

Deep vein thrombosis and bilateral pulmonary embolism following minor trauma to the popliteal fossa: could this have been avoided?

Jason Orlik, BSc, MD* ; Jennifer McVey, BSc, MSc, MD†

ABSTRACT

Deep vein thrombosis (DVT) with subsequent pulmonary embolus (PE) is frequently fatal if untreated. Athletes may be susceptible to DVT following minor blunt trauma to the popliteal fossa. We report an adult male hockey player with no "classic" risk factors for DVT who presented with a DVT and bilateral PE following minor popliteal blunt trauma. This case report illustrates the utility of likelihood ratios when interpreting the results of diagnostic tests such as Doppler ultrasonography.

RÉSUMÉ

La thrombose veineuse profonde (TVP) suivie d'une embolie pulmonaire (PE) est souvent mortelle si elle n'est pas traitée. Les athlètes peuvent être sensibles à la TVP après un traumatisme fermé mineur du creux poplité. Nous décrivons le cas d'un joueur de hockey adulte ne présentant aucun facteur de risque « classique » de TVP, mais ayant une TVP et une EP bilatérale consécutives à un traumatisme fermé du creux poplité. Ce rapport de cas illustre l'utilité des rapports de vraisemblance lors de l'interprétation des résultats de tests diagnostiques tels que l'échographie Doppler.

Keywords: deep vein thrombosis, likelihood ratio, minor trauma, popliteal fossa, pulmonary embolism

Presentation of patients to emergency departments (EDs) with symptoms and signs suggestive of deep vein thrombosis (DVT) is common. DVT has an incidence of 66 per 100,000 per year,¹ and DVTs commonly occur in the popliteal and femoral veins.² From these sites, thrombi may embolize to the lungs. Pulmonary embolism (PE) will develop in approximately 50% of untreated DVT's, many of which will be

asymptomatic.³ PEs are potentially fatal; 35% of patients will die if left untreated or the PE is undetected, and 5% of patients will die even with appropriate treatment.³ It is vitally important to accurately diagnose DVT and promptly initiate treatment to reduce the risks of patients' developing a PE. As the symptoms of DVT are nonspecific,⁴ investigation of DVT is dependent on physicians' having a high index of clinical suspicion. Pretest probability (PTP) for DVT can be based on gestalt or clinical decision aids; the Wells criteria are a sensible, reliable, and valid tool developed and used widely in Canada.⁵ After determining PTP, further investigative decisions are dictated by the low, moderate, or high PTP status of each patient.

The following case describes a patient with a DVT and subsequent PE following minor trauma to the popliteal area,⁶ with a discussion of how to proceed following ambiguous test results. The case illustrates how PTPs may be used to guide interpretation of test results in conjunction with positive and negative likelihood ratios (LRs) and, therefore, subsequent patient management.

CASE REPORT

A 37-year-old male presented to the ED with pain and swelling to the left calf. He had been hit in the popliteal fossa with a hard plastic ball while playing ball hockey 10 days previously. His past medical history was significant only for myocardial infarction 3 years previously, for which he underwent coronary

From the *UBC Okanagan Family Medicine Program, Kelowna, BC; and †Department of Emergency Medicine, Dalhousie University, Halifax, NS.

Correspondence to: Dr. Jason Orlik, Family Medicine Residency Office, 2268 Pandosy Street, Kelowna, BC V1Y 1T2; jorlik@dal.ca.

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stent placement. The patient had no other known risk factors for DVT or PE (specifically no history of smoking, malignancy, recent long trips, surgery, or immobilization, and there was no family history of clotting disorders). Also of note, there was no period of relative immobility following his injury. His only medication was rosuvastatin. On physical examination, he looked well and his vital signs were normal. He denied any shortness of breath or chest pain. His only complaint and physical examination finding were swelling and pain in the left upper calf, which was 5 cm greater than the right. There was also pitting edema and whole leg swelling.

Laboratory investigations included a positive D-dimer (287 ng/mL); his international normalized ratio (INR) was 1.2, and his partial thromboplastin time (PTT) was 54 seconds. A Doppler sonogram was positive for DVT with thrombus located in the posterior tibial veins, and the patient was placed on 18,000 units of dalteparin. A follow-up Hematology consultation was arranged for the next day, and repeat ultrasonography (US) performed then revealed no DVT but, rather, a thrombus in the small saphenous vein (also known as the short, or lesser, saphenous vein), which was superficial. The decision was made by the hematologist to discontinue anticoagulant therapy. The rationale was that it would be unlikely that the thrombus would extend because it had been present for approximately 10 to 12 days. The patient was placed on naproxen for his symptoms.

Nine days later, a repeat sonogram demonstrated that the clot had extended into the proximal popliteal vein. The patient was again placed on dalteparin and warfarin. After 5 days, dalteparin was discontinued and warfarin was maintained as his INR was therapeutic.

Seven days later, the patient woke up with intense midthoracic back and chest pain described as pleuritic in nature. On returning to the ED, he denied any shortness of breath, fever, cough, or hemoptysis. His vital signs were normal, he appeared well, and his physical examination was unremarkable; however, his PTP for PE was high (Table 1). His INR was 3.3. Spiral computed tomography revealed bilateral PE. The patient was briefly treated with intravenous heparin and then discharged home on warfarin, with no further adverse events. Of note, follow-up investigations for thrombophilia were negative, including antithrombin III deficiency, factor V Leiden, anticardiolipin, anti-nuclear antibody, anti-DNA, and lupus anticoagulant.

Table 1. Wells rule for predicting pretest probability of pulmonary embolism

Clinical characteristic	Score
Previous pulmonary embolism or deep vein thrombosis	1.5
Heart rate > 100 beats per minute	1.5
Recent surgery or immobilization	1.5
Clinical signs of deep vein thrombosis	3
Alternative diagnosis less likely than pulmonary embolism	3
Hemoptysis	1
Cancer	1

Clinical probability of pulmonary embolism; low = 0–1; intermediate = 2–6; high = greater than 7.¹⁴

DISCUSSION

Could the extension of DVT to a PE been avoided in this case? Following his primary presentation to the ED, a repeat diagnostic test (US) was obtained for this patient. The results contradicted earlier findings and culminated in a change in management without meaningful interpretation of a previously positive sonogram. This issue is discussed in detail below.

This patient had no classic risk factors for DVT (Table 2); however, using the established clinical criteria for DVT probability of Wells and colleagues,⁷ his score was 3 (e.g., entire leg swelling, localized

Table 2. Risk factors observed in patients with venous thromboembolism

Risk factor	Patients (%)
Age > 40 yr	88.5
Obesity	37.8
History of venous thromboembolism	26.0
Cancer	22.3
Bed rest > 5 d	12.0
Major surgery	11.2
Congestive heart failure	8.2
Varicose veins	5.8
Fracture (hip or leg)	3.7
Estrogen treatment	2.0
Stroke	1.8
Multiple trauma	1.1
Childbirth	1.1
Myocardial infarction	0.7

Adapted from Anderson FA and Spencer FA.¹⁵

tenderness along the distribution of the deep venous system, and calf swelling > 3 cm larger than asymptomatic side). As per the Wells criteria, the PTP of DVT was high (Table 3). With a high PTP, the prevalence of DVT is approximately 53% (95% CI 44–61).⁷ In other words, there is a 53% chance that this patient has a DVT, or about the same as flipping a coin.

A valuable diagnostic test is performed to shift this PTP of disease to a higher or lower posttest probability. In this sense, it is useful to consider LRs when interpreting test results⁸ as this ultimately affects management decisions. The LRs are derived from the sensitivities and specificities of a given test.

In this case, the appropriate first diagnostic test was Doppler US. Although a D-dimer may be used in low and moderate test circumstances, Doppler US has reported sensitivity of 0.89 (95% CI 0.88–0.90) and specificity of 0.94 (95% CI 0.93–0.94).⁹ Therefore, calculations of LRs are as follows: $+LR = \text{sensitivity}/1 - \text{specificity} = 14.8$ $-LR = 1 - \text{sensitivity}/\text{specificity} = 0.12$.

A test with a $+LR > 10$ is considered useful for ruling in a given condition with a moderate PTP.⁸ Conversely, a test with a $-LR < 0.10$ would be considered useful for ruling out the same condition in a similar group.⁸ The Doppler US therefore meets the psychometric properties of a valuable diagnostic test. These data are then applied on a Fagan nomogram,¹⁰ as

shown in Figure 1. Using this figure, we can see that given that our patient had a PTP for DVT of 53%, the posttest probability is increased to over 90% with the positive sonogram. Even a negative initial sonogram would have reduced the posttest probability only to approximately 12% and would mandate further investigative strategies (ie, other testing or repeat US in 1 week). Although it is important that US be repeated to detect missed DVT's in high-probability patients,^{7,11} a repeat sonogram that is negative after an initial positive sonogram will not change the pretest probability. Thus, the results from the second sonogram mean that the patient still had at least a 12% chance of DVT, which would warrant further investigation. That being said, in the setting of an initially positive sonogram, one could argue that the PTP was even higher before the second sonogram.

Of interest, this report also highlights the need for serial US in the case of a suspected calf vein DVT. If a below knee ("calf vein") DVT was suspected, treatment with nonsteroidal antiinflammatory agents would be appropriate assuming that serial US tests were available to detect the progression of clot into more proximal deep veins. Although rare, this progression is an important finding, one that emergency physicians should suspect.

In our case, when the second sonogram was reported as negative, this posed a diagnostic dilemma influencing the decision to continue anticoagulation. This is

Table 3. Wells criteria for predicting pretest probability of deep vein thrombosis

Clinical characteristic	Score
Active cancer (treatment ongoing, administered within previous 6 mo, or palliative)	1
Paralysis or paresis or recent plaster immobilization of the lower extremities	1
Recently bedridden > 3 d or major surgery within previous 12 wk requiring general or local anesthesia	1
Localized tenderness along distribution of the deep venous system	1
Swelling of entire leg	1
Calf swelling > 3 cm larger than asymptomatic side (measured 10 cm below tibial tuberosity)	1
Pitting edema confined to the symptomatic leg	1
Collateral superficial veins (nonvaricose)	1
Previously documented DVT	1
Alternative diagnosis at least as likely as DVT	-2

Adapted from Wells PS et al.⁷
DVT = deep vein thrombosis.
Score of 2 or higher indicates that the probability of DVT is "likely"; a score of less than 2 indicates that the probability is "unlikely."

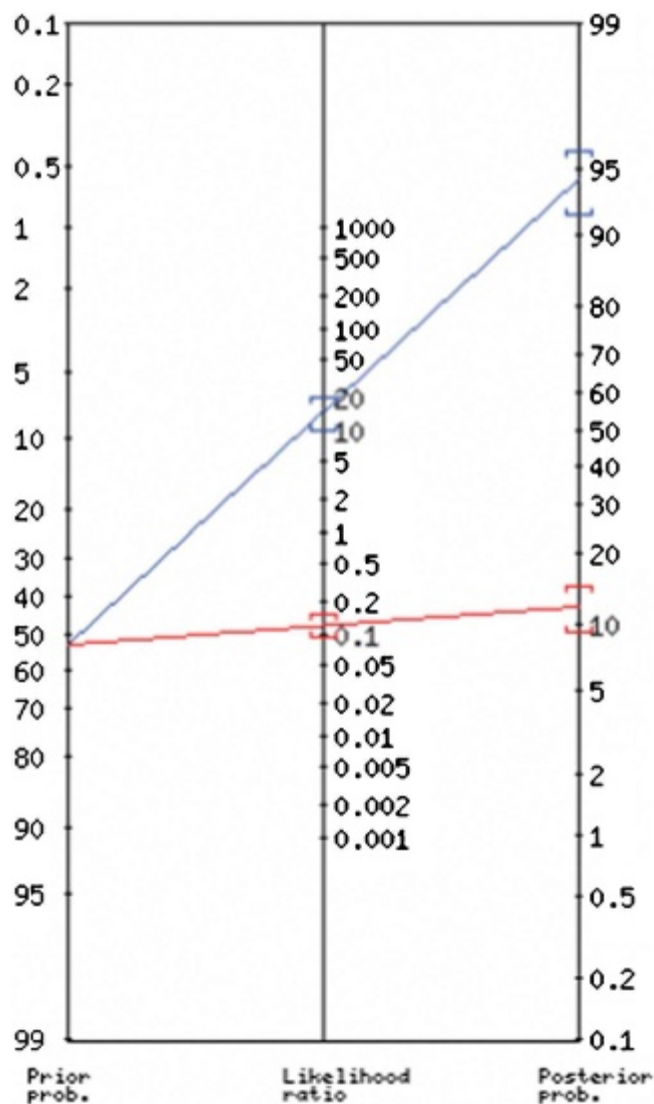


Figure 1. Nomogram: likelihood ratios of deep vein thrombosis with high pretest probability and ultrasound testing. Previous probability (OR) 53% (1.1). *Positive test:* positive likelihood ratio 15, 95% CI 10–21; posterior probability (OR) 94% (16.9), 95% CI 92–96. *Negative test:* negative likelihood ratio 0.12; 95% CI 0.09–0.15; posterior probability (OR) 12% (0.1), 95% CI 9–14. Adapted from Schwartz A.¹⁰

an excellent example of how LRs may be used to guide the interpretation of test results and therefore management decisions. Fortunately, the patient underwent a third sonogram that again was positive, and the decision was made to restart anticoagulation.

In terms of the discrepancy between the two US reports, this could have been due to interrater reliability; however, it has been shown that with experienced observers, interobserver reliability for lower extremity DVT is excellent, at 94%.¹² It is unclear why the second sonogram was negative;

however, it does not change the fact that there was a previous positive sonogram. This patient had a posttest probability of DVT greater than 90% after the initial positive sonogram, suggesting that he should have been maintained on the appropriate dose and duration of anticoagulant therapy. Confirmation of venous thromboembolism is a critically important issue for all physicians and patients; discordant test results should mandate a more vigorous search for the truth. Despite resuming anticoagulant therapy and demonstrating therapeutic INRs, this patient experienced a subsequent PE, illustrating that PEs are a risk in patients with DVTs even when receiving appropriate therapy. As heparin accelerates clot removal over 48 to 72 hours by allowing unopposed action of plasmin, this patient was started on intravenous heparin and maintained on oral anticoagulation without further complication.¹³

CONCLUSION

This case report of DVT and bilateral PE provides an excellent illustration of the utility of PTP and LRs for interpreting diagnostic test results. It also demonstrates the potential impact that this may have on subsequent management decisions and patient outcomes.

Competing interests: None declared.

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