

Virtual risk assessment pathway for deep venous thrombosis: a preliminary model

Karthikeyan P Iyengar ¹, Vijay Kumar Jain ², Manjusha Soni,³ Zuned Hakim¹

¹Department of Orthopaedics, Southport and Ormskirk Hospital NHS Trust, Southport, UK

²Department of Orthopaedics, Atal Bihari Vajpayee Institute of Medical Sciences, Dr Ram Manohar Lohia Hospital, New Delhi, India

³Department of Acute Medicine, Warrington and Halton General District Hospital, Warrington, UK

Correspondence to

Vijay Kumar Jain,
Department of Orthopaedics,
Atal Bihari Vajpayee Institute
of Medical Sciences, Dr. Ram
Manohar Lohia Hospital, New
Delhi, 110001;
drvijayortho@gmail.com

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ABSTRACT

Background COVID-19 has necessitated the reduction in conventional face-to-face patient consultation to reduce the risk of novel coronavirus SARS-CoV-2 transmission. Traditional pathways to risk assess for deep venous thrombosis (DVT) would involve face-to-face assessment to formulate an appropriate management plan following an initial presentation usually in secondary care or in-hospital settings. Appropriate antithrombotic measures can prevent complication of DVT such as pulmonary embolism with prompt early diagnosis and treatment.

Methods This observational, pilot study evaluates the possibility of combining telemedicine technology and a virtual examination pathway for remote triage and assessment of patients with suspected DVT.

Results Piloting and development of a virtual risk assessment pathway for DVT involves various challenges and multidisciplinary co-ordination.

Conclusion Advances in telecommunication technology can enable clinicians, specialist nurses and hospital departments to develop a virtual examination pathway for remote triage and assessment of patients with suspected DVT. This pathway is not a replacement for conventional 'face-to-face' evaluation, but we believe the template can be explored and refined to act as a blueprint for future applications even when the pandemic has stabilised.

INTRODUCTION

COVID-19 pandemic has resulted in a profound impact on the delivery of healthcare. The novel coronavirus SARS-CoV-2 outbreak has limited the traditional 'face-to-face' interaction between a clinician and a patient due to social distancing and infection prevention strategies to prevent viral transmission.^{1 2} This has necessitated a shift away from in-hospital visits, reduced 'face-to-face' outpatient and general practitioner clinic appointments and a search for innovative ways to address patient continuity of care.³ COVID-19 has introduced a new conundrum in the natural history of venous thromboembolism (VTE). VTE often manifests clinically as deep vein thrombosis (DVT) or pulmonary embolism (PE). DVT of the lower limb commonly starts in the deep calf veins. Of these thrombi 10% to 20% can propagate proximally and may lead to fatal PE. Appropriate antithrombotic measures can prevent this complication with prompt early diagnosis and treatment. It has been acknowledged that COVID-19 is associated with inflammation and a prothrombotic condition.⁴ COVID-19 associated coagulopathy is common in patients with associated cardiovascular risk factors

such as hypertension and coronary artery disease.^{5 6} Cardiovascular disease is a strong risk factor for rapid progression and bad prognosis of COVID-19.⁷ Higher incidence of thrombotic complications has been seen in patients with severe SARS-CoV-2 infection and in patients who are critically ill in the intensive care unit.⁸ There is an urgent call to introduce closed ultrasound screening and monitoring for VTE in hospitalised patients⁹ and the need to be vigilant about VTE during the COVID-19 pandemic in the community. These mechanisms may be possible to initiate in a hospital setting; however, at-risk patients in the community may benefit from a virtual assessment for VTE especially due to the limitations posed by reduced face-to-face interactions and community care visits. Advances in information and communication technology with the availability of web-based telecommunication platforms have made it possible to deliver healthcare by remote medical consultation.^{10 11} COVID-19 has triggered an accelerated development of telemedicine (TM) in patient care both at primary and secondary care.¹² TM applications have been used in the management of various musculoskeletal injuries.^{13 14} TM has been explored for virtual orthopaedic examination, and remote orthopaedic consultations have been found to be convenient and cost-effective.^{15 16}

Combining TM technology using real-time synchronous audio–video transmission and a virtual examination technique may provide a remote triage and assessment of patients suspected of DVT, a common cause of VTE. The proposed model can be tried, re-enforced during this current pandemic. This will allow optimal utilisation of stretched hospital resources, support social distancing/infection prevention guidelines during the current COVID-19 pandemic and may be a model of such remote assessment of DVT in the future when the risk of COVID-19 has reduced.

Deep venous thrombosis

VTE is a term used to describe how thrombi form in a vein and break off to embolise into the vascular system. This includes DVT and PE. The European Society of Cardiology guidelines for the diagnosis and management of PE report annual incidence rates of venous thrombosis and PE of approximately 0.5–1.0 per 1000 inhabitants.¹⁷ DVT is a common VTE disorder with the formation of a thrombus in a deep vein, usually of the lower limbs and can lead non-fatal or fatal PE including include post-thrombotic syndrome.^{18 19} In the community, patients with DVT commonly present with pain, swelling and redness of the affected limb. The



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patient is then referred to secondary care or a hospital for confirmation of the diagnosis and initiation of anticoagulation. Despite National Institute of Health and Care Excellence (NICE) guidelines, the early management of DVT in UK hospitals varies broadly with a wide variation in clinical pathways across the National Health Service (NHS) hospitals.²⁰ A remote assessment model will be useful in preliminary evaluation of patients at home or in the community care home settings.

PREPARATION FOR VIRTUAL DVT CONSULTATION

TM portal set-up

The virtual DVT consultation system will require infrastructure organisation with setting up of 'virtual consultation portals'. Availability of appropriate TM applications including compatible computer or mobile devices with fast fibre broadband internet connectivity is essential for reliable image transfer. Various web-based platforms are being used for video consultations. The common ones include Zoom, Microsoft Teams, Cisco Webex. There have been growing concerns about data security with some of these platforms. To address this implementation of 'Attend Anywhere', NHS digital web-based platform supported and promoted by the NHS Improvement as a part of national digital strategy will allow a safe and secure link with the patients.²¹ The video applications will have to be downloaded on both the clinician and patient's computer, laptop or smartphone.

Synchronisation

Remote access to electronic patient record and complementary radiology imaging systems such as patient archiving and communication system and patient administration system such as Medway for biochemical, haematological or histo-pathological investigations included in the NHS records will be helpful to understand patient clinical condition during the virtual consultation. The patient archives including medical and surgical history, medications, allergies, social and family history will allow clinicians to populate the virtual clinical assessment template for DVT (table 1).

Virtual 'handshake'

Once the video consultation link has been established with the patient, preliminary introductions are made to confirm the identity of the patient. A valid consent is obtained for remote consultation. The General Medical Council has published TM practice guidelines that apply to remote consultations as to any other, for example, face-to-face consultations.²² The patient will need an explanation about how the consultation is going to progress and limitations of the virtual consultation. Ancillary staff attending the appointment are introduced. Appropriate clothing, dressing and camera positioning for the virtual clinical examination will need to be explained to the patient.

Undertaking patient history

The diagnosis of DVT relies on assessment of the patient's history and physical examination, risk stratification, followed by imaging.²³ Pain and swelling of the involved extremity are the most common symptoms of DVT. Pain can be felt like cramping or soreness of the leg. There may be subtle ankle and calf swelling with slight pain, but if the clot is extensive then the entire leg can be swollen, tight, discoloured and painful. The other symptoms of DVT include redness, mild fever, superficial vein dilatation or bluish discoloration. A history of underlying risk factors, medications and recent surgical procedure of major joints within 4 weeks or recent immobilisation should be obtained from the patient with suspected DVT (table 1).

Patients tested positive for COVID-19 are considered to have a hypercoagulable state and are at an increased risk for a broad range of vascular sequelae including DVT.²⁴ Concurrent or recent onset of COVID-19 symptoms such as fever, running nose, sore throat continuous dry cough, tiredness, gastrointestinal symptoms such as diarrhoea and change or loss of smell and/or taste should be obtained from every patient. It may be difficult to ascertain the symptoms of PE; however, shortness of breath, pleuritic chest pain, dizziness or fainting, palpitations, blue lips or face, coughing up blood, etc., should be enquired. Patients with these symptoms should be asked to visit hospital immediately for further diagnosis and management.

Virtual clinical examination

The physical examination should be done in a well-lit room. The camera of the patient should face the patient from the front. Patient should be seated on a chair with eye at the level of the camera. The feet are flat on the floor and knees bent. If bed bound, knees are bent and feet flat. The examination findings of vitals such as blood pressure, temperature and pulse rate are noted from the patient if possible.

The leg and ankle examination includes core examination consisting of look (inspection), feel (palpation) and movement assessment.

Look

Bilateral lower extremities should be evaluated for swelling of the leg or calf, any sign of inflammation, bluish discoloration and dilated veins. Severity of swelling, that is, involving the entire leg or only ankle and foot region should be noted. Surgical scars if the patient has a history of any previous surgery should be observed. The virtual examination should include both standing and seated positions, with camera views from the front, side and back of the leg and ankle.

Feel

The patient should be asked to use the back of their hand to compare the temperature of the calf. They should be asked to use one finger to point to the area of maximal pain or discomfort and press that area with their thumb. Localised tenderness along distribution of deep venous be noted. Pitting/non-pitting oedema should also be documented by asking the patient to press the front of the leg above the ankle for 30 s. The patient should be asked if they can feel a cordlike structure in the leg suggestive of thrombosed superficial veins.

Move

The patient's gait should be evaluated for any limping or discomfort. Pain of the calf on sudden dorsiflexion of the ankle joint should be noted. The range of motion testing should be tested actively (asking patients to move their joints) or passively (asking family members to move the joints) of hip, knee and ankle. Finally, the patient should be asked to measure their leg circumference from specific points (measured 10 cm below tibial tuberosity) and any difference in measurement between limbs conveyed to the examiner.

DECISION-MAKING PATHWAY

The patients with a positive history and physical examination should be assessed with the Wells score to determine the pretest probability of DVT.²⁵⁻²⁷ This score reduces the need for serial ultrasound testing for the diagnosis of DVT. Current NICE

Table 1 Virtual clinical risk assessment template for deep venous thrombosis

Parameters	Evaluation	Instructions/findings/documentation
<i>Undertaking virtual patient history</i>		
History	General	Note area of tenderness Length of time of symptoms. Rule out trauma. Exclude bilateral leg swelling.
	Well-being	
	COVID-19 symptoms	
	- Fever	
	- Continuous cough	
	- Change or loss of smell and/or taste	
	DVT	
	Calf pain—throbbing, erythema, swelling, tenderness, cramps	
	PE	
	-Pleuritic chest pain	
	-Sudden shortness of breath	
	-Dizziness or fainting	
	-Haemoptysis	
	-Palpitations	
	-Peripheral cyanosis	
Risk factors	Prolonged immobility, surgery, plaster cast, long haul flight, HRT, pregnancy, smoking, cancer, previous thrombosis, coagulation disorders, for example, APS	
Medications	Hormone treatment, OC pills, chemotherapy	
Recent surgery	Hip and knee arthroplasty, hip fracture	
Medical history	Enquire relevant medical history and in-hospital admissions	
<i>Virtual examination of limb</i>		
Parameters	Evaluation to document	Verbal clues and instructions for the patient
Look	General advice for the virtual examination	<i>It is acceptable if the patient needs help from a relative or friend for reassurance and help during virtual examination. Extremity being examined should face the camera. Patient sat in a chair. Feet flat on the floor and knees bent. Please wear shorts or skirt. Patient to remove shoes and socks. Please expose both legs up-to mid-thigh.</i>
	Swollen, oedema of the leg <i>None/mild/moderate/severe/</i> If obvious oedema/swelling of the leg	<i>Leg being examined should face the camera please. With camera facing you, please place your thumb against the shin and press the front of the leg just above the ankle for 30 s.</i>
	Erythema, any signs of inflammation, redness or bluish discoloration Any obvious collateral (non-varicose) superficial veins dilatation or superficial thrombophlebitis.	<i>Leg being examined should face the camera please. Do you feel the leg hot?</i>
	Any scars, for example, from an operation	<i>Do you have any scars for us to see?</i>
Feel	Calf pain Ensure deep veins examined.	<i>Is the leg or calf painful? Please point with your finger the site of pain. Please try to press your calf—Does this cause pain?</i>
	Leg temperature	<i>Please use the back of your hand to check for temperature and compare it with the opposite leg.</i>
Move	Painful dorsiflexion and plantar flexion of ankle Pain on weight-bearing, observe gait	<i>Does stretching your ankle up and down cause pain? Please walk few steps away from the camera. Turn around and walk back towards the camera.</i>
	Measurement	
	Calf circumference If >3 cm difference from other leg-> significant	<i>Ask patient to measure calf swelling by measuring tape, measuring 10 cm below the bony prominence below and front of the knee. A representative picture can be shown on synchronous transmission. Please measure the girth of your both legs at same levels.</i>

APS, anti-phospholipid syndrome; DVT, deep venous thrombosis; HRT, hormone replacement therapy; OC, oral contraceptives; PE, pulmonary embolism.

guideline NG158 recommends a two-tier score of whether DVT is unlikely (≤ 1 point) or DVT is likely (≥ 2 points). Patients with low probability should be tested with D-dimer and if positive, venous duplex ultrasonography (VDU) should be performed (figure 1—flow chart). The D-dimer levels are uniformly elevated in patients with COVID-19. So, it is difficult to predict the level of significance in concomitant COVID-19 and DVT pathologies. Anticoagulation is strongly recommended in patients with

positive VDU. For negative results, repeat VDU can be considered for re-evaluation in cases with high suspicion of DVT.

LIMITATION OF THE STUDY

Authors acknowledge the proposed pathway is not a validated route of assessment yet. Validation will require comparing TM approach with the traditional approach that involves physical examination by a clinician and investigation of the patient.

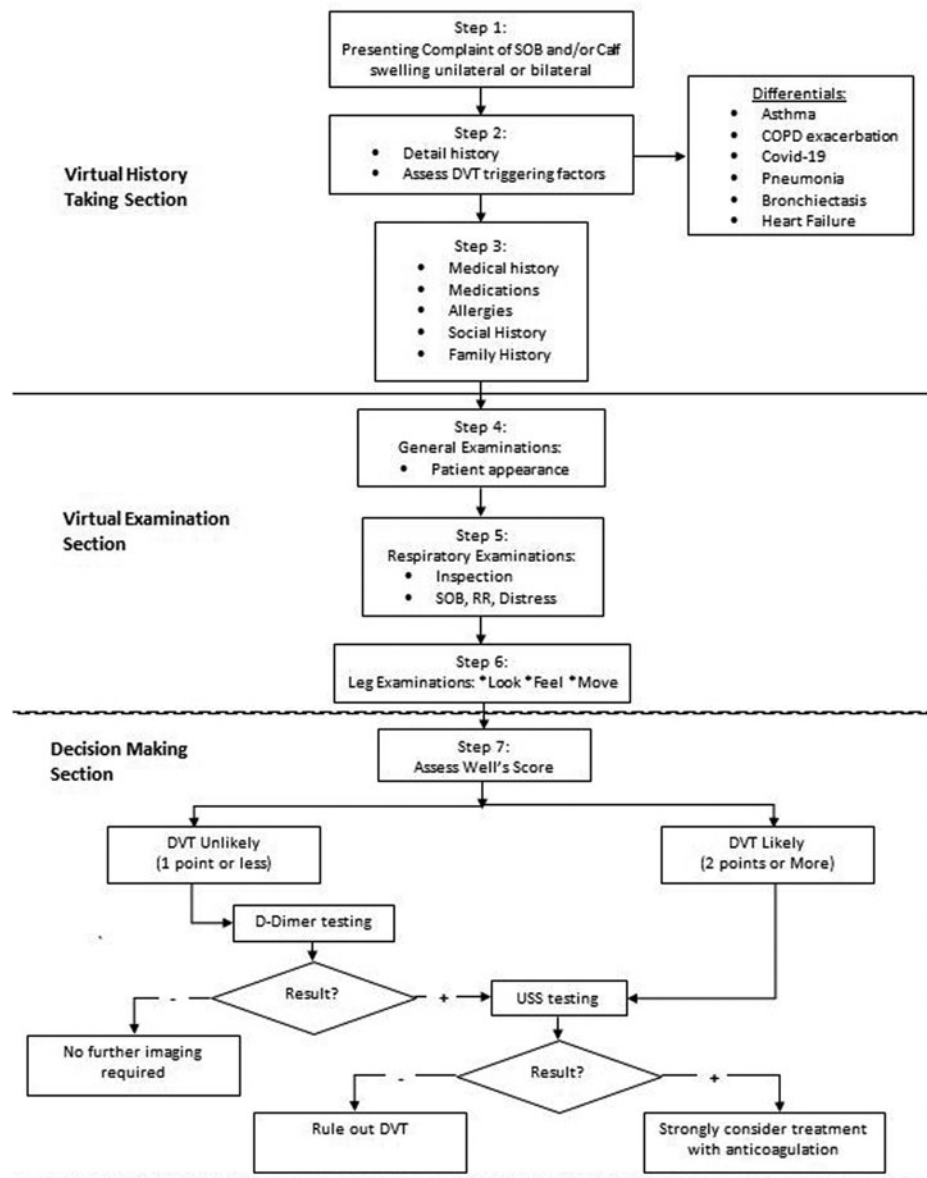


Figure 1 Flow chart for virtual deep venous thrombosis (DVT) risk assessment. COPD, chronic obstructive pulmonary disease; RR, respiratory rate; SOB, shortness of breath; USS, ultrasound scan.

There will be a need to ensure quality assurance and improvement of this model. However, virtual DVT assessment examination model is a novel concept put forward by the authors. The model will surely be developed further to become a consistent form of assessment as the process is refined; regular audits are undertaken for quality assurance and monitor continual improvement. Patient perception and acceptance of virtual DVT assessment with TM will need to be considered which can be evaluated by further research studies.

CONCLUSION

COVID-19 has restricted traditional 'face-to-face' assessments and attendances at primary care and in-hospital outpatient departments. Innovative ways need to be found to facilitate early diagnosis and management of a patient with suspected DVT as with other significant medical conditions. This is particularly relevant during the current pandemic since COVID-19 is acknowledged as a pro-coagulant condition. Virtual assessment

pathway is not a replacement for conventional 'face-to-face' evaluation, but we believe the template can be explored and refined to act as a blueprint for future applications even when the COVID-19 pandemic has stabilised.

Main messages

- ▶ Social distancing and infection prevention guidelines due COVID-19 have necessitated the need to discover alternatives to conventional 'face-to-face' DVT risk assessment in the primary care and community settings.
- ▶ Virtual DVT risk assessment pathway may allow initial remote assessment for DVT and help formulate a management plan.
- ▶ Virtual DVT risk assessment will thus support initial evaluation in the community and prompt referral to secondary care following decision-making probability score.

Current research questions

- ▶ How to validate such a virtual DVT risk assessment pathway?
- ▶ Patient-directed examination compared with clinical evaluation—a comparison to assess variability.
- ▶ How do we assess patient acceptability of telemedicine to diagnose DVT? Will they feel confident and accept it?

What is already known on the subject

- ▶ DVT of the lower limb can lead to non-fatal or fatal PE.
- ▶ Diagnosis of DVT depends upon a combination of history, assessment of clinical risk and investigations.
- ▶ Antithrombotic prophylaxis is safe and effective.

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ORCID iDs

Karthikeyan P Iyengar <http://orcid.org/0000-0002-4379-1266>
Vijay Kumar Jain <http://orcid.org/0000-0003-4164-7380>

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