Clinical

A comparison of methods used for the prevention of venous thromboembolic disease among orthopaedic surgeons at Wolverhampton, United Kingdom and Auckland, New Zealand

P Bennett

Introduction

The report endeavours to highlight variations in the use of pharmacological and mechanical methods of thromboprophylaxis for patients undergoing lower limb arthroplasty. Surgeons within the military are more likely to be exposed to the practices of other countries than their civilian colleagues and therefore need to be aware of variations they may encounter. The report does not aim to assess the outcomes of the methods employed by comparing rates of venous thromboembolic disease post-operatively.

The sample populations compared were from New Cross Hospital in Wolverhampton, UK and City Hospital in Auckland, New Zealand. Profiles of the populations and healthcare systems are provided in Table 1(1-8). With both countries experiencing an increase in the percentage of people aged over 65 it is likely that the demand for arthroplasties will increase in the coming years(7-10).

Literature Review

The overall complication rate of lower limb

<table>
<thead>
<tr>
<th>Population</th>
<th>United Kingdom</th>
<th>New Zealand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>60.9 million</td>
<td>4.3 million</td>
</tr>
<tr>
<td>Population aged 65 years and over</td>
<td>6.7 million (15.9%)</td>
<td>463,501 (11.5%)</td>
</tr>
<tr>
<td>IMF ranking of developed countries</td>
<td>6th</td>
<td>54th</td>
</tr>
<tr>
<td>GDP</td>
<td>$2.8 trillion</td>
<td>$0.128 trillion ($128 billion)</td>
</tr>
<tr>
<td>Health Care System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Government funded NHS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Private healthcare available</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Hospital care: free</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• GP care: NZ$45/70 ($17-27)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Private healthcare available</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual number of arthroplasties performed</td>
<td>7068 total: 103,306</td>
<td>2007 total: 14,067</td>
</tr>
<tr>
<td>• Hip: 49,642 (44%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Knee: 53,664 (42%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Comparison of the United Kingdom and New Zealand(1-8)
arthroplasty is 2.2% (10) with a mortality rate of 0.5-1.0% (10-14). Deep vein thrombosis (DVT) is a common complication of lower limb arthroplasty. Historically the incidence has been quoted as 40-60% (15) but recent research has shown that the figure is much smaller, occurring in between 0.9-4.0% of total hip and total knee replacements (10,11,13). DVT is associated with pulmonary embolism (PE), which occurs in 0.9% of total hip replacements (THR) (11,17) and 0.7% of total knee replacements (TKR) (13).

Primary thromboprophylaxis has been shown to decrease the incidence of DVT, PE and fatal PE (18); its use has been recommended for THR and TKR since 1986. There are both mechanical and pharmacological methods available to reduce the incidence of venous thromboembolism (see Table 2). Abundant research has been carried out to determine the relative efficacy of each method though none appears to be definitive. In light of this uncertainty both the British Orthopaedic Association and New Zealand Orthopaedic Association suggest that it is the responsibility of the individual surgeon to determine which modality of thromboprophylaxis is most suitable for their patient (7,8). Though there have been several attempts to produce guidelines that prescribe pharmacological or mechanical methods of thromboprophylaxis depending on the patient’s individual risk factors, these have been largely unsuccessful with some groups claiming they can result in more harm than good (20).

Despite the absence of conclusive and universally accepted research the vast majority of orthopaedic surgeons agree that their patients should receive some form of thromboprophylaxis. In 1992 only 32% of surgeons gave chemoprophylaxis to patients undergoing elective arthroplasty: in 1999 that figure had increased to 57% and now, a decade later, the number is likely to be much higher (19). In New Cross Hospital 94% of arthroplasty patients were prescribed thromboprophylaxis over an observed five week period in 2008.

It is widely accepted that patients undergoing orthopaedic surgery are at a greater risk of developing thromboembolic disease than those having general surgery (20). There are characteristics of orthopaedic operations that contribute to venous stasis and therefore result in this increased risk of thromboembolism including the anatomic position of the limb and the consequential intimal injury of the blood vessels. Additionally, patients listed for knee arthroplasty are usually managed with an inflatable thigh tourniquet to produce a bloodless field.

Mechanical methods of prophylaxis are generally considered to be effective and without a significant side-effect profile (21). Their use is not recommended in patients with severe peripheral arterial disease (22). The efficacy of graduated compression stockings (GCS), intermittent pneumatic compression and foot pumps has been shown to be equal (22). When used without
pharmacological prophylaxis all three methods have been shown to be effective at decreasing the incidence of thromboembolic events(23), independent of whether they are below-knee or above-knee devices(24). Though mechanical prophylaxis is relatively safe non-compliance by patients can be problematic(25). Using foot pumps without simultaneous use of GCS might maintain the efficacy of DVT prophylaxis whilst increasing patient compliance(25). Work has shown that the use of foot pumps following THR is as effective as the use of low molecular weight heparin (LMWH) for the prevention of DVT(26).

Pharmacological methods of preventing venous thromboembolism have a significantly greater side-effect profile than their mechanical counterparts, of which their propensity to increase haemorrhage is of greatest concern for the surgeon. Oral anticoagulants place the patient at a twofold increase of major bleeding when compared with a placebo(22). Consequently the ideal thromboprophylactic agent needs to not only be effective but safe.

Research has shown that LMWH is more effective than warfarin at decreasing the incidence of DVT(27-30). Though LMWH is effective concerns remain over its safety. Evidence exists that shows patients receiving LMWH endure a higher rate of haemorrhagic complications than those receiving warfarin(27,31,32). Conversely, a number of studies have been published that showed no difference in the rates of haemorrhagic complications between patients receiving LMWH and warfarin(28-30). Despite this, recent work has described LMWH as the gold-standard pharmacological agent for the prevention of venous thromboembolism(33).

Mechanical methods of thromboprophylaxis can be safely used in conjunction with pharmacological agents. It has been demonstrated that a combination of both methods significantly decreases the risk of DVT, but the effect on PE has yet to be determined(34). It is generally considered that this multimodal approach is safer and confers equal benefit(35,36).

Additional to the uncertainty surrounding the ideal method of thromboprophylaxis surgeons need to determine the optimal duration of prophylaxis. It is recognised that the risk of developing venous thromboembolism exists three months following surgery(37,38). It is now recommended that the minimum duration of prophylaxis should be ten days post-operatively. Extended prophylactic regimes of 28-35 days are recommended for all patients undergoing THR, and for those patients undergoing TKR who are at a higher risk of venous thromboembolism, such as those with clotting deficiencies or a previous history of DVT(37-39).

The final variable that the surgeon needs to consider is the timing of administration of thromboprophylaxis. Work on the efficacy of LMWH when started pre-operatively compared with post-operatively is inconclusive with evidence determining that the incidence of venous thromboembolism is not decreased by pre-operative regimes(40) in contrast to studies suggesting that the efficacy, and even safety, is enhanced(41). It is likely that surgeons will rely upon their own experience to determine the ideal point of delivery of pharmacological thromboprophylaxis and that many will be hesitant to use it before surgery because of the increased risk, perceived or otherwise, of haemorrhage.

Methods
Data was obtained from Wolverhampton New Cross Hospital over a five week period in October and November of 2008. The observations from Auckland City Hospital were gathered over four weeks in April and May of 2009. In both instances all observations were made by consulting the notes and drug charts of patients who had undergone either a THR or TKR. It was noted whether or not the patients were wearing mechanical methods of prevention. Further information was obtained by discussions with the surgeons.

Observations
At Auckland City Hospital all patients undergoing lower limb arthroplasty were
treated with both mechanical and pharmacological prophylaxis (see Table 3). From admission patients wore GCS bilaterally. Post-operative care involved GCS and foot pumps. Upon discharge patients were advised to continue wearing stockings for six weeks following the date of their operation. In addition all patients were commenced on aspirin 100 mg daily on the first day following their operation. This was continued for six weeks. It was recognised that patients were often not compliant with mechanical methods of prophylaxis upon discharge.

Patients who were determined to be at high risk of developing DVT were considered for daily subcutaneous LMWH in addition to the mechanical methods described above; aspirin was omitted. The use of LMWH in these patients was not universal. If a post-operative DVT or PE had been confirmed the patient was commenced on warfarin and a heparin infusion. The heparin infusion was stopped once warfarin reached therapeutic levels, typically 48-72 hours after it was commenced.

Arthroplasty patients at Wolverhampton New Cross Hospital were also managed with mechanical and pharmacological prophylaxis (see Table 4). Upon admission all patients were prescribed above-knee GCS unless contraindications were identified. These continued to be worn until the patient was discharged from hospital. Foot pumps were not used on any patients. LMWH was administered subcutaneously once daily to all post-operative patients considered at low-risk of developing venous thromboembolism. Its use continued until discharge whereupon patients were prescribed aspirin 75 mg OD for six weeks. If a patient had been on warfarin before their hospital admission they had their dose omitted on the day of surgery then resumed one-day post-operatively to maintain the INR within therapeutic range; these patients were not prescribed LMWH. Patients with a contra-indication to LMWH or warfarin were managed with 300 mg aspirin OD for six weeks following their operation.

Patients considered at high risk of DVT or PE were given 40 mg LMWH subcutaneously for the three days preceding their operation. They received 40 mg on the day of their operation and the dose continued to be administered until their discharge from hospital. Following discharge these patients received 75 mg aspirin OD for six weeks.

**Discussion**

From the differences in practice observed between Auckland City Hospital and Wolverhampton New Cross Hospital it is apparent that the uncertainty surrounding best practice for the prophylaxis of thromboembolic disease suggested by the literature is evident in clinical practice, and that military surgeons working in different countries are likely to

---

**Table 3: Management of thromboprophylaxis for lower-limb arthroplasty patients at Auckland City Hospital**

<table>
<thead>
<tr>
<th>Patient’s Risk of Developing DVT or PE</th>
<th>Pharmacological Prophylaxis</th>
<th>Mechanical Prophylaxis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td><em>Aspirin 100 mg p.o OD</em></td>
<td><em>Mechanical foot pumps</em></td>
</tr>
<tr>
<td></td>
<td><em>Commenced once day post-operatively</em></td>
<td><em>Blender</em></td>
</tr>
<tr>
<td></td>
<td><em>Continued for six weeks</em></td>
<td><em>Heparin infusion</em></td>
</tr>
<tr>
<td>High</td>
<td><em>LMWH 5000 IU</em></td>
<td><em>Unilateral compression stockings</em></td>
</tr>
<tr>
<td><em>Phenprocoumon</em></td>
<td><em>Heparin infusion and warfarin</em></td>
<td><em>Blender</em></td>
</tr>
<tr>
<td>PE or DVT confirmed</td>
<td><em>Heparin infused once INR 2.5-3</em></td>
<td><em>Unilateral compression stockings</em></td>
</tr>
</tbody>
</table>

---
experience practice that varies from that seen in the UK. The surgeons at Auckland City Hospital place a greater emphasis on the use of mechanical methods of prophylaxis, particularly foot pumps. The evidence for the use of this device is acceptable and it would appear a reasonable degree of benefit would be acquired from them. This benefit may be enhanced by the simultaneous use of GCS. It seems worrying that patients were expected to continue wearing the stockings for six weeks after their operation as the body of evidence suggests that compliance with this method is poor. It is therefore probable that the surgeons believed their patients were more protected against the development of venous thromboembolism than they actually were. Perhaps to compensate for the recognised poor compliance levels, and as a reflection of its anti-thrombotic properties, patients also continued aspirin 100 mg OD from the day following their operation and for six weeks thereafter. Compliance with both the mechanical and pharmacological methods of prophylaxis following discharge is likely to be highly dependent on the patient’s understanding on the requirement for them. The orthopaedic discharge teams should therefore impress upon the patient the importance of the use of the GCS and aspirin.

The practice for patients determined to be at high risk of developing venous thromboembolism indicates a degree of caution against the use of heparin. It appears that warfarin is preferred to heparin because of the ability to reverse it with vitamin K, despite the fact that the evidence available demonstrates heparin to be more effective in its antithrombotic properties and fully reversible with the use of protamine sulphate. This uncertainty is reflected in patients with confirmed DVT or PE where a heparin infusion is used only until warfarin reaches therapeutic levels. It seems that despite specific dosage regimes being available for heparin in the treatment of established thromboembolic disease the evidence suggesting it causes an increased incidence of haemorrhagic complications prevents its widespread use.

At Wolverhampton New Cross Hospital the prophylaxis of venous thromboembolic disease appeared to rely more on the daily use of LMWH than mechanical methods, though all patients were expected to wear GCS before and after their operation. Despite the recognised risk of haemorrhage it appears the evidence supporting the efficacy of heparin in the prevention of DVT and PE is preferred to the benefit conferred by mechanical methods. Subcutaneous administration of a fixed dose of LMWH has the advantage of being controlled and standardised across the patient population. By not continuing the use of GCS upon discharge from hospital it is probable that the low

Table 4: Management of thromboprophylaxis for lower-limb arthroplasty patients at New Cross Hospital
compliance levels are recognised and accepted.

Patients at Wolverhampton who were considered to be at high risk of developing thromboembolic disease had the same post-operative management as those determined to be at low-risk. The differences in their management occurred in the pre-operative period where they were anti-coagulated before their surgery. This practice was not seen in any risk categories at Auckland’s City Hospital.

Similar practice was seen in the scoring of patients’ risk of developing thromboembolic disease with neither team using a formal assessment tool. It is probably that risk factors were identified when asking the patient’s medical history. In today’s litigious society it may be wise to incorporate a section within the pre-operative documentation for formal scoring of the patient’s risk of developing thromboembolic disease. Though the evidence suggests it would be unwise to then develop rigid guidelines for the patient’s management it would at least provide surgeons with a succinct, standardised summary of the patient’s risk factors.

Early mobilisation was recognised by both centres to be crucial in the prevention of thromboembolic disease. Physiotherapists assisted patients in mobilising the day following their operation so that circulation increased, venous stasis decreased and the risk of the development of DVT was therefore reduced.

Further to the research that suggests developing guidelines to assist in the post-operative management of arthroplasty patients may be detrimental to their care, neither Auckland City Hospital nor Wolverhampton New Cross Hospital had published recommendations on this subject. In both instances, the determination of best practice was left to individual surgeons.

Conclusions
The different approaches taken to thromboprophylaxis for lower limb arthroplasty patients at Wolverhampton and Auckland highlight the variations in practice that exist between countries, even those with ostensibly similar healthcare systems.

Practice as a military surgeon is likely to be most strongly influenced by the practices undertaken as a registrar, which in turn is likely to be determined by the preferences of supervising consultants and colleagues at the time. Though this is no different to how the practice of civilian surgeons can be expected to develop, surgeons within the Armed Forces are nonetheless in the unique position of having greater exposure to the practices of many countries and therefore a wider range of influences. In addition, performing surgery in operational situations can result in practices developing that are not normal or routine, but that utilise whatever facilities and equipment may be available at the time. In turn this may then influence the surgeon's practice when back in civilian environments.

While the requirement for any new technique to still have compelling evidence to support it is just as necessary regardless of its origins, it does not seem unreasonable to suggest that military surgeons may be in the position of bringing alternative practice to the attention of consultants within this country. Ultimately this may result in patients here benefiting from the preferences and knowledge of highly skilled consultants from other countries, in conjunction with their consultant in the UK, to optimise their care.

References


Surgeon Sub Lieutenant Philippa Bennett Royal Navy
Final year medical student, The University of Birmingham