Management of suspected deep venous thrombosis in an emergency medicine ward in Hong Kong

香港急症科病房對深部靜脈栓塞的治理

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Introduction: Clinical signs and symptoms can vary for patients with deep venous thrombosis (DVT). DVT is an important diagnosis to recognise as it can lead to proximal embolism into the pulmonary circulation resulting in sudden collapse and death. The objective of this study is to describe the management of patients with suspected DVT in the emergency medicine ward (EMW) setting in Hong Kong using a standardised clinical pathway. Methods: A retrospective review was conducted for patients with suspected DVT admitted to the EMW from April to December 2008 using a standardised protocol. The use of a clinical prediction rule and diagnostic tests (including the modified Well’s score, D-dimer and ultrasound examination) and outcomes (including the length of stay and secondary admission rate) were investigated. Results: A total of 100 patients with suspected DVT were admitted to the EMW in the nine-month study period. DVT was confirmed in 30% using ultrasonography. Fifty-two percent of patients were in the high-risk category according to the modified Well’s score. Seventy-six percent of patients had positive D-dimer results. Ten percent of patients were safely discharged without an ultrasound examination. Mean length of stay in the EMW was 1.99 days. Thirteen percent of patients required second admission to other specialties. Conclusions: This study suggests that a standardised clinical pathway based in the EMW can be used for patients with suspected DVT to reduce hospital admission. (Hong Kong J Emerg Med. 2011;18:13-19)

簡介：患有深部靜脈栓塞的病人，他們的體徵和症狀可以有很多不同。認識深部靜脈栓塞的診斷非常重要，因為它可以造成近端肺動脈栓塞而導致休克和死亡。這個研究的目的是論述在香港急症科病房層面，如何用一套標準化的臨床治療方案來處理懷疑患有深部靜脈栓塞的病人。方法：由二零零八年四月至十二月期間，用標準化治療方案對急症科病房內懷疑患有深部靜脈栓塞的病人進行一個回顧性的檢討。對臨床預後指標的採用、診斷性的檢驗（包括改良韋氏計分法，D-聚體和超聲波檢查）和效果（包括住院的總時間和再入院的比例）進行了研究調查。結果：在香港月的研究時間裏，一共有100個懷疑患有深部靜脈栓塞的病人住於急症科病房內。百分之三十的病人用超聲波確診為深部靜脈栓塞。百分之五十二的病人根據改良韋氏計分法屬於高危組別。百分之七十六有D-聚體陽性反應。百分之十的病人沒有做超聲波檢查而安全地出院。平均急症科病房住院時間為1.99天。百分之十三的病人須要再入院到其他專科病房。結論：這個研究提供一個標準化的臨床治療方案去處理對於懷疑患有深部靜脈栓塞的病人入住急症室病房，對減低住院率提供了一個可行的方法。

Keywords: Clinical decision unit, clinical prediction rule, D-dimer, short stay unit

關鍵詞：決定性的臨床單位、臨床預後指標、D-聚體、短暫住院病房

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**Introduction**

Clinical signs and symptoms can vary for patients with deep venous thrombosis (DVT). DVT is an important diagnosis to recognise as it can lead to proximal embolism into the pulmonary circulation resulting in sudden collapse and death. It is a challenge for emergency physicians to accurately diagnose patients with suspected DVT in the emergency department (ED) setting.

For the diagnosis of DVT, the golden standard is by venography. However, due to its invasive nature and the limited availability, nowadays it is less commonly used. Studies have found that ultrasonography (USG) is a reliable alternative for the diagnosis and exclusion of DVT. In a study looking at 526 patients who had ultrasound for suspected DVT by Subramaniam, the negative predictive value of a single lower limb US examination to exclude DVT was 99.6% and it is safe to withhold anticoagulation therapy in these patients.

With the increasing availability of USG, many EDs are now equipped with ultrasound machines with increasing training on their use. With the introduction of emergency medicine wards (EMW) to EDs in Hong Kong in 2007, emergency physicians could potentially have a greater role to diagnose and treat patients with suspected DVT.

The EMW in Prince of Wales Hospital was opened in October 2007. It is a standard ward with 28 beds. Specialists in emergency medicine perform ward rounds twice daily and patients can be admitted and discharged at any time of the day. With the opening of the EMW, patients with specific conditions could now be managed by emergency physicians using standardised protocols. Patients with suspected DVT have been managed under an integrated care pathway (ICP) since April 2008.

Patients with suspected DVT are first seen by the emergency physician on duty and actively enrolled into the ICP. The physician is required to fill in an ICP record form which includes parameters like the modified Well's score and D-dimer (ELISA) assay. The D-dimer assays are only available within office hours during weekdays and are performed by the chemical pathology laboratory using an ELISA method.

Patients in the low risk category according to the modified Well’s score and a negative D-dimer result (<500 ng/mL) are discharged home directly from the ED. Patients in the high risk category or those with a positive D-dimer result are admitted to EMW and have an ultrasound examination arranged in the radiology department to diagnose or exclude DVT (Figure 1).

The ED has an arrangement with the radiology department for two slots for lower limb USG every working day and the patients can proceed directly for USG from the ED if they attend within office hours and slots are available. Those who are found to have an above knee DVT by USG are treated with subcutaneous low molecular weight heparin (LMWH) and warfarin under a standardised protocol. LMWH is given daily for at least 5 days or until the INR has been in the therapeutic range for 2 successive days, whichever is the longer. At the same time the patient is started on 5 mg warfarin according to nomogram, and discharged on day 2 with regular ward follow up on day 3, 4 and 6 for subcutaneous LMWH injections and warfarin titration. After sufficient warfarin titration (INR 2-3), they are given a follow up appointment in the medical specialist out patient clinic for further workup and continuation of warfarin therapy.

The objective of this study is to firstly describe the management of patients with suspected DVT in the EMW setting using a standardised clinical pathway in Hong Kong, secondly to look into the effectiveness of this new management pathway in terms of length of stay (LOS), and thirdly to identify ways to improve the care for these patients.

**Methods**

This is a retrospective study reviewing consecutive patients with suspected DVT admitted to the EMW of Prince of Wales Hospital in the nine months from
April to December 2008. All patients who were admitted to the EMW under the ICP for DVT were included. The exclusion criteria were those factors which would exclude patients from following the ICP, namely age less than 18 years old, pregnant, taking oral contraceptive pill, previous history of DVT or pulmonary embolism, serious or unstable medical co-morbidity, uncontrolled pain, communication difficulties, a history of non-compliance to medication or follow up, or any contraindication to LMWH or warfarin.

The ED records and the ICP record forms were reviewed for all the patients who were admitted to the EMW in the study period and information was supplemented by the computerised Clinical Management System (CMS). Descriptive statistics were used to describe patient demographics and outcomes including the length of stay and second admission rate (defined as those patients who required transfer to the care of another inpatient specialist, such as general medicine or geriatrics). All statistical computations were performed using SPSS software (SPSS, Version 16.0, SPSS Inc., Chicago, Il, USA).

Results

A total of 100 cases were identified in the nine-month period of which 80 had completed Wells’ scores. The mean age of the 100 cases was 61.7 years old with 62 (62%) female. Three (3%) patients who had previous history of DVT were inappropriately admitted into the protocol. Fifty-two (52%) patients belonged to the high-risk category by modified Well’s score and 28 (28%) in the low risk category with 20 (20%) who did not have a recorded score. The frequency distribution for the criteria of the modified Well’s score is shown in Table 1. Seventy-six (76%) patients were found to have a positive D-dimer (>500 ng/mL) and 22 (22%) patients with negative results with two (2%) who did not have a D-dimer result. Ninety (90%)
**Table 1.** Frequency distribution for criteria of the modified Well’s score

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Score</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pitting oedema</td>
<td>1</td>
<td>46</td>
</tr>
<tr>
<td>Localised tenderness along distribution of the deep veins</td>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td>Calf swelling &gt;3 cm cf. other leg</td>
<td>1</td>
<td>34</td>
</tr>
<tr>
<td>Entire leg swollen</td>
<td>1</td>
<td>32</td>
</tr>
<tr>
<td>Recently bedridden &gt;3 days, or major surgery in past 4 weeks</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Paralysis, paresis, or recent cast immobilisation of lower limb</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Distended superficial veins</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Alternative diagnosis unlikely</td>
<td>-2</td>
<td>5</td>
</tr>
<tr>
<td>Active cancer</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Previously documented DVT</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

DVT=deep venous thrombosis

Fifty-five (53%) patients were sent home without ED follow up, 34 (34%) were discharged with ward follow up after one week, and 13 (13%) had second admission to other specialties. Reasons for second admission included suspected pulmonary embolism and patients found to have co-morbidities or alternative diagnoses requiring further inpatient management.

The mean LOS for all patients reviewed was 1.99 days (Figure 2). Of the 30 patients with DVT the mean LOS was 3.14 days compared with 1.49 days for the group without DVT. It was found that the time spent waiting for USG was a key area for improvement as the median time recorded from ED registration until USG was performed was 21 hours with the range of 96 hours and interquartile range of 19 hours. Comparing the subgroup of patients who did and did not undergo USG, the LOS for the no-USG group (n=10) was 1.23 days versus 2.07 days for the USG group.

During a comparable period in 2007, results from the Hospital Authority computerised CMS showed that the mean LOS for DVT patients ranged from 2 to 8 days with the average LOS of 5.25 days. This meant

**Table 2.** Two by two table on frequency of DVT with modified Well’s score

<table>
<thead>
<tr>
<th></th>
<th>DVT</th>
<th>No DVT</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wells score high probability</td>
<td>16</td>
<td>36</td>
<td>52</td>
</tr>
<tr>
<td>Wells score low probability</td>
<td>9</td>
<td>19</td>
<td>28</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>55</td>
<td>80</td>
</tr>
</tbody>
</table>

DVT=deep venous thrombosis

**Table 3.** Two by two table on frequency of DVT with D-dimer assay

<table>
<thead>
<tr>
<th></th>
<th>DVT</th>
<th>No DVT</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-dimer positive</td>
<td>29</td>
<td>47</td>
<td>76</td>
</tr>
<tr>
<td>D-dimer negative</td>
<td>0</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>69</td>
<td>98</td>
</tr>
</tbody>
</table>

DVT=deep venous thrombosis

patients underwent USG testing and 10 (10%) were discharged without USG. All those discharged without USG had their medical records traced from the CMS and none of them re-presented to Hong Kong public hospitals with a diagnosis of DVT within three months of the date of the index ED attendance.

Thirty (30%) patients were confirmed to have DVT by USG with 21 (70%) above knee and 9 (30%) below knee. Twenty-three (77%) patients were anticoagulated with LMWH and warfarin including all of the above knee DVT and the two with below knee DVT. The decision on whether to give anticoagulation for those with below knee DVT was made by the EMW specialist on duty after consultation with the geriatrician. Other diagnoses found from ultrasound examination included 11 patients with Baker cyst, six patients with groin mass or groin lymph nodes, four with muscle tears, two with superficial vein thrombosis and one with cellulitis.

The modified Well’s score was found to have a sensitivity of 64% in our study and specificity of 34.5% with a cutoff using 2 score or above indicating a high probability (Table 2). The D-dimer assay had 100% sensitivity and 31.9% specificity (Table 3).
that for the patients admitted to the EMW of our hospital, there was a reduction of 2.11 days for each DVT patient managed, which translated to a saving of 84 bed days per year.

**Discussion**

This study shows that emergency physicians can safely manage DVT in the EMW setting using an ICP, with a reduction in average LOS of two days per patient.

The prevalence of DVT of 30% among patients with suspected DVT in our study was high compared with findings from previous studies ranging from 15.7 to 21.7%. This may partly explain the reason for the lower percentage of patients who did not require USG (10%) compared to the 39% from Well’s 2003 study using a similar protocol. The sensitivity and specificity of the modified Well’s score found in our study of 64% and 34.5% were lower than the 75% and 55% quoted by Subramaniam. However, the sensitivity of the D-dimer assay was found to be 100% in our study.

The ICP used in our study adopted the commonly used combination of an established clinical prediction rule and D-dimer testing for suspected DVT patients. Since the Well’s score was introduced, studies have shown that such a clinical prediction rule in combination with D-dimer testing can safely stratify risk in patients with suspected DVT. It has been shown to be cost effective to safely select patients who do not require an USG examination. Other clinical prediction rules like the Hamilton Score have been introduced but not proven superior to the modified Well’s score.

The aim of the ICP is to safely reduce the LOS of patients with suspected DVT. The strategy used was by careful selection of patients to undergo USG using the clinical prediction rule and D-dimer assay, early USG examination and outpatient warfarin titration. It was found that a significant contribution to the LOS was the time spent waiting for USG examination, especially during weekends when radiology department provided USG is not available. Two strategies could be considered to shorten the LOS for patients waiting
for USG. The first is by empirically treating the patients in the high risk category with LMWH and discharging those patients who are haemodynamically stable and otherwise fit for outpatient care. They can be given an early USG slot when next available. The second strategy is the use of ultrasound by emergency physicians (ED ultrasound). Since most emergency physicians in Hong Kong nowadays have been trained to perform ED ultrasound, this approach will not only shorten the LOS but also reduce the number of EMW admissions during office hours. From the literature internationally, emergency physicians commonly undergo a structured 30-hour training course before ED ultrasound can be performed independently. The sensitivity and specificity of ED ultrasound is reported to be variable. Frazee et al in 2001 showed a sensitivity of 88.9% and specificity of 75.9, and Jang et al in 2004 showed a sensitivity and specificity of 100% and 91.8% respectively. Jacoby’s 2007 study included 121 examinations by six emergency residents and found a specificity of 89%. Magazzini et al showed 95% positive predictive value and 100% negative predictive value for USG in the ED. A 2008 systematic review showed overall sensitivity was 95% and specificity was 96%. However the reviewing authors found methodological flaws in several studies and commented that the results may be overly optimistic. A more recent study by Shiver published in 2010 showed a sensitivity of 86% and specificity of 100% for ED ultrasound compared with CT venography in the US. With the increase in USG training and supervision by senior emergency physicians, ED ultrasound has become an important ED assessment tool for patients with suspected DVT.

Different studies have shown that the EMW is a safe and effective alternative to conventional hospital admissions. It is achieved by streamlining the care of patients for specific conditions. A local study by Chan has shown that EMW has been successful in management for patients with mental health disorders. Our study has demonstrated that with the careful selection of patients for ultrasound examinations, patients with suspected DVT can be safely and effectively managed in the ED and EMW setting.

It is possible that introducing the ICP to medical wards would also reduce LOS in hospitalised patients. This is something that would need further study.

The major limitation of the study is that no formal control group was available for comparison, making it difficult to perform systematic comparisons on the strength and weaknesses of the current management protocol for suspected DVT patients in the EMW setting.

We have no data on the reason for the 20 cases with missing Well’s score. It is likely that either some doctors did not comply with the protocol to calculate the Well’s score or that the score calculated was not recorded. The calculation of the sensitivity and the specificity is based on the 80 cases with recorded Well’s score, and therefore we do not know the impact of the missing data on these values.

**Conclusion**

This study suggests that patients with suspected DVT can be managed in the EMW and reduce hospital admissions, with a shortened length of stay.

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**References**


