Original Article

The effect of nursing intervention based on Autar scale results to reduce deep venous thrombosis incidence in orthopaedic surgery patients

Hui-Zhen Yin a, Ci-Ming Shan b, *

a College of Nursing, Zhengzhou University, High-tech Development Zone, Zhengzhou, Henan Province 450001, China
b People’s Hospital of Henan Province (People’s Hospital of Zhengzhou University), Zhengzhou, China

ABSTRACT

Purpose: To reduce the incidence of deep venous thrombosis (DVT) with nursing intervention based on the Autar DVT risk assessment scale among orthopaedic surgery patients.

Methods: We recruited 216 orthopaedic surgery patients at our hospital between September 2013 and March 2014. The patients were assigned to intervention and historical control groups based on the time of admission. Using the Autar DVT risk assessment scale, we assessed the DVT risk levels in both groups; the intervention group received the corresponding prophylactic measures while the control group received routine nursing.

Results: The DVT incidence rate and the D-dimer level on postoperative day 3 in the intervention group were lower (1.82%; 623 ± 225 mg/L, respectively) than that of the control group (9.43%; 825 ± 201 mg/L, respectively); both differences were statistically significant (p < 0.05).

Conclusions: The Autar scale is beneficial when used in orthopaedic surgery patients; corresponding nursing intervention based on Autar scale assessment can prevent DVT effectively.

1. Introduction

Deep venous thrombosis (DVT) refers to the abnormal coagulation of blood; its complications are pulmonary embolism and embolism syndrome, which not only affect the quality of life of patients, but also can cause high mortality [1,2]. Compared to those abroad, health practitioners in our country focus less on preventing DVT; moreover, the prevalence of obstructive diseases is high, especially in major orthopaedic
surgery, which includes total hip replacement, total knee replacement, and hip fracture surgery [3,4]. Research suggests that health practitioners should focus on DVT prophylaxis in addition to using an effective risk assessment tool to identify high-risk patients, and implement the appropriate measures to decrease the morbidity rate effectively [5].

The possibility of developing DVT can be scored using the Autar DVT scale, which assesses risk quantitatively for nursing assessment and can avoid inaccurate evaluation stemming from differing levels of clinician experience. The scale was described by Autar in 1996 and is based on Virchow’s triad of DVT risk factors: decreased blood flow velocity, damaged vessels, and abnormal coagulation [6]. Lai et al. [6] used the Autar scale to assess 115 patients with cerebral haemorrhage, and implemented the corresponding preventive measures according to the assessment results. The authors found that DVT incidence in the intervention group was lower than that in the control group (0.8% vs. 6.8%) and that the difference was statistically significant ($\chi^2 = 5.399$, $p = 0.020$). Typically, most health practitioners assess DVT risk in patients based on their own experience, which is not appropriate for clinical assessment [7]. Health practitioners should identify patients with DVT risk objectively, and not based on experience, and would benefit from using the Autar scale as a standard DVT risk assessment tool.

The purpose of this study was to explore the effect of the Autar scale for assessing DVT risk within orthopaedic surgery patients and to apply the corresponding preventive measures to reduce DVT incidence. This provides a method for clinical standardised nursing risk assessment of DVT, achieving a better predictive effect.

2. Methods

2.1. Patients

Data were collected from a large general hospital in Henan, China. We enrolled patients undergoing orthopaedic surgery of the lower extremities in the prospective study from September 2013 to March 2014. Patient age ranged 35–83 years; the average age was 46.8 ± 16.1 years. The diagnoses were osteoarthritis, pelvic fracture, joint dislocation, femoral head necrosis, fracture, or bone neoplasm of the lower extremity; the surgical approach was arthroscopic surgery.

A total 216 orthopaedic surgery patients were assigned to a historical control group ($n = 106$) and intervention group ($n = 110$) according to the time of admission (September–December 2013 vs. January–March 2014). There were no differences with respect to general features such as age, original disease, surgical approach, duration of surgery, Autar scale score, and D-dimer level before intervention between the two groups ($p > 0.05$).

2.2. Instruments

The Autar scale [8] is mainly used for evaluating hospitalised patients who have undergone surgery; the total score is 30 points. It consists of the following seven distinct risk categories of factors with 41 items: age ([years] 10–30: 0 points; 31–40: 1 point; 41–50: 2 points; 51–60: 3 points; >61: 4 points), body mass index (16–19: 0 points; 20–25: 1 point; 26–30: 2 points; 31–40: 3 points; >41: 4 points), physical mobility (ambulant: 0 points; limited with self-assistance: 1 point; very limited with assistance: 2 points; wheelchair-bound: 3 points; bed-bound: 4 points), particular DVT risks (contraceptive pill: 20–35 years old, 1 point; >35 years old, 2 points; pregnancy or puerperium: 3 points), trauma (head: 1 point; chest: 1 point; head and chest: 2 points; spinal: 2 points; pelvic: 3 points; lower limb: 4 points), surgery (minor: 1 point; major: 2 points; emergency major: 3 points; pelvic: 3 points; thoracic: 3 points; abdominal: 3 points; orthopaedic below the waist: 4 points; spinal: 4 points), high-risk disease (ulcerative colitis: 1 point; sickle cell anaemia: 2 points; polycythaemia anaemia: 2 points; haemolytic anaemia: 2 points; chronic heart disease: 3 points; myocardial infarction: 4 points; malignancy: 5 points; varicose veins: 6 points; previous DVT or cerebral vascular accident: 7 points).

The scale has four risk levels: no risk, score <6 points, no risk; low risk (DVT probability <10%), 7–10 points; moderate risk (DVT probability 10%–40%), 11–14 points; high risk (DVT probability >41%), <15 points. The scale is a reliable and valid measure that has been tested in trauma and orthopaedic units with 100% sensitivity, 81% specificity, and a correlation coefficient of 0.98 [8].

2.3. Intervention group

We implemented the following preventive measures according to risk level as determined by the Autar scale assessment.

2.3.1. No risk

A researcher taught patients the basic knowledge of preventing DVT in daily life pre-surgery. This involved eating a light diet and avoiding high-fat and high-sugar foods, which would increase blood viscosity and decrease blood flow velocity. Patients were taught to avoid wearing tight clothes, especially leggings, and to keep warm at all times, which prevent the backflow of blood and vasoconstriction stimulated in cold environments. Patients were also taught to avoid sitting for prolonged periods or lying with legs down, and to lift their legs to a certain height to avoid blood stasis and to improve blood flow velocity when supine.

2.3.2. Low risk

Patients with low DVT risk were not only taught DVT prevention methods, but were also instructed to perform active or passive movements such as flexing, stretching, and foot rotation independently or aided by their healthcare practitioners during recovery after surgery. Low-risk patients were taught to begin early ambulation as soon as possible, and received guidance from the researcher according to the protocol for lower limb functional exercise [9].

2.3.3. Moderate risk

Patients with moderate DVT risk required mechanical or pharmacological prophylactic measures, or both. In addition, they were required to adopt health education and early ambulation. Moderate-risk patients were introduced to intermittent pneumatic compression, a mechanical
prophylactic device that tracks lower limb skin and temperature twice daily, at 20–30 min per interval, and to graduated compression stockings, another mechanical prophylactic device. The patients were required to improve their tolerance of either device, know how to select a device, and how the device was used. Patients with moderate DVT risk were to avoid mechanical prophylaxis if there was accompanying congestive heart failure, pulmonary oedema, lower extremity vascular lesions, or impaired skin integrity [10]. Pharmacological prophylaxis was involved injecting 40 mg/dose low molecular heparin (nadroparin calcium, Fraxiparine, Shuanglu pharmaceutical c.o, BeiJing, China) subcutaneously once daily according to physician orders; it was accompanied by regular coagulation function monitoring and biochemical testing. Pharmacological prophylaxis was prohibited if the patient had bleeding, blood coagulation dysfunction, low platelet count, or recent skull injury.

2.3.4. High risk
Both mechanical and pharmacological prophylaxes were recommended for patients with DVT high risk [11]. The duration of intermittent pneumatic compression was increased to 45 min–1 h per session and the frequency was increased to three times a day; while molecular heparin (Fraxiparine) was administered added up to twice daily according to physician orders. The injection of anticoagulant drugs renders it easy for haemorrhage to occur in body parts such as the gums, mucosa, and skin. Patients were instructed to be careful when brushing their teeth and to avoid collisions. In addition, the duration of pressure after injection was extended, and blood coagulation was to be observed routinely; if irregularity such as abnormal bleeding was observed, the dose was decreased or the drug stopped entirely [12].

2.4. Control group
Patients in the historical control group received routine nursing, mechanical and pharmacological prophylactic measures were implemented when the patients were deemed at high risk for DVT based on clinical experience and basic information. We used the Autar scale to assess the control groups well; no preventative measures were implemented based on the Autar scale scores, which were only used for comparison with that of the intervention group.

2.5. Outcome measures
We collected related cases based on Autar scale scores after admission. Clinically, there are many cases of asymptomatic DVT, and the most widely recommended diagnostic method is combining D-dimer levels with duplex ultrasonography for early detection [13]. The D-dimer level is an ideal indicator of fibrinolytic and thrombin marker, and is a specific marker of thrombosis and fibrin degradation, which contribute to a close relationship between a high blood coagulation state and thrombosis [14]. High D-dimer levels are common if there is a tumour, infection, or thrombosis; the diagnosis of thrombosis may be excluded if the D-dimer level <350 μg/L [15]. D-dimer levels >860 μg/L are highly suspicious of DVT even if there are no obvious clinical symptoms postoperatively [16].

Ultrasonography is a non-invasive imaging method with high diagnostic sensitivity and specificity that is widely used in the clinic. If the D-dimer level was high, ultrasonography was suggested to exclude thrombosis. We determined the D-dimer level from the venous blood before surgery and on postoperative day 3; duplex ultrasonography was performed on postoperative day 4–7.

2.6. Statistical analysis
Analyses were conducted using SPSS 17.0 (Armonk, NY, USA). Data are presented as the mean ± standard deviation (SD) for continuous variables with normal distribution and as n (%) for categorical variables. The independent sample t test was used for comparing differences in baseline data and D-dimer levels between the two groups. The continuous correction χ² test or Fisher’s exact test was used for comparing the differences in DVT incidence between the two groups.

3. Results

3.1. Autar scale scores and the number of patients according to DVT risk level pre-surgery
Table 1 lists the pre-surgery Autar scale scores and the number of patients at each DVT risk level in the two groups. Both results were not different.

3.2. Perioperative D-dimer levels
Table 2 shows that the D-dimer levels of the two groups did not differ before surgery. On postoperative day 3, the D-dimer level in the control group (was higher than that in the intervention group (825 ± 201 μg/L vs. 623 ± 225 μg/L), and there was a statistically significant difference between the two groups (p < 0.05).

3.3. Incidence of DVT
There were two high-risk patients in the intervention group; in the control group, one, three, and six patients had low, moderate, and high DVT risk, respectively. Table 3 shows that DVT incidence rate in the intervention group was 1.82% (n = 2) as compared with the 9.43% (n = 10) in the control group; the difference in DVT incidence of the two groups was statistically significant (p = 0.032).

4. Discussion

4.1. The Autar scale is beneficial and effective for identifying DVT risk levels orthopaedic surgery patients
Table 3 shows that the number of patients with DVT was in line with the number of high-risk patients in both groups, which confirms the effectiveness of Autar scale–based assessment. As we had implemented preventive measures in the two groups, the number of patients with low, moderate, and high DVT risk was inconsistent with the probability
determined according to the Autar scale. One low-risk patient developed DVT, as did three moderate-risk patients, indicating the need for the use of correspondingly prophylactic measures in patients with low and moderate DVT risk in addition to that implemented for patients with high DVT risk. Clinicians may be able to identify patients with high DVT risk based on experience, while patients with low and moderate risk are often overlooked. An accurate predictive tool is important for aiding risk assessment. The Autar scale consists of seven risk categories and 41 items, including general information and patient history and disease conditions, which is more comprehensive for assessing risk as compared with the Wells score [17]. The Wells score contains only 10 items, most of which are related to the clinical symptoms recommended in the American College of Chest Physicians (ACCP) guidelines, such as the clinical probability score; Rahiminejad et al. [18] reported that patients with DVT received low Wells scores and that the identified risk factors were not included in the score. The Autar scale contains most of the risk factors the Wells score does not, and accounts for a special high-risk group that is easily overlooked, namely women who are pregnant and in puerperium, as well as those taking oral acetylsalicylic acid.

Wang et al. [19] interviewed 50 orthopaedics nurses from different hospitals and found non-regular and non-standard application of the assessment methods used for preventing DVT in the clinic, which is in accord with the findings of Cui et al. [7]. Evaluating a surgery patient objectively and quantitatively can easily prevent the onset of disease, especially DVT, where most of the clinical symptoms are asymptomatic. Clinical experience may render it easy to identify patients with high DVT risk, but this is not true of low- and moderate-risk patients. The Autar DVT risk assessment scale is a comprehensive and valid instrument that improves the consistency of nursing assessment and creates a reference for preventing DVT in nursing practice [20]. The Autar scale should be used widely as an objective risk assessment tool to standardise nursing assessment methods and to provide quantitative data for quality investigation [6,14].

### Table 1 – Autar scale scores and patients at each DVT risk level pre-surgery.

<table>
<thead>
<tr>
<th>Group</th>
<th>No risk (n)</th>
<th>Low risk (n)</th>
<th>Moderate risk (n)</th>
<th>High risk (n)</th>
<th>Autar scale scores (mean ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
<td>11</td>
<td>23</td>
<td>37</td>
<td>39</td>
<td>15.73 ± 1.93</td>
</tr>
<tr>
<td>Control</td>
<td>9</td>
<td>20</td>
<td>36</td>
<td>41</td>
<td>15.26 ± 2.34</td>
</tr>
<tr>
<td>$\chi^2$</td>
<td>0.146</td>
<td>0.141</td>
<td>0.003</td>
<td>0.241</td>
<td>1.532</td>
</tr>
<tr>
<td>p</td>
<td>0.702</td>
<td>0.707</td>
<td>0.960</td>
<td>0.624</td>
<td>0.126</td>
</tr>
</tbody>
</table>

#### 4.2. Corresponding nursing intervention based on risk level prevents DVT effectively

Table 2 shows that the mean D-dimer level in the control group was higher than that in the intervention group; the difference was statistically significant. Table 3 shows a statistically significant difference between DVT incidence in the two groups, where the number of patients with DVT in the intervention group was lower due to the distinct risk levels and corresponding nursing intervention. DVT prophylaxis mainly involves early mobilisation and mechanical prophylaxis and pharmacological prophylaxis. Early mobilisation accelerates blood flow velocity in the lower limbs and is suitable for low-risk patients, although patients easily exhibit low compliance and pain when the surgical site was touched unintentionally [21]. Mechanical prophylaxis is mainly applicable for patients with low compliance and immobility, accelerating blood flow velocity and stimulating anticoagulant production [22] by imitating muscle function in the lower extremities, and is usually used for patients with different risk levels. Pharmacological prophylaxis is one of the most effective measures for preventing DVT, especially in high-risk patients, although the risk of major bleeding, the most obvious side effect of pharmacological prophylaxis, should be taken into consideration [23]. With corresponding nursing intervention, these measures are effective for improving treatment satisfaction at lower hospitalisation costs.

#### 4.3. An effective screening method is necessary for monitoring DVT

D-dimer is a product of fibrin breakdown and is a biomarker of fibrin decomposition. It is used routinely for monitoring suspected acute thrombosis in the clinic. The D-dimer level is a sensitive indicator of thrombosis and is a routine test, but its specificity is low, therefore many reasons other than thrombosis can cause high D-dimer levels. High D-dimer levels manifest easily in the disease process in the presence of infection, surgery, trauma, pregnancy, malignant tumour, and older age. The SD of the D-dimer levels in both groups was not normal (Table 2) due to the surgery conditions of each patient:

<table>
<thead>
<tr>
<th>Group</th>
<th>DVT (%)</th>
<th>No DVT (%)</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention (110)</td>
<td>2 (1.82)</td>
<td>108 (98.18)</td>
<td>4.604</td>
<td>0.032</td>
</tr>
<tr>
<td>Control (106)</td>
<td>10 (9.43)</td>
<td>96 (90.57)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Continuous correction $\chi^2$ test was used.

### Table 2 – D-dimer levels of the two groups (μg/L; mean ± SD).

<table>
<thead>
<tr>
<th>Group (n)</th>
<th>Preoperative</th>
<th>Day 3 after surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention (110)</td>
<td>312 ± 147</td>
<td>623 ± 225</td>
</tr>
<tr>
<td>Control (106)</td>
<td>323 ± 151</td>
<td>825 ± 201</td>
</tr>
<tr>
<td>$t$</td>
<td>0.542</td>
<td>7.293</td>
</tr>
<tr>
<td>p</td>
<td>0.072</td>
<td>0.000</td>
</tr>
</tbody>
</table>

### Table 3 – DVT incidence in the two groups.

<table>
<thead>
<tr>
<th>Group (n)</th>
<th>DVT (%)</th>
<th>No DVT (%)</th>
<th>$\chi^2$</th>
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</tr>
</tbody>
</table>
some patients had infection or malignant tumour perioperatively and some did not, thus there was relatively great deviation among the D-dimer levels.

There are some advantages to diagnosing DVT by ultrasonography. Thrombosis is easily visualised by colour Doppler ultrasound probing, but it is costly, and many hospitals find it inconvenient to use it in a timely manner; in addition, performing a bedside ultrasound on hospitalised patients is difficult. Only 0.4% of D-dimer levels are abnormal in lower extremity DVT development, thus clot formation can be excluded if D-dimer levels are low [24]. The testing of D-dimer levels is fast and economical and can be used as an important screening method for excluding DVT in the clinic; we used both methods to monitor thrombosis. The D-dimer level is always observed first: if it is high, ultrasonography can be arranged to exclude thrombosis.

5. Conclusions

The Autar DVT scale is a quantifiable and standardised assessment tool for evaluating patients with DVT risk and can increase the awareness of prevention among orthopaedic surgery patients and health practitioners. The benefits are not limited to orthopaedic surgery patients; given the high incidence of DVT in gynaecology and oncology departments, our findings can be extended to these departments in future studies. The Autar DVT scale can be used to achieve optimal predictive effects as reported in this study, improve work efficiency, and decrease DVT incidence with the corresponding prophylactic and improved nursing interventions.

Conflict of interest

No conflict of interest has been declared by the authors.

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