE in patients who have yet to be evaluated clinically, because the high frequency of false-positive results will increase, rather than decrease, the need for additional testing.

Venous US for DVT

Venous US is the imaging test of choice for diagnosing DVT. It is noninvasive and relatively easy to perform.[1,6] Proximal venous US examines the common femoral vein, femoral vein (previously called the superficial femoral vein), popliteal vein, and the calf vein trifurcation (ie, proximal junction of deep calf veins). With whole-leg venous US, the examination is extended to include the distal (ie, calf) veins. Inability to fully compress (ie, obliterate) the vein lumen with pressure from the US probe is the primary criterion for DVT. Duplex US, which combines compression US with pulsed or color-coded

Table 2. Wells score for PE clinical pretest probability

	Number of points	Proportion of patients	Prevalence of PE
Variables			
Clinically suspected DVT	3		
Alternative diagnosis is less likely than PE	3		
Heart rate >100 beats/min	1.5		
Immobilization or surgery in previous 4-wk period	1.5		
History of VTE	1.5		
Hemoptysis	1		
Malignancy or treatment of it in previous 6-mo period	1		
Score interpretation			
High probability*	≥6.5	10%	60%
Moderate probability*	4.5-6.0	30%	25%
Low probability†	≤4.0	60%	5%

*A score of ≥4.5 (moderate and high probability groups combined) has been termed "PE likely." This group makes up ~40% of patients and has a prevalence of PE of ~33%.
†Is also termed "PE unlikely." In the original derivation of the Wells PE model, patients were required to have a score of ≤1.5 to be categorized as low probability, but a score of ≤4 has subsequently been used for low probability.[8,9]

Table 3. Results that "rule-in" or "rule-out" leg DVT

Results
Rules-in a first leg DVT
Venous ultrasound
Noncompressibility of proximal veins (calf vein trifurcation included)
Noncompressibility of distal veins, when findings are extensive
Intraluminal defect (unequivocal) with associated absence of flow in the iliac veins or inferior vena cava, when compressibility cannot be assessed
Venography
Intraluminal filling defect in proximal or distal deep veins
Rules-out a first leg DVT
D-dimer
Negative very sensitive test (eg, D-dimer <500 μg/L) AND low or moderate CPTP
Negative moderately sensitive test (including D-dimer <1000 μg/L) AND low CPTP
Venous ultrasound
Fully compressible proximal veins AND low CPTP
Fully compressible proximal veins AND moderately or very sensitive D-dimer test
Fully compressible proximal and distal veins (whole-leg US)
Fully compressible proximal veins AND normal repeat proximal US after 7 d
Venography
All deep veins seen and no intraluminal filling defects
Rules-in a recurrent leg DVT
Venous ultrasound
A new, noncompressible proximal vein segment
A 4-mm increase in diameter of the common femoral or popliteal vein compared with a previous test
A unequivocal extension of thrombosis (eg, additional 10 cm) within the femoral vein
Venography
Intraluminal filling defect in proximal or distal deep veins (new, or >3 mo after last event)
Rules-out a recurrent leg DVT
All criteria that rule-out a first DVT
Venous ultrasound
≤1 mm increase in diameter of the common femoral, and femoral and popliteal veins compared with a previous test AND remains unchanged on repeat testing after 2 d and 7 d

Doppler technology, facilitates the identification of the deep veins (particularly in the calf; see later discussion) and allows the presence of thrombus to be assessed when it is not feasible to perform venous compression (eg, iliac or subclavian veins).

Proximal venous US

Venous US is very accurate for the diagnosis of a first proximal DVT, with a sensitivity and specificity approaching 95%.[1,6] An unequivocally positive test is diagnostic for DVT. On its own, however, a negative proximal venous US cannot exclude all DVT, including isolated distal DVT which may subsequently extend into the proximal veins. The combination of a negative proximal venous US with either: (1) a low CPTP for DVT; or (2) a negative moderately or very sensitive D-dimer test, effectively excludes all DVT (ie, there is either no DVT or only isolated distal DVT that is very unlikely to extend).[1,3] If DVT cannot be excluded by low CPTP or D-dimer in a patient with a negative proximal venous US, there are 2 options. The first is to withhold treatment and repeat the proximal venous US after 7 days to detect the small number of isolated distal DVT that subsequently extend into the proximal veins (~3%). If the test remains negative, the risk that thrombus is present and will extend is negligible. The second is to do whole-leg venous US.

Whole-leg venous US

This can exclude isolated distal DVT (ie, all DVT), and avoid the need for a repeat US examination after 7 days.[1,30] However, examination of the distal veins has the disadvantage of diagnosing ~50% to 100% more DVT and, compared with serial proximal venous US (initial and 7 days), does not reduce the risk of VTE during follow up (~1% over 3 months in both groups). Abnormalities that are confined to the distal veins may be false-positive findings, muscular vein thrombosis, previous thrombosis, or acute DVT; of the acute DVT, only a minority will extend without treatment. Some institutions (including the author's own) almost never do whole-leg US, whereas others do it whenever a venous US is performed. If the distal veins are routinely examined, institutions need to have a strategy for deciding which patients with isolated distal abnormalities are anticoagulated and which are not anticoagulated, but will have US surveillance to detect extending thrombosis that require treatment. The American College of Physicians guidelines for the treatment of VTE suggests criteria for making this decision.[31]

Recurrent DVT

US findings that exclude a first DVT also exclude recurrent DVT. Patients with effectively treated DVT, however, often have a persistently abnormal US (~50% of proximal DVT at 1 year).[1-3] Confirmation of recurrent ipsilateral DVT, therefore, requires evidence of new thrombosis compared with previous examinations. The most convincing finding is a new noncompressible popliteal or common femoral segment. Failing this, a substantial increase in the compressed diameter (ie, ≥4 mm) of the popliteal or common femoral vein or convincing extension within the femoral vein of the thigh (≥10 cm) can be considered diagnostic.[1-3,6,32] Qualitative findings on US, such as thrombus echogenicity, thrombus irregularity, and changes in venous flow, may help, but cannot be depended upon to distinguish new thrombus from old. If thrombus in the proximal veins appears similar to a previous US or is suspected of being old (no previous US available), anticoagulants can be withheld and serial US is performed.

Upper-extremity DVT

US can accurately assess venous compressibility in the arm (up to and including the axillary vein) and the jugular vein, and can assess the subclavian vein using color-flow Doppler, but US is unable to reliably assess the innominate veins and superior vena cava.[33] US generally has high negative predictive value for upper-extremity DVT; it can be repeated after ~4 to 7 days if findings are indeterminate or there is high CPTP.[29,34]

Venography for leg and upper-extremity DVT

Ascending venography was the reference standard for the diagnosis of DVT (proximal, distal, and upper extremity). In patients with suspected recurrent DVT, venography distinguishes new thrombus (intraluminal filling defect) from old (no intraluminal filling defect), but may be nondiagnostic if there is extensive nonfilling of the deep veins due to old disease. Venography is costly, technically difficult, can be painful, and requires injection of radiographic contrast. Consequently, ascending venography is now rarely performed. It continues to be used in difficult to diagnose cases of upper-extremity DVT.

Table 4. Results that "rule-in" or "rule-out" upper-extremity DVT

Results
Rules-in upper-extremity DVT
Venous ultrasound
Noncompressibility of the axillary, brachial veins, or jugular vein
Intraluminal defect (unequivocal) with associated absence of flow in the subclavian vein
Venography (includes CT and MRI)
Intraluminal filling defect within brachial vein to superior vena cava
Rules-out upper-extremity DVT
Venous ultrasound
No DVT within brachial to subclavian veins AND not suspected of having a more central DVT
No DVT on US AND normal repeat US after 7 d
D-dimer
Negative very sensitive test (eg, D-dimer <500 μg/L) AND low or unlikely CPTP
Venography (includes CT and MRI)
No intraluminal filling defect within brachial vein to superior vena cava

CT and magnetic resonance imaging (MRI) venography for DVT

CT and MRI appear to be accurate for DVT diagnosis (sensitivity and specificity >90%), but are rarely used because CT requires radiographic contrast and is associated with high radiation exposure, and both CT and MRI are costly.[1,35,36] CT and MRI are valuable options if US examination of the pelvic veins, inferior or superior vena cava, or innominate veins is inadequate. CT and MRI appear to distinguish between new (ie, thrombus surrounded by contrast on CT; shortened T1 signal on direct thrombus imaging due to methemoglobin) and old thrombus better than US.[2,37] Diagnosis of DVT on CT (or, less commonly on MRI) may be an incidental finding in patients with cancer. In this situation, because the clinical suspicion for DVT is low and the examination will not have been designed to diagnose DVT, patients need to be carefully reviewed and often require additional diagnostic testing (eg, US).

CTPA for PE

CTPA, which outlines thrombi in the pulmonary arteries and often identifies alternative diagnoses, has become the imaging test of choice for PE.[3,18,38,39] The accuracy of CTPA varies with the extent of PE and CPTP. The positive predictive value has been estimated as 97% with main or lobar abnormalities and 68% with thrombi in the segmental vessels, but only 25% to 50% with isolated subsegmental pulmonary artery abnormalities. For those with a high, intermediate, and low CPTP, the positive predictive value is 96%, 92%, and ~60%, respectively.[39] PE is excluded by a good quality negative CTPA (Table 5).[38]

Isolated subsegmental abnormalities, which account for ~15% of diagnosed PE, may be due to PE that are truly causing symptoms, incidental PE that are not responsible for symptoms (eg, after knee replacement surgery[40]), or may be false-positive findings.[38] It is uncertain if patients with these findings should be treated or not be treated while receiving clinical surveillance, which may be supplemented with serial bilateral venous US. At a minimum, patients who are not treated need to have proximal DVT excluded at initial presentation. The American College of Physicians guidelines for the treatment of VTE suggests which patients should be treated or have surveillance.[31]

Recurrent PE

A clear intraluminal filling defect on CTPA >3 months after a previous PE is likely to reflect acute recurrent PE.

Cautionary note

CTPA can lead to contrast-induced nephropathy, is associated with substantial radiation exposure, and is expensive; consequently, use of CTPA should be minimized. Avoidance of radiation is particularly important in young women (eg, <40 years of age, particularly during pregnancy) due to the risk of breast cancer; V/Q scanning is often preferred in these patients.

MRI

Currently, MRI is rarely used for the diagnosis of PE because it less accurate, available, and well evaluated than CTPA.[18,41]

V/Q lung scanning for PE

A normal perfusion scan excludes PE but is obtained in only ~25% of patients. Normal scans occur more often in younger patients (including pregnancy), do not have lung disease, and have a normal chest radiograph. An abnormal perfusion scan is non-specific. Ventilation imaging improves the specificity of perfusion scanning, with an 85% or higher prevalence of PE in patients with 2 or more large (>75% of a segment) perfusion defects that are normally ventilated ("high-probability scan"). However, over 50% of patients with suspected PE have an abnormal perfusion scan that is nondiagnostic and, therefore, requires further testing.

Single-photon emission CT (SPECT) V/Q scanning

Three-dimensional SPECT has been replacing planar V/Q scanning. SPECT appears to be more accurate than planar V/Q scanning and, with current approaches to interpretation, yields much fewer nondiagnostic results.[42] However, the predictive value of a PE-positive SPECT and the safety of withholding anticoagulation with a PE-negative SPECT have not been evaluated in large prospective studies.

Table 5. Results that "rule-in" or "rule-out" PE

Results
Diagnostic for PE
CTPA
Intraluminal filling defect in a lobar or main pulmonary artery
Intraluminal filling defect in a segmental pulmonary artery AND moderate or high CPTP
V/Q scan
High-probability scan AND moderate or high CPTP
Positive diagnostic test for DVT (with a nondiagnostic V/Q scan or CTPA, or scan not done)
Rules-out PE
CTPA
Negative good quality scan
Perfusion scan (usually part of V/Q scan)
Normal
D-dimer
Negative very sensitive test (eg, D-dimer <500 μg/L) AND low or moderate CPTP
Negative moderately sensitive test AND low CPTP
In patients over 50 y, D-dimer level <10 times the patient's age AND a low or moderate CPTP
Nondiagnostic V/Q scan or CTPA AND normal proximal venous US AND one of:
Low CPTP
Negative moderately or very sensitive D-dimer test
Normal repeat proximal US after 7 d and 14 d

Table 6. Factors that influence sequence of diagnostic testing

Factor	Implication
CPTP	
Low or moderate	Favors D-dimer over imaging
High	Favors imaging over D-dimer
Indications for a specific test	
May identify a suspected alternative to PE (eg, progressive malignancy; aortic dissection)	Favors CTPA over V/Q scanning
May identify a suspected alternative to DVT (eg, ruptured Baker cyst; hematoma)	Favors venous US over D-dimer
Severe calf symptoms	Favors whole-leg US over serial proximal US
Venous US available in the clinic	Favors venous US over D-dimer
Contraindication to a specific test	
D-dimer will be high even if no DVT or PE (eg, postoperative; inpatient; sepsis)	Favors imaging over D-dimer
Younger, particularly if females and pregnant	Favors V/Q over CTPA
Lung disease or abnormal chest radiograph	Favors CTPA over V/Q
Renal impairment	Favors V/Q over CTPA
Contrast dye allergy	Favors V/Q over CTPA

Venous US as an indirect test for PE

Venous US can serve 2 purposes in patients with suspected PE. First, finding DVT (particularly if proximal) serves as indirect evidence of PE.[6,43] Proximal DVT is present in ~5% of patients with nondiagnostic V/Q scans and, if US is done initially, detecting DVT may avoid the need for PE imaging entirely, which is particularly attractive during pregnancy. Second, in patients with nondiagnostic imaging for PE (most often a nondiagnostic V/Q scan), if there is no proximal DVT at presentation and on repeat testing after 1 and 2 weeks (DVT present in ~2%), PE can be considered excluded.

Pulmonary angiography

Pulmonary angiography, using a catheter in the pulmonary artery, is now very rarely performed because it is invasive and can usually be replaced by CTPA.

Sequence of testing for DVT and PE, and results that are diagnostic

This starts with a clinical assessment of: (1) CPTP; (2) indications for specific diagnostic tests; and (3) contraindications to specific tests. Subsequent testing is guided by these evaluations and test availability (Table 6). Combinations of test results that rule-in and rule-out DVT or PE are summarized in Tables 3-5.

Conclusion

There are many ways to rule-out and rule-in PE and DVT, and no single approach is optimal for all situations. Sometimes it is not possible to rule-out or rule-in VTE because definitive testing is contraindicated (eg, due to renal impairment) or test results are equivocal. Usually, these patients can be managed safely with active surveillance, which often includes serial proximal venous US. As an added precaution, patients who have VTE excluded should be asked to return if they have further problems. If that occurs, repeat evaluation for VTE is required, often with more extensive testing than on the first occasion.

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