Suspected deep vein thrombosis: a management algorithm for the accident and emergency department

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Venous thromboembolism is a common and potentially fatal disease. Accurate diagnosis of deep vein thrombosis (DVT) and the prompt initiation of adequate treatment are essential to prevent both pulmonary emboli, recurrent thrombosis, and post-thrombosis phlebitis. The diagnosis of DVT is notoriously difficult to make as most of the symptoms and signs of the disease are non-specific. Although some patients will present to their general practitioner, many present directly to accident and emergency (A&E) departments. The numbers involved are not small. One Scandinavian study estimated an incidence of 1.6 cases of DVT per 1000 inhabitants per year, which translates to approximately 400 patients per year in an average district general hospital. Many more patients than this will present to A&E departments with a possible DVT.

The aim of this article is to review current available diagnostic procedures and to present an algorithm aimed at improving the diagnosis of DVT in patients presenting to A&E departments.

Clinical diagnosis
Diagnosing DVT on purely clinical grounds has been estimated at being correct no more than 50% of the time. Symptoms and signs are non-specific and occur in a variety of other conditions. Previously, clinicians have been left to consider each patient’s case individually and personally assign relative importance to a number of different factors such as symptoms, signs, and past or family history of DVT. This is no longer acceptable as studies have shown that the positive predictive value of informal clinical judgment is poor. In 1995 Wells et al designed a clinical model to predict the probability of DVT in patients before they had any imaging carried out. They subsequently simplified this model and demonstrated that its use, in conjunction with ultrasound, could improve the management of patients who present with suspected DVT. The model is shown in table 1. It categorises patients into low, moderate, or high risk according to their score based on assessment of a number of clinical parameters.

Certain parameters were eliminated from their original model having been found to be not significantly associated with DVT when assessed by stepwise logistic regression. These included recent trauma, erythema, age, sex, duration of symptoms, and hospital admission. A more recent study confirmed that there was no association between age and DVT. Additionally, male sex, orthopaedic surgery, warmth, and superficial venous dilatation on examination were independent predictors of symptomatic DVT. However, this study had several limitations and until the conclusions have been prospectively evaluated in other patient populations it is probably safer to use Wells’ clinical index.

Imaging
Historically, the gold standard investigation for diagnosing a DVT has been a positive contrast venogram. However, this is an invasive technique requiring the injection of contrast medium into one of the pedal veins, may be painful, and can cause allergy or other side effects. It is an expensive test that is not easily repeatable and itself carries a 2%–5% chance of causing a DVT.

Venous compression ultrasonography is now widely used. The inability to completely compress a vein indicates the presence of a DVT. An abnormal result has a high predictive value and pooled analyses have demonstrated a sensitivity of 96% and a specificity of 98% when applied to proximal leg veins. Its use in assessing calf veins is less reliable. Fortunately, calf vein thromboses embolise so rarely that they are considered to be clinically unimportant so long as they do not extend proximally. A repeat ultrasound at one week to examine the proximal and popliteal veins is currently used.
to assess this possibility. The advantages of ultrasound over venography are that it is non-invasive, cheaper, and acceptable to patients; it is, however, very operator dependent and partial obstructions are more difficult to assess.

Colour flow duplex combines standard ultrasound with Doppler and provides a real time image with velocities of flow. It is a safe, non-invasive technique that has no specific contraindications and is repeatable, but still requires skill in interpretation. Colour duplex scans certainly match venography when examining the popliteal veins or more proximally, with a sensitivity of 100% and a specificity of 95% reported in one comparison study.

Another diagnostic procedure still used in some centres is impedance plethysmography. It is an electrical signal technique that compares the electrical impedance of patent and obstructed veins. Again it is non-invasive, quick, and cheap but relies heavily on the cooperation of the patient. It has largely been superseded by ultrasound and Doppler techniques.

An article in this journal in 1998 described the use of light reflection rheography. This is a non-invasive, plethysmographic technique that relies on the principle of increased light reflectivity in patent veins during calf exercise. With a negative predicted value reported to be 97%, it was used to exclude patients from further investigation when negative. However, in view of its significant false positive rate, patients with a positive result on light reflection rheography still required venography as a confirmatory test.

**D-dimers**

D-dimers are products of fibrin degradation. Raised serum concentrations are considered to reflect the presence of intravascular thrombosis. Therefore, measuring serum values provides a highly sensitive method of detecting acute venous thromboembolism with a reported sensitivity of up to 100% depending on the assay. However, specificity is very low with reported figures of 35%-60%. This is due to other co-morbid conditions increasing D-dimer concentrations—for example, infection, trauma, and malignancy.

A number of methods are now available for detecting raised D-dimer concentrations and include the latex agglutination assay, enzyme linked immunosorbant assay (ELISA), and, more recently, whole blood agglutination assay (SimpliRED). ELISA has a high sensitivity but low specificity and is not suitable for testing in the A&E department as the kits are designed for batch assays and require several hours for processing. Latex agglutination tests can be done for individuals and have a faster turnaround time, however, sensitivity is generally too low to be used as an exclusion test in the emergency setting. SimpliRED is a novel whole blood agglutination assay that can be performed at the bedside and produces a result in just over two minutes. It utilises a bispecific antibody that has epitopes to both D-dimer and red cells. Therefore, in the presence of a raised D-dimer value, agglutination of the patient’s red cells occurs that is visible to the naked eye in the test well. Several studies have assessed the reliability of this assay and reported sensitivities of 88%-100%.

A recent systematic review of the role of D-dimer estimation concluded that, at present, there is not enough evidence to base clinical decisions solely on D-dimer measurements, but that these may be useful in conjunction with other diagnostic tools to select a subgroup of patients to undergo further tests.

**Management**

In an ideal world all A&E patients with a clinically suspected DVT would have one highly sensitive and specific test performed as an outpatient to confirm or refute the diagnosis, followed by the initiation of appropriate anticoagulant treatment. Unfortunately, no test is reliable in isolation and most hospitals do not offer 24 hour access to imaging. Combining clinical pre-test probability scores with the D-dimer concentration assessment and imaging techniques, fig 1 is an evidence based management algorithm that could be employed in an A&E setting for the outpatient diagnosis of DVT in symptomatic patients.

Various D-dimer assays are commercially available but vary in performance characteristics. This algorithm assumes a high sensitivity
of the assay and this must therefore be discussed with individual laboratories.

Where imaging is not immediately available, it is not necessary to admit patients to hospital; however, it is prudent to use prophylactic subcutaneous low molecular weight heparin in these patients until the duplex scan can be performed. This should not alter the results of the scan in any way and can be given in the A&E department. It must obviously be withheld in patients with contraindications to the drug, which include uncorrected bleeding disorders, bleeding or potentially bleeding lesions, a history of heparin hypersensitivity, and a history of heparin induced thrombocytopenia or thrombosis.

Current practice in most centres is still to admit patients with a positive diagnosis of DVT for the start of anticoagulation treatment. With the advent of the use of low molecular weight heparin it may become increasingly possible to treat as well as diagnose this disease as an outpatient. The team at Chertsey described a regimen for managing anticoagulation as an outpatient that was safe, acceptable to patients and staff, and avoided admission to hospital in most patients with uncomplicated DVT.\(^\text{10}\)

Conflict of interest: none.

Funding: none.

Questions relating to this article
(1) List the parameters found to be positively associated with DVT according to Wells’ clinical model.
(2) Outline the current use of D-dimer measurements in diagnosing DVT.
(3) Do you understand the pathophysiology of vein thrombosis?

Read Lensing et al (Lancet 1999;353:479–85) and name the inherited prothrombotic abnormalities that may be found in some patients with a first episode of vein thrombosis.

Further reading