Prevention of Peri-operative Venous Thromboembolism in Paediatric Patients

Summary

The Association of Paediatric Anaesthetists of Great Britain and Ireland guidelines committee on thromboprophylaxis in children have reviewed the literature and where possible provided advice on the care of children in the peri-operative period. Areas reviewed include the incidence of peri-operative venous thromboembolism (VTE), risk factors, evidence for mechanical and chemical prophylaxis and complications. In summary there are few areas of strong evidence. Routine prophylaxis cannot be recommended for young children. Post-pubertal adolescents (approximately 13 years and over) are at a slightly increased risk and should be assessed for prophylaxis as may warrant intervention if other risk factors are present. However the incidence of VTE remains significantly lower than in the adult population

Below is a summary of the key recommendations and risk assessment charts. A fuller description of the literature review and the strength of recommendation can be found in the following document.

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1. Key Recommendations

1.1. Risk assessment

1.1.1. Most paediatric surgical patients do not require thromboprophylaxis. ☑

1.1.2. The risk of developing VTE should be assessed on admission to hospital, prior to any operative procedure and throughout the inpatient stay. ☑

1.1.3. This assessment should focus on adolescents (>13years) particularly those with one or more risk factor who are or will be immobile during their inpatient stay. ☑

1.1.4. Prophylactic measures should be used to prevent VTE in those considered at risk. (C)

1.2. Methods of venous thromboembolism (VTE) Prophylaxis

1.2.1. Early mobilisation and good hydration should be encouraged in all immobilised patients. ☑

1.2.2. The use of mechanical methods (pneumatic compression devices and anti embolism stockings) for VTE risk reduction should be considered in at risk children age 13yrs and over where size is appropriate. (C)

1.2.3. Anti-embolism stockings (AES) reduce VTE in surgical patients and are recommended where size is appropriate. Anti-embolism stockings are only useful in children or adolescents who weigh >40kg. (B)

1.2.4. Intermittent pneumatic compression (IPC) devices are effective and recommended for intraoperative use in children age 13 years and over who weigh >40kg and who are expected to have surgery lasting >60 minutes. (B)

1.2.5. Anti-embolism stockings may be combined with pharmacological prophylaxis or intermittent pneumatic compression in surgical patients, to increase efficacy of prophylaxis against deep vein thrombosis. (D)

1.2.6. Children age 13 years and over with multiple risk factors for thrombosis should be considered for thromboprophylaxis with LMWH (C).

1.2.7. In post-pubertal girls undergoing surgery, consideration should be given to withholding the combined contraceptive pill for 4 weeks prior to planned surgery. However the risk of unwanted pregnancy should be balanced against that of VTE. ☑

1.3. Central Venous Catheter

1.3.1. Central venous catheters are the commonest risk factor for paediatric VTE and should be removed as early as possible when no longer required. ☑

1.3.2. Catheter placement in the Internal jugular vein is associated with a lower risk of thrombosis (B)

1.4. Surgery, Orthopaedics and Trauma

1.4.1. Prophylaxis is not normally necessary in prepubertal children, even after major surgery in the absence of other risk factors for VTE. ☑

1.4.2. There is no evidence for routine use of VTE prophylaxis in adolescents undergoing surgery on the spine, hip or pelvis therefore in the absence of additional risk factors. VTE pharmacological prophylaxis is not recommended as routine. (D)

1.4.3. In post-pubertal children undergoing very major surgery preventing early mobilisation, mechanical prophylaxis should be considered. ☑

1.4.4. In patients with multiple other risk factors for VTE, LMWH prophylaxis should be considered.☑

1.5. Burns

1.5.1. There is no evidence for routine prophylaxis in children. ☑

1.5.2. Adolescents with extensive injury and an increased risk of thrombosis may be considered for prophylaxis. (D)

1.6. Regional Anaesthesia and Anticoagulant Prophylaxis

1.6.1. The use of LMWH (low molecular weight heparin) thromboprophylaxis in patients at risk is not a contraindication to the performance of neuraxial anaesthesia in the absence of a coagulopathy. Timing must be carefully planned in relation to LMWH administration. (D)

1.6.2. In patients on prophylaxis, the placement of a needle or epidural catheter, or removal or repositioning of the catheter should occur at least 12 hours after standard prophylactic LMWH doses.☑

1.6.3. If a bloody tap occurs during needle or catheter placement, LMWH should be delayed for 24 hours. (D)

1.6.4. In patients with indwelling catheters it is recommended that the first dose of LMWH should be given at least 12 hours after surgery, rather than immediately postoperatively. ☑

1.6.5. In children on once daily dose thromboprophylaxis the removal of the epidural should be at least 10-12 hours after the last dose of LMWH. (D)

1.6.6. Those on twice daily dose the removal of the epidural catheter should be at least 8 hours (2 half-lives) after the last dose. ☑

1.6.7. In children on once or twice daily dose thromboprophylaxis, the next dose of LMWH should be given at least 4 hours after the removal of the epidural catheter. ☑

1.6.8. In patients with an epidural indwelling catheter, on LMWH thromboprophylaxis, concomitant treatment with drugs that affect hemostasis (e.g. NSAID's) or antiplatelet medication should be used with caution. ☑

1.6.9. Any patient with an epidural infusion presenting significant leg weakness should have the epidural infusion stopped, and no further LMWH until recovery. If there is no recovery of leg strength within 4 hours, a MRI scan should be performed to exclude spinal haematoma. ☑

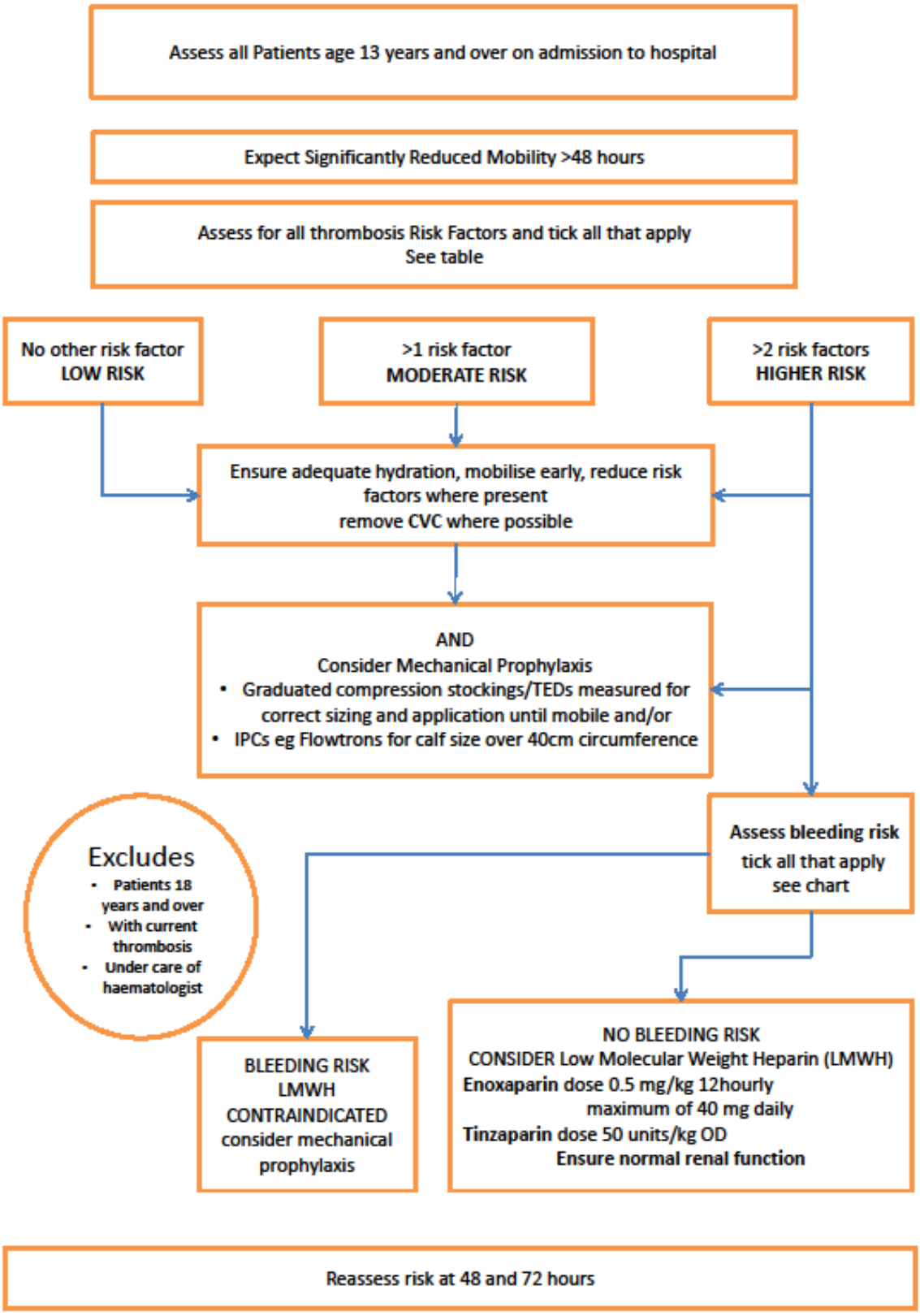
1.7. Non-Neuraxial Blocks

1.7.1. Bleeding may be the most serious complication of non-neuraxial regional techniques in the anticoagulated patient, Therefore in high risk procedures, the same guidelines as for neuraxial blocks regarding timing of LMWH and performance of the regional anaesthesia technique, including insertion and removal of plexus catheters, should be applied. ☑

1.8. Screening

1.8.1. Routine screening of asymptomatic children below teenage years with a family history of thrombophilia is not warranted, as the risk of spontaneous thrombosis is low (A)

RISK ASSESSMENT FOR VENOUS THROMBOEMBOLISM (VTE) FOR ADOLESCENTS AGE 13 YRS +



RISK ASSESSMENT FOR VENOUS THROMBOEMBOLISM (VTE) FOR ADOLESCENTS AGE 13 YEARS +	
Date of admission	PLEASE AFFIX PATIENT LABEL HERE
Risk assessed by	
Designation	
Signature	
Date	

Review the patient related factors shown on the assessment sheet for thrombosis risk, ticking each and any box that applies. Clinicians may consider further risks apply in addition to those listed.

Bleeding risk

Patient related	Tick	Admission Related	Tick
Acquired bleeding disorders (such as acute liver failure)		Neurosurgery, spinal surgery or eye surgery	
Untreated inherited bleeding disorders (such as haemophilia and von Willebrand's disease)		Neurosurgery, spinal surgery or eye surgery	
Concurrent use of anticoagulants known to increase the risk of bleeding (such as warfarin with INR >2)		Lumbar puncture/epidural/spinal anaesthesia expected within the next 12 hours	
Thrombocytopenia		Lumbar puncture/epidural/spinal anaesthesia within the previous 4 hours	
Uncontrolled systolic hypertension (>230/120 mmHg)		Active bleeding	

Thrombosis Risk

Patient related	Tick	Admission Related	Tick
Central venous Catheter		Significantly reduced mobility for 3 days or more	
Active cancer or cancer treatment		Severe Trauma with ISS score >9	
Dehydration		Spinal cord injury with paralysis	
Known thrombophilias		Total anaesthetic + surgical time > 90 minutes	
Obesity (BMI> 30kg/m2)		Acute severe sepsis	
One or more significant medical comorbidities (e.g. congenital or low output heart disease, sickle cell disease, metabolic or inflammatory conditions)		Surgery involving pelvis or lower limb with a total anaesthetic + surgical time > 60 minutes	
Personal history of VTE first-degree relative with a history of VTE age <40 years		Critical care admission intubated and ventilated	
Use of oestrogen-containing contraceptive therapy		Severe burns	
Pregnancy or < 6 weeks post partum (see NICE guidance for specific risk factors)			

If an increased risk of bleeding is documented on the risk assessment – thromboprophylaxis with LMWH is relatively contraindicated

Prescribe the appropriate intervention if required and complete all the prescription chart documentation

Outcome ***(tick any that apply)***	
No Thromboprophylaxis	
Mechanical Thromboprphylaxis	
LMWH	

Completed by :
Date :

2. Introduction

The epidemiology of VTE in children is different from adults. The incidence of VTE in the paediatric population is significantly lower than in adults. Differences in the physiology of the coagulation system before puberty may play a part. Vitamin K-dependent clotting factors are circulating at only 50% of adult concentrations at birth and the concentration of alpha-2-macroglobulin (an important inhibitor of thrombin) is typically double that found in adults. Children aged 1-16yrs have been shown to have a 25% lower ability to form thrombin compared with adults aged 20-45 years(1). National registry data suggests an incidence of 5-8 cases per 10,000 hospital admissions and 0.05-0.14 per 10,000 of the paediatric population(2)(3). These data suggest that the risk of VTE is higher in children who are admitted to hospital. More than 80% of paediatric VTE events occur in children with one or more risk factors (around 50 % of adult VTEs occur in the absence of risk factors i.e. are unprovoked). In contrast to adult VTE, where the majority of VTEs involve the veins of the lower leg, paediatric VTEs occur equally in the upper and lower limb venous systems, reflecting the relation to CVC use in children. There are two peaks in incidence of VTE that are seen in infants (less than 2 years old) and adolescence. At adolescence the physiology of the coagulation system matures and additional risk factors such as smoking, obesity, pregnancy and the oestrogen containing oral contraceptive pill become relevant. There is a 2:1 preponderance of females amongst adolescents who develop VTE. (4)(5)(6)

Venous thromboembolic disease (VTE) is the most important preventable cause of morbidity and mortality in adult hospitalised patients(7). The need for evidenced based thromboprophylaxis in adults is now accepted throughout the world and there are a number of high quality guidelines on the subject (8)(9). Thromboprophylaxis in children has been considered (10)(11)(12)(13)(14)(15).The Canadian registry of VTE in paediatric patients estimated the risk to be 5.3 per 10,000 hospital admissions in 1990, which is around one tenth of the risk in adults, but also identified risk groups of children who may merit primary prophylaxis(2). Later a single centre registry of VTE in Australia recorded 8 per 10,000 admissions(16). These registries recorded *symptomatic* VTE in children so the true incidence could have been significantly higher as the majority of VTEs are clinically silent.

A multicentre study across the United States from 2001-2007 indicated an increase in the diagnosis of VTE at children's hospitals of 70% to 58 per 10,000 admissions. This may be because of the increased complexity of medical conditions and surgical procedures in paediatric patients in tertiary care hospitals (17).

The Canadian Childhood Thrombophilia registry followed children aged 1 month to 18 years after thrombosis and found significant morbidity, with a recurrence rate of 8% and a rate of post-phlebitis syndrome of 12%. *Kuhle et al.* reported an incidence of post-thrombotic syndrome (a serious long-term problem resulting from damage to the deep valves and resulting in pain, swelling, discoloration and ulceration of the affected limb) of 63%(18). Mortality in the Canadian registry was 2.2% but 8.4% (all causes) in the Australian registry(2)(16).

3. Remit and Scope of the Clinical Practice Guidance

This document attempts to identify paediatric patient groups at risk of *peri-operative* VTE *(see section 3)* and describe the available methods of prophylaxis *(see section 4)*, with general recommendations about efficacy and safety. Appropriate methods of prophylaxis for specific patient groups are considered in subsequent sections. Neonates are specifically excluded as neonatal VTE is associated with central venous catheterisation and neonatal intensive care. For the purpose of risk in relation to VTE in this guidance, adolescent risk is discussed for children age 13 years and over.

3.1. Target users

It is hoped this guidance will be of interest to medical practitioners dealing with the care of children in a wide range of specialties including anaesthesia, intensive care, surgery, orthopaedics and medical paediatrics.

3.2. Statement of Intent

This guidance is not intended to be construed as or to serve as a standard of care. Standards of care are determined on the basis of all clinical data available for an individual case and are subject to change as scientific knowledge and technology advance and patterns of care evolve. Adherence to guidance recommendations will not ensure a successful outcome in every case, nor should they be construed as including all proper methods of care or excluding other acceptable methods of care aimed at the same results. The ultimate judgement must be made by the appropriate healthcare professional(s) responsible for clinical decisions regarding a particular clinical procedure or treatment plan. This judgement should only be arrived at following discussion of the options with the patient, covering the diagnostic and treatment choices available.

The guideline group searched for the best available evidence and graded that evidence on which to base the strength of recommendations where possible. Where there was little or no evidence, consensus opinion was sought. Very few areas of strong evidence to guide practice were found but the current document collates useful information for good clinical practice. The grade of recommendation relates to the strength of the supporting evidence on which the recommendation is based. It does not reflect the clinical importance of the recommendation. Evidence to support routine prophylaxis in under 13 year olds undergoing surgery is lacking and therefore cannot be recommended even for major general or orthopaedic surgery. Where there are areas of concern or in higher risk patients, we have tried to present the evidence and a recommendation. Good practice points (☑**)** have been added where clinical consensus suggests best practice. The majority of the available evidence is level 2+ in adults but level 3 or 4 in children and thus the usual grade of recommendation in paediatrics is D.

3.3. Development of the recommendations

3.3.1. Introduction

The Association of Paediatric Anaesthetists of Great Britain and Ireland Guidelines Committee receives requests from its members to develop advice relevant to practice of paediatric anaesthesia. Thromboprophylaxis was once such area.

The following were considered the most appropriate key areas that the group needed to cover in their review of the literature.

- incidence of VTE in children.
- at risk age groups (excluding neonates)
- risk factors: sub-divided into patient factors and procedure factors (operation or injury).
- evidence for efficacy of different types of thromboprophylaxis in children.
- evidence for and against thromboprophylaxis in children.
- evidence of the risks of thromboprophylaxis - especially bleeding, osteoporosis, and heparin induced thrombocytopenia (HITT).

3.3.2. Guideline development group

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3.3.3. Systematic literature review

Databases searched were Medline, Embase, Cinhal and the Cochrane library. This was supplemented by material identified by the individual members of the group. Any relevant current guidelines were also reviewed including SIGN and NICE for adult practice, ACCP and BSCH guidelines in children.(9)(8)(11)(12) The literature was assessed where possible using SIGN methodology.

Levels of Evidence:

1 for well-conducted meta analyses, RCTs with a low risk of bias

2 for well-conducted case control or cohort study

3 for case report or case series

4 for expert opinion

Grade of Recommendation

A for level 1 evidence directly applicable to the target population

B for extrapolated evidence from level 1 studies

C for level 2 evidence directly applicable to the target population

D for evidence level 3 or 4 *or* extrapolated evidence from level 2 studies

Good Practice Points

☑ Recommended best practice

3.3.4. Delphi process and statements

The Delphi process is based on the principle that opinions from a structured group of experts are more accurate than those from individuals. There were many areas lacking evidence for VTE prophylaxis in children and so a list of consensus statements were drawn up by the guideline group with sections on risks and prophylaxis, paediatric surgery, orthopaedics and trauma. Each section was circulated to the relevant peer group via the APA, British Society of Paediatric Surgeons (BAPS), British Society for Children's Orthopaedics, and British Society of Paediatric Haematology. Some of the more useful responses are found in Appendix 1.

4. Risk Factors for Venous thromboembolism

4.1. Introduction

There are many risk factors for VTE in children (Table 1) and most cases of VTE occur in children with multiple co-existing thrombophilic risk factors.(19)(20)(21)(22)(23) Only 5 % of cases of VTE have no identifiable risk factors. However, there is insufficient evidence to weight individual factors or show if the presence of more than one risk factor is additive in any way(24). The distribution of cases peaks at 1 year old and again in adolescence.(25) The incidence does appear to be increasing, although it is difficult to show whether this is a true increase with changing population, the advances in medical management of complex diseases or an increase in awareness and detection.

The Canadian registry, the largest to date, found that the presence of a central venous catheter (CVC) was a factor present in 90% of VTE cases. In a prospective study of children admitted to PICU, serial Doppler scanning following CVC insertion showed a VTE incidence of 18.3% (26). The method of screening has an influence on detection rate. The PARKAA study used ultrasound, venography and MR on children with acute lymphoblastic leukaemia (ALL) receiving L-asparaginase via CVC, and revealed that 37% had evidence of VTE although without symptoms (27).

- **Central venous catheters are the commonest risk factor for paediatric VTE and should be removed as early as possible when no longer required.** ☑

The site of CVC is also an important factor; the PROTEKT study was a randomized control trial of riviparin vs unfractionated heparin for DVT prophylaxis in children with CVCs. It reported an overall incidence of 13% for VTE, but also reported a higher incidence of VTE for lines sited in the femoral vein (32%) compared with the internal jugular vein (8%) (28)(29).

- **Catheter placement in the Internal jugular vein is associated with a lower risk of thrombosis (B)**

TABLE 1: Risk factors for VTE (level of evidence shown in brackets where possible)

Age	Incidence of VTE highest if age <1 year and >13 years
Central Venous line	Present in >90% of neonatal VTE Present in >33% of other cases Risk highest in lower limb >subclavian >jugular (1B) Risk may be higher in PICC lines (?evidence level)
Surgery (3)	Present in 10-15% cases
Malignancy	present in 25% cases presents x2 increase High with Acute Lymphoblastic Leukaemia
Infection / Sepsis (2)	Present in > 33% cases maybe related to CVL presence
Major trauma / Burns (2)	Present in approximately 10%
Drugs	Chemotherapy e.g. aspariginase Contraceptive pill (3 fold increase risk) Parenteral nutrition (may be line related)
Immobility	25% cases with prolonged bed rest
Pregnancy (2)	2 fold increase
Congenital thrombophilia (3/4)	Factor V Leiden Antithrombin III deficiency Protein C / S deficiency Increased F VIII
Acquired Thrombophilia (3/4)	Nephrotic syndrome Antiphospholipid syndrome Connective tissue disease
Obesity (2)	Increased incidence of VTE
cardiac disease	Congenital disease and its surgery
inflammatory bowel (IBD)	UC greater than Crohn's (D)
Sickle cell disease	

4.2. Clinical Assessment

4.2.1. The risk of developing VTE should be assessed on admission to hospital, prior to any operative procedure and throughout the inpatient stay. ☑

4.2.2. This assessment should focus on adolescents (>13years) particularly those with one or more risk factor who are or will be immobile during their inpatient stay. ☑

4.2.3. Prophylactic measures should be used to prevent VTE in those considered at risk. ☑

4.2.4. An algorithm for assessing risk has been designed based on the UK Department of Health's toolkit (see Appendix 2). This is a guide only and should be individualised for each child and clinical setting. ☑

4.3. Laboratory Assessment for Thrombosis Risk

4.3.1. Routine screening of asymptomatic children below teenage years with a family history of thrombophilia does not seem warranted, as the risk of spontaneous thrombosis is low (30)(31)(32) (A)

4.3.2. Adolescents with other risk factors have an increased likelihood of thrombosis in the presence of an inherited prothrombotic condition and should be considered for prophylaxis (30). (A)

5. Methods of Prophylaxis

5.1. General Measures

Immobility increases the risk of VTE and therefore early mobilisation of patients at risk should be encouraged. Dehydration increases blood viscosity and reduces blood flow therefore good hydration should be encouraged in patients at risk of VTE.

Key Recommendation

- **Early mobilisation and good hydration should be encouraged in all patients recently immobilized.** ☑

5.2. Mechanical Prophylaxis

These methods may reduce lower limb venous stasis and increase blood velocity (33) (9) and can be classified as static devices in the form of Anti Embolism Stockings (AES) or dynamic devices, namely Intermittent Pressure Compression (IPC) boots that can be applied to foot or calf. Unlike pharmacological methods, mechanical methods do not increase the risk of bleeding and may be preferred in those whom bleeding risks outweigh the antithrombotic efficacy of pharmacological prophylaxis. They can be used in patients with contraindications to pharmacological agents and in those where bleeding is an unacceptable risk(34)(35)(36)(37). They may also act synergistically with pharmacological agents (8). Review of the literature in this area shows that all of the RCTs are adult studies, mostly in surgical settings. Most reviews consider a relative small number of thromboembolic events, and therefore most treatment estimates in those reviews are underpowered (38). There are no formal studies to draw upon in the paediatric population(39) . A more recent review suggests the use of mechanical methods for VTE risk reduction should be considered in older children and adolescents at risk where size is appropriate (40).

5.3. Anti Embolism Stockings (AES)

AES reduce venous distension and direct superficial venous return to the deep system, increasing flow.(41) In adults, AES on their own are effective in reducing VTE but may be more effective when combined with another prophylactic method (8)(9)(20)(42). They are available as above and below knee designs. Most trials assessed above knee stockings and there is not enough evidence to determine if above- or below-knee models are equally effective, although a meta-analysis sug-

gested equivalent efficacy in surgical patients (34)(9). The above-knee AES are less comfortable and are likely to be worn incorrectly while below-knee designs are easier to use(8). The optimal duration of use is unclear.

Key recommendations

- **AES reduce VTE in surgical patients and are recommended where size appropriate.**
- **AES are only useful in children or adolescents >40kg due to size limitations.** (**B)**
- **AES should be worn until the return of usual mobility.** ☑

5.3.1. Intermittent Pressure Compression boots (IPCs)

These inflatable garments wrap around the legs and provide pulsatile compression preventing venous stasis in the deep leg veins and promote fibrinolysis. It is recommended that all patients 13 years of age or older who are expected to have a surgical procedure lasting > 60 min be started on a pneumatic compression device following the induction of anaesthesia, unless there are contraindications to mechanical prophylaxis. (15)

Key recommendation

- **IPC devices are effective and recommended for intraoperative use in adolescents 13 years and over who weigh over 40kg and who are expected to have a procedure lasting >60 minutes, unless there are contraindications to mechanical prophylaxis. (B)**

5.3.2. Complications and Contraindications to mechanical methods

There are very few contraindications to mechanical methods. Accurate measurement and safe fitting of stockings is paramount and correct wearing should be monitored regularly(8)(43). No paediatric sizes of AES or IPC are available. Their use therefore is limited to older and larger children, teenagers and those weighing >40 kg. Standard size calf IPCs work up to a calf circumference of 43cm. Poorly fitted or worn stockings could produce a tourniquet effect and increase the risk of thrombosis(33)(9)). The top must not be rolled down, which is more likely to occur with thigh length stockings (34)They should be removed daily for hygiene and skin inspection purposes.

TABLE 2: Contraindications to IPCs

- Massive leg oedema or pulmonary oedema (congestive heart failure)
- Severe peripheral vascular disease or neuropathy
- Any local condition where the IPCs would interfere - dermatitis, recent skin graft/poor tissue viability, leg wound infection
- Extreme leg deformity

5.4. Pharmacological Prophylaxis

5.4.1. Low molecular weight heparin (LMWH)

LMWHs have become the mainstay of treatment and pharmacological prophylaxis in both adults and children. They offer several potential benefits over unfractionated heparin (UFH) and warfarin including predictable pharmacokinetics, minimal monitoring, less alteration by disease and other concurrent medications, and ease of administration by the subcutaneous route eliminating the need for intravenous access(44)(45). There is less heparin induced thrombocytopenia (HIT) and osteoporosis (46)(47)(44). LMWH has been shown to be as effective as an anticoagulant in VTE as UFH .(48)(49)

Studies have shown a variable range based on age and weight to achieve target anti-Xa levels. *Dix et al., 2000* looked at 131 courses of treatment and 31 courses of prophylaxis in patients aged 1 day to 18 years and found 30% of children in the target anti-Xa range 100% of the time, and 65% in range 70% of the time, with only 50% achieving this within the first day (47).In a retrospective study of 87 treatment courses and 60 courses of prophylaxis of enoxaparin and concluded that neither dose nor anti-Xa level predicted treatment success, and therefore suggested caution in using this as a guide for therapeutic dosing in children (50).

The REVIVE study was the first randomised controlled trial assessing LMWHs (riviparin) vs UFH for VTE treatment in children, and although underpowered, did show a better safety profile for LMWH(44). The bleeding rate for treatment was 9.2% as was the rate of recurrence of VTE. Studies of prophylactic dosing for children have not noted bleeding.

Dose finding studies by *Massicote et al.,* have shown that newborn infants have an increased dose requirement for LMWH(44). Clearance is also age dependent with neonates having an accelerated clearance compared with adults. Twice daily dosing in children has been shown to be effective based on half-life and clearance. *Ignjatovic et al.* also demonstrated significant variation

in dosing requirements for children <5 years of age (51). *Schobess et al.* looked at once and twice daily dosing in children and found no difference in efficacy(52).

The decision on once or twice daily dosing is a pragmatic one; younger patients under 40 kg with faster clearance are advised to receive twice daily dosing; for older children over the 40 kg limit, once daily dosing may be simpler and better tolerated, and sensible with regional techniques.

Table 3 shows the LMWH dosing in children. LMWHs are excreted via the renal system and so reduced clearance occurs with renal impairment(53). The dose and time interval will need adjusting in those patients with altered creatinine clearance and these patients should be discussed with a haematology specialist. Anti Xa levels may need closer monitoring (trough levels) to ensure clearance and therefore safety. Target range for antiXa not well defined for efficiency but taken as 0.1- 0.4 U/ml. (53)(54)

TABLE 3: LMWH dosing in children

Enoxaparin			
<5kg/2 months	0.75 mg/kg	subcutaneous	12 hourly
>5kg/>2 mths	0.5 mg/kg	subcutaneous	12 hourly
>45 kg	40 mg	subcutaneous	once daily
Tinzaparin			
>1 month	50 units/kg	subcutaneous	once daily

Normally prescribed at 0600 Hrs and 1800 Hrs. Administer via s/c catheter (ideally Insuflon^{TM} to reduce dead space) to reduce the number of needle insertions

5.4.2. Combined Mechanical and Pharmacological Prophylaxis

Combining mechanical prophylaxis and pharmacological prophylaxis lowers the overall risk of VTE compared to either single modality. (55)(56)(57)

Key recommendation

- **Anti-embolism stockings may be combined with pharmacological prophylaxis or intermittent pneumatic compression in surgical patients, to increase efficacy of prophylaxis against deep vein thrombosis. (D)**

6. Thromboprophylaxis in Surgical Patients

6.1. General Surgery

Prophylaxis is not normally necessary in prepubertal children, even after major surgery in the absence of other risk factors for VTE. In post pubertal children undergoing very major surgery preventing early mobilisation, mechanical prophylaxis should be considered. In patients with multiple other risk factors for VTE, for prolonged surgery with continued reduced mobility, LMWH prophylaxis should be considered on an individual basis in relation to risk factors (see Appendix 2).

6.2. Elective Orthopaedic Surgery

6.2.1. Prophylaxis is not normally necessary in prepubertal children, even after major surgery in the absence of other risk factors for VTE.

6.2.2. In post pubertal children undergoing very major surgery preventing early mobilisation, mechanical prophylaxis should be considered. Although, there is a higher risk of VTE in an obese adolescent as for example for SUFE (slipped upper femoral epiphysis) or acetabular dysplasia surgery, there is no indication for LMWH prophylaxis in the absence of any additional factors. In patients with multiple other risk factors for VTE, LMWH prophylaxis should be considered.

6.2.3. Prolonged immobilisation used to be common but there are no other reports of deep venous thrombosis in children on traction or treated in spica casts. It must be assumed that immobilisation is a contributory factor in patients with spinal cord injury although *Rousseau et al.* has suggested that this is only so in the early phase of injury(58). He monitored 57 patients over an 18 yr period and observed no cases of VTE. However it is interesting to note that Lohiya suggests that VTE is not an issue in cerebral palsy suggesting that spasticity

might in itself be a protective factor(59). The only patient they observed with a VTE was on the oral contraceptive pill and was factor V Leiden positive.

6.2.4. Reconstructive hip surgery represents a significant component of children's orthopaedics addressing the sequelae of conditions such as developmental dysplasia of the hip, Perthes disease, slipped upper femoral epiphysis and cerebral palsy. Despite the frequency with which such procedures are performed there are no reports of the frequency of VTE or guidance on VTE prophylaxis. Procedures such as pelvic and femoral osteotomy are recognised as high-risk procedures for VTE in adults, but this would not appear to be the case in children, although obesity, smoking or oral contraceptive pill use in adolescent cases may be important additional risk factors(60).

6.2.5. Elective spinal surgery in children is mostly to correct scoliosis but there is no consensus among spinal surgeons regarding VTE prophylaxis. Preoperative traction was associated with a high incidence of DVT in patients prior to scoliosis surgery (61)but is now seldom used. In a survey of Scandinavian scoliosis centres between 1963 and 1976, DVT was reported in 8 of 1229 cases (62)only three cases were between age 15 and 18 years, the remainder being older. At this time 3 weeks bed rest was the routine postoperative management and it was recognised that this must have contributed to the risk of DVT. In a recent article, 40 successive pubertally mature adolescents undergoing posterior spinal instrumentation for non-syndromic scoliosis underwent regular ultrasonography to look for DVT. Two minor transient thromboses were identified which resolved spontaneously. Although a small, unique study the authors concluded that prophylaxis should not be recommended (63).

Key recommendations

- **VTE prophylaxis is not routinely recommended in prepubertal children undergoing major spinal surgery.**
- **In the absence of any additional risk factors pharmacological VTE prophylaxis is not recommended as routine for adolescents undergoing major spinal surgery. Consideration needs to be given to the risk of bleeding (C/D)**

6.3. Trauma

Up to 50% of adults with trauma may develop DVT and 0.5-10% may develop PE (64). Trauma-related VTE in children is much less common with incidences of 0.08-0.3% based on clinical findings without supportive imaging. VTE is often not considered in children and in many cases will be asymptomatic (65)(66)(67)(68). It has been suggested that minor PE may be a lot more common in children than is currently appreciated (69). Patients with inherited thrombophilic defects do present following trauma and in the three cases of VTE reported in 158 injured children by *Ozyurek et al.* two had a factor V Leiden mutation. Clearly where there is a family history of an inherited thrombophilic defect the risks for VTE are increased (70).

Age is an important consideration in VTE in children subjected to injury and an overall incidence of 0.08% has been reported in 58,716 paediatric patients from the USA (65). When stratified for age, the incidence was 0.02% at age < 5y, 0.04% at age 5-9y and 0.13% at age 10-15y. In a ten-year survey from a single level one trauma centre (71) there were no cases reported in 1192 children age <13y with 2/1021 at age 13-17y. As a consequence they suggested that the risk for VTE in children <13y is negligible and this is supported by a further survey in a level one trauma centre in which there were 3 / 2746 cases all of whom were >14y (72). It would thus seem appropriate to subdivide children into preadolescent and adolescent and that 13years would seem an appropriate age at which to make this distinction.

6.3.1. The injury severity score (ISS) is used in many articles as an identifiable risk factor for VTE. In a three year survey of paediatric intensive care admissions at two Canadian trauma centres VTE was found in 11 / 3,291 (0.33%) admissions (66). An ISS>9 was identified as significant with an odds ratio of 5.3 (95% CI: 1.6-17.3). In an audit of 58,716 patients treated in non-specialist trauma centres 45 cases of VTE were reported with a mean ISS of 17.1 in patients with VTE compared with a mean ISS of 8.5 in those without VTE (65). In 28,692 trauma victims up to the age of 19y two PEs were observed both of whom had ISS >25 (64). Similarly in the three VTEs observed in 3637 patients by *Truitt et al.,* all had an ISS >25 and the two adolescents reported by *Azu et al.* in his survey of 1021 cases both had an ISS of >24 (73)(71).

Key recommendations

- **There is little evidence in the literature to support VTE prophylaxis in preadolescent children irrespective of their ISS and current opinion supports this.**

- **The incidence of VTE in adolescents remains much lower than adults, there are reports in the literature suggesting a relation to ISS, there is however no consensus on the level of ISS which should trigger prophylaxis. This ambiguity which exists in the literature is reflected by the apparent uncertainty in current practice. It would seem reasonable to consider prophylaxis with an ISS > 9, and administer it when the ISS is >25. Specific detail of the injuries contributing to the ISS and the coexistent treatment may lower the threshold for instigating prophylaxis. (D)**

6.3.2. **Injury type**

6.3.2.1. **Head injury** is common in seriously injured children with a GCS <8 frequently recorded (64)(73). In isolation it does not appear to carry a specific increased risk and there were no cases in a survey of 1123 closed head injuries in children age <16y with no additional risk factors (72). In a study of 60 adolescents over age 13y admitted to a rehabilitation unit with severe traumatic brain injury, all of whom were comatose for at least 6 hours, three DVTs and two PEs were reported.(74)

Key recommendations

- **There is no evidence to support routine VTE prophylaxis in prepubertal children with head injury and this opinion is widely supported.**

- **VTE prophylaxis is not recommended in isolated head injury in adolescents but should be considered in the absence of intracranial bleed; if additional factors i.e. prolonged ventilation, immobilisation, and multiple injuries coexist. (D)**

6.3.2.2. **Spinal cord injury** with paralysis is a risk factor for VTE with quoted incidences of 5.9 – 6.5/1000 and thoracic spine injury may be a particular concern due to associated chest and pulmonary injuries(65). In a group of 532 children attending a rehabilitation centre over four years there was an overall incidence of VTE of 2.2% (75). In those with spinal cord injury, 1/20 (5%) patients age <15y and 7/67 (10.4%) >15y had a DVT suggesting prophylaxis was not needed in younger children. Spinal injury particularly with cord injury

and paralysis is very uncommon in prepubertal children in the UK. Current practice in spinal injury units in the UK varies widely (76). A recent meta-analysis of thromboprophylaxis in spinal cord injury unfortunately only included patients over 18y of age(77). Their recommendation was that due to the hypercoagulability state that arises within hours of injury, chemical prophylaxis should be commenced within 72h and should continue for 12 weeks. Mechanical prophylaxis is safe and can be commenced immediately thus covering the initial phase following injury during which secondary haemorrhage may be a concern.

Key recommendations

- **It would appear that pharmacological VTE prophylaxis is not required in spinal injury without paralysis or other risk factors such as additional injuries causing prolonged immobilisation.(D)**

- **Spinal cord injury in prepubertal children is very rare and as such there is no evidence for or against VTE prophylaxis. In view of the relative rarity of VTE in prepubertal children generally it would seem logical to use mechanical methods if anything for at least the first three weeks during which the hypercoagulable state is thought to exist.**

- **In specialist spinal injury units, adolescents receive the same VTE prophylaxis as adults with mechanical methods in the immediate post injury period and chemical prophylaxis subsequently for three months.**

6.3.2.3. **Isolated fractures** 2.5/1000 cases of VTE were observed with isolated fractures (relative risk 3.8), compared with 3.2/1000 in pelvic injuries (relative risk 4.4) and major vascular injury (19.3/1000)(65). The importance of “venous manipulations” for example a history of central venous cannulation in particular of the femoral vein has been identified as a particular risk factor (72). Internal fixation of lower limb fractures is often quoted as a risk factor for VTE (65) however there is no specific information regarding which procedures are a particular risk. Operative stabilisation of the femur is the most common major fixation in children but VTE has not been reported.

Key recommendations

- **VTE prophylaxis is not required in isolated limb fractures in either prepubertal or adolescent children.(D)**
- **There is little support for the use of VTE prophylaxis in multiple limb fractures in prepubertal children.**
- **Uncertainty exists with regard to VTE prophylaxis in multiple limb fractures in adolescents with a tendency to avoiding it in the absence of any additional risk factors.**

6.4. Burns

Burns are often associated with multiple other injuries, thus increasing VTE risk (11). Prospective studies have shown an incidence of symptomatic VTE of 2.4%, and asymptomatic VTE of 23% on screening (78)(79). Increased total body surface area of burn increases VTE risk, as does the presence of CVCs, wound infection, and increased body weight (78)(80)(81)(82)(83).Most evidence pertains to adults(84)(85).

Key recommendations

- **Routine prophylaxis cannot be recommended for pre-pubertal children.**

- **Where adolescents are extensively injured e.g. >20% burns, consideration of an increased risk of thrombosis may be warranted and prophylaxis should be considered. (D)**

7. Regional Anaesthesia and Anticoagulant Prophylaxis

The use of regional anaesthesia as an alternative to general anaesthesia, may provide additional protection against VTE. In adult studies, compared with general anaesthesia regional anaesthesia reduced the risk of DVT, and this benefit appeared similar in each of the surgical settings studied (86)(38).

7.1. Risk of vertebral canal haematoma

There is concern that spinal or epidural block may be followed by an increased risk of vertebral canal haematoma (87)(88). The actual incidence of neurological dysfunction resulting from haem-

orrhagic complications associated with central neuraxial block is unknown. The incidence cited in the literature is estimated to be less than 1 in 150,000 cases in which epidural anaesthesia was used and less than 1 in 220,000 cases of spinal anaesthesia. However, the series involved in these calculations were conducted before the implementation of routine perioperative thromboprophylaxis. The risk increases when there are associated coagulation abnormalities, whether from disease or intended anticoagulation. Recent case series and epidemiologic surveys suggest that the risk has increased (87)(89)(90)(91)(92) . Moreover, cases of spontaneous spinal hematomas associated with LMWH without neuraxial block have also been reported (87)(89)(90). Nearly half of all cases of bleeding occur during the removal of the epidural catheter, and this procedure should be regarded as hazardous as catheter insertion (89). Although there are cases of epidural haematoma and spinal cord injury and infarction in children, we are not aware of any case report of spinal haematoma and neuraxial blockade in paediatric patients receiving thromboprophylaxis.

Most series involve adult patients; however there are two retrospective reviews of paediatric cardiac surgery including a total of 250 patients that report no spinal haematoma. In these the blocks were performed at least 1 hour before heparinisation when CPB was used. In the cases were an epidural catheter was inserted, the catheter removal was performed only after normal coagulation function was restored. In these series there were no cases of peridural haematoma (93)(94). The pharmacological properties of Standard intravenous heparin however are different from the LMWH. The anticoagulant effects of Standard heparin are neutralised by an equimolar dose of protamine. Because of reduced protamine binding to LMWH fractions, only the anti-IIa activity is reversed, whereas anti-Xa activity is not fully neutralised. Moreover, both anti-IIa and anti-Xa activity may return up to 3 hours after protamine reversal, possibly due to release of additional LMWH from the subcutaneous depot (95). Routine laboratory investigations do not always detect impaired coagulation. Monitoring with anti Xa activity is not a reliable indicator of bleeding and is not routinely recommended (96)

The perioperative management of patients receiving LMWH requires coordination and communication between the entire patient care team, including the surgeons who are likely writing the anticoagulation orders and the nurses who will be administering the drug and taking out the catheters and the pain teams involved in daily reviews. Education of the entire patient care team is necessary to avoid potentiation of the anticoagulant effect (95)(97)(98)(99)(100)

7.1.1. **Risk factors for spinal haematoma**

Complicated punctures: anatomical spinal deformities, vascular malformations, difficulties in identifying the epidural space leading to several attempts. (86)(95)

Traumatic procedure: a bloody procedure represents the single greatest risk factor for spinal haematoma, with or without abnormal clotting (91).
Type of insertion - epidural catheters present the highest risk, followed by single shot epidural, then single shot spinal.
Concomitant use of LMWH with other anticoagulants/antiplatelets (86)(96).
Insufficient intervals between cessation/initiation of LMWH and neuraxial block performance / catheter removal. There is no evidence to support any of the intervals, however the time between cessation of medication and neuraxial blockade is calculated at two times the elimination half-life of the drug to coincide with the lowest anticoagulant blood level (96)(86)(89)(101)
Renal impairment Most drugs used for thromboprophylaxis are eliminated by the renal route and will accumulate in those with renal impairment therefore dose adjustment or longer time intervals are required (89).
Hepatic impairment due to a decreased synthesis of coagulation factors.

7.1.2. **Vigilance**

In the reported cases of patients who developed spinal haematoma, neurologic compromise presented as progression of sensory or motor block, or bowel/ bladder dysfunction, severe radicular back pain seems to be a less common presenting symptom (95)(96)(102). Neurologic deficits appeared 12 hours or more following catheter removal. Spinal cord ischemia tended to be reversible in patients who underwent surgical decompression within 8 hours of onset of neurologic dysfunction (95).

Any patient who has significant leg weakness should have their epidural infusion stopped, if there is no recovery of leg strength within 4 hours, an MRI scan should be performed. No further LMWH should be administered until recovery of symptoms (89)(91)(96). The epidural catheter should be left in place, as further manipulation may increase the bleeding.
Careful assessment of the presence of sensory and motor function for 24 hours following the catheter removal is recommended (90)(96)

7.2. NSAIDs, antiplatelet medications, neuraxial blocks and thromboprophylaxis

NSAIDs alone do not significantly increase the risk of spinal haematoma. Large series have documented the safety of neuraxial techniques in patients receiving NSAIDs. There not seem to be specific concerns as to the timing of single-shot or catheter techniques, including catheter removal, in relationship to the dosing of NSAIDs. However, combinations of anticoagulants with different

pharmacodynamics have an additive effect on haemostasis and coagulation with increased bleeding tendency, and theoretically a synergistic fibrinolytic effect of NSAID's in combination with LMWH has been suggested. Antiplatelet medications or dextran administered in combination with LMWH may increase the risk of spinal haematoma. New recommendations have been introduced advising caution if the patient is receiving any additional hemostasis-altering medication including NSAID's, particularly in cases of traumatic puncture. The anti-inflammatory COX-2 inhibitors have minimal effect on platelet function and should be considered when using NSAID's in combination with other anticoagulants.(86)(87)(89)(90)(95)(96)(101)

Key recommendations

- **The use of LMWH (low molecular weight heparin) thromboprophylaxis in patients at risk is not a contraindication to the performance of neuraxial anaesthesia.**
- **Neuraxial blocks should be avoided in a patient with known coagulopathy from any cause**
- **Most recommend that the INR should be 1.5 or lower, functioning platelets > 50 x 109/l, and APPT - 45 s, for institution of a block or removal of a catheter**
- **Patients on preoperative LMWH thromboprophylaxis can be assumed to have altered coagulation. In these patients, needle placement should occur at least 12 hours after the last LMWH dose.**
- **The placement of an epidural catheter, removal or repositioning of the catheter should occur at least 12 hours after standard prophylactic LMWH doses.**
- **The presence of blood during needle or catheter placement does not necessitate postponement of surgery. However, LMWH should be delayed for 24 hours, avoiding the involvement of any other circumstance that might increase the risk of spinal bleeding (including NSAID's) in the immediate postoperative period.**
- **In patients with indwelling catheters it is recommended that the first dose of LMWH should be given at least 12 hours after surgery, rather than immediately postoperatively**
- **In children on once daily dose thromboprophylaxis the removal of the epidural should be at least 10-12 hours after the last dose of LMWH.**
- **In children receiving twice daily doses of LMWH the removal of the epidural catheter should be at least 8 hours (2 half lives) after the last dose.**
- **In children on once or twice daily dose thromboprophylaxis, the next dose of LMWH should be given at least 4 hours after the removal of the epidural catheter.**
- **In patients receiving LMWH, monitoring and observation of the patient neurological status should be continued for at least 24 hours after the catheter removal.**

- **In patients with an epidural indwelling catheter, on LMWH thromboprophylaxis, concomitant treatment with drugs that affect hemostasis or antiplatelet medication (e.g. NSAID's) should be used with caution. Any patient with an epidural infusion presenting significant leg weakness should have the epidural infusion stopped and no further LMWH until recovery. If there is no recovery of leg strength within 4 hours, a MRI scan should be performed to exclude spinal haematoma.**

Level of evidence 3 or 4 throughout section 6
Recommendation grade D

7.3. Plexus and Peripheral Block in the anticoagulated patient

There are no studies examining the frequency and severity of haemorrhagic complications following plexus or peripheral blocks in anticoagulated patients.
Several cases of vascular injury with or without resultant nerve dysfunction have been described following plexus or peripheral techniques in patients with normal and abnormal haemostasis, mainly in cases in which psoas compartment or lumbar sympathetic blocks were performed (103). In all the cases which of neurological deficit, neurologic recovery was complete within 6 to 12 months. Thus, while bleeding into a neurovascular sheath may result in significant deficit, the expandable nature of the peripheral site may decrease the chance of irreversible neural ischaemia (87).

It seems that significant blood loss, rather than neural deficits, may be the most serious complication of non-neuraxial regional techniques in the anticoagulated patient.
Additional information is needed to make definitive recommendations. However, in order to avoid potential bleeding, it might be sensible to apply the same guidelines as for neuraxial blocks regarding timing of LMWH and performance of the regional anaesthetic technique, including insertion and removal of plexus catheters(86)(87)(89)(104)

8. Adverse Effects of Pharmacological Prophylaxis

8.1. Bleeding risk

The use of LMWH in prophylactic trials in adults has found no detectable increase in bleeding. In a prospective cohort study of LMWH in pediatric patients, 146 courses of therapeutic LMWH and 31

courses for prophylaxis were administered. They found no major bleeds and 2 minor bleeds at the Insuflon™site in the prophylaxis group (47)

8.2. Heparin Induced Thrombocytopenia

Severe HIT is defined as a reduction of >50% in the platelet count occurring ≥5 days after heparin exposure, in response to antibody production against the heparin-platelet complex. Mild HIT presents as a drop in platelet count but can be asymptomatic. It is more likely with therapeutic than prophylactic doses of heparin. The incidence seems to be lower in children than adults and is lower with LMWH. (16)(105)

We could find no evidence in the literature regarding osteoporosis risk of the prophylactic use of LMWH in children.

9. Consultation and Peer review

The guideline was written with input from specialists in key areas of paediatric medicine and surgery. Each specialist was asked to disseminate the guideline while in draft form to their specialty group or society for comment on accuracy, evidence base and recommendations made, from which each response was addressed in subsequent draft versions.
The draft guideline was then submitted for review to the APA council members and each response addressed. A final draft was submitted to council for editorial input and quality check.

10. References

1. Andrew M, Vegh P, Johnston M, Bowker J, Ofosu F, Mitchell L. Maturation of the Hemostatic System During Childhood. Blood. 1992;80(8):1998–2005.
2. Andrew M, David M, Adams M, Ali K, Anderson R, Barnard D, et al. Venous Thromboembolic Complications (VTE) in Children: First Analyses of the Canadian Registry of VTE. Blood. 1994;83(5):1251–7.
3. Stein PD, Kayali F, Olson RE. Incidence of venous thromboembolism in infants and children: data from the National Hospital Discharge Survey. J Pediatr. 2004 Oct;145(4):563–5.
4. Biss TT, Alikhan R, Payne J, Alamelu J, Williams M, Richards M, et al. Venous thromboembolism occurring during adolescence. Arch Dis Child [Internet]. 2016 May;101(5):427–32. Available from: http://dx.doi.org/10.1136/
5. Chalmers EA. Epidemiology of venous thromboembolism in neonates and children. Vol. 118, Thrombosis Research. 2006. p. 3–12.
6. Chan AK, Deveber G, Monagle P, Brooker LA, Massicotte PM. Venous thrombosis in children. J Thromb Haemost. 2003 Jul;1(7):1443–55.
7. Department of Health. Report of the independent expert working group on the prevention of venous thromboembolism in hospitalised patients. A report to Sir Liam Donaldson Chief Medical Officer. 2007; Available from: http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_073944
8. Venous thromboembolism: reducing the risk for patients in hospital | Guidance and guidelines | NICE. [cited 2017 Mar 12]; Available from: https://www.nice.org.uk/Guidance/cg92
9. Scottish Intercollegiate Guidelines Network. Key To Evidence Statements and Grades of Recommendations. Management [Internet]. 2008;SIGN(June):Available from www.sign.ac.uk/guidelines/fulltext/. Available from: www.sign.ac.uk
10. Cole CH. Primary prophylaxis of venous thromboembolism in children. J Paediatr Child Health. 2010 Jun;46(6):288–90.
11. Geerts WH, Bergqvist D, Pineo GF, Heit JA, Samama CM, Lassen MR, et al. Prevention of venous thromboembolism: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition). Chest. 2008 Jun;133(6 Suppl):381S–453S.
12. Chalmers E, Ganesen V, Liesner R, Maroo S, Nokes T, Saunders D, et al. Guideline on the investigation, management and prevention of venous thrombosis in children. Br J Haematol. 2011 Jul;154(2):196–207.
13. JACKSON PC, MORGAN JM. Perioperative thromboprophylaxis in children: development of

a guideline for management. Pediatr Anesth [Internet]. 2008 Jun [cited 2017 Mar 23];18(6):478–87. Available from: http://doi.wiley.com/10.1111/j.1460-9592.2008.02597.x

14. Children C, Medical Center H. Title: Venous Thromboembolism (VTE) Prophylaxis in Children and Adolescents. 2014;
15. Raffini L, Trimarchi T, Beliveau J, Davis D. Thromboprophylaxis in a pediatric hospital: a patient-safety and quality-improvement initiative. Pediatrics. 2011 May;127(5):e1326-32.
16. Newall F, Wallace T, Crock C, Campbell J, Savoia H, Barnes C, et al. Venous thromboembolic disease: a single-centre case series study. J Paediatr Child Health. 2006 Dec;42(12):803–7.
17. Raffini L, Huang Y-S, Witmer C, Feudtner C. Dramatic increase in venous thromboembolism in children's hospitals in the United States from 2001 to 2007. Pediatrics. 2009 Oct;124(4):1001–8.
18. Kuhle S, Koloshuk B, Marzinotto V, Bauman M, Massicotte P, Andrew M, et al. A cross-sectional study evaluating post-thrombotic syndrome in children. Thromb Res. 2003;111(4–5):227–33.
19. Nowak-Gö U, Junker R, Kreuz W, Von Eckardstein A, Kosch A, Nohe N, et al. Risk of recurrent venous thrombosis in children with combined prothrombotic risk factors.
20. Parasuraman S, Goldhaber SZ. Venous thromboembolism in children. Circulation. 2006 Jan;113(2):e12-6.
21. Saleh T, Matta F, Yaekoub AY, Danescu S, Stein PD. Risk of venous thromboembolism with inflammatory bowel disease. Clin Appl Thromb Hemost. 2011 Jun;17(3):254–8.
22. Stein PD, Goldman J. Obesity and thromboembolic disease. Clin Chest Med. 2009 Sep;30(3):489–93, viii.
23. Gerotziafas GT. Risk factors for venous thromboembolism in children. Int Angiol. 2004 Sep;23(3):195–205.
24. Samama MM, Dahl OE, Quinlan DJ, Mismetti P, Rosencher N. Quantification of risk factors for venous thromboembolism: a preliminary study for the development of a risk assessment tool. Haematologica [Internet]. 2003;88:1410–21. Available from: http://www.haematologica.org/2003_12/1410.htm
25. Rosendaal FR. Thrombosis in the young: epidemiology and risk factors. A focus on venous thrombosis. Thromb Haemost. 1997 Jul;78(1):1–6.
26. Beck C, Dubois J, Grignon A, Lacroix J, David M. Incidence and risk factors of catheter-related deep vein thrombosis in a pediatric intensive care unit: a prospective study. J Pediatr. 1998 Aug;133(2):237–41.
27. Mitchell LG, Andrew M, Hanna K, Abshire T, Halton J, Anderson R, et al. A prospective cohort study determining the prevalence of thrombotic events in children with acute

lymphoblastic leukemia and a central venous line who are treated with L-asparaginase: results of the Prophylactic Antithrombin Replacement in Kids with Acute. Cancer. 2003 Jan;97(2):508–16.

28. Male C, Julian JA, Massicotte P, Gent M, Mitchell L. Significant association with location of central venous line placement and risk of venous thrombosis in children. Thromb Haemost. 2005 Sep;94(3):516–21.
29. Male C, Chait P, Andrew M, Hanna K, Julian J, Mitchell L. Central venous line-related thrombosis in children: association with central venous line location and insertion technique. Blood. 2003 Jun;101(11):4273–8.
30. Simioni P, Sanson BJ, Prandoni P, Tormene D, Friederich PW, Girolami B, et al. Incidence of venous thromboembolism in families with inherited thrombophilia. Thromb Haemost. 1999 Feb;81(2):198–202.
31. van Ommen CH, Heijboer H, Buller HR, Hirasing RA, Heijmans HS, Peters M. Venous thromboembolism in childhood: a prospective two-year registry in The Netherlands. J Pediatr. 2001 Nov;139(5):676–81.
32. Tormene D, Simioni P, Prandoni P, Franz F, Zerbinati P, Tognin G, et al. The incidence of venous thromboembolism in thrombophilic children: a prospective cohort study. Blood. 2002 Oct;100(7):2403–5.
33. Morris RJ, Woodcock JP. Evidence-based compression: prevention of stasis and deep vein thrombosis. Ann Surg. 2004 Feb;239(2):162–71.
34. Sajid MS, Tai NRM, Goli G, Morris RW, Baker DM, Hamilton G. Knee versus thigh length graduated compression stockings for prevention of deep venous thrombosis: a systematic review. Eur J Vasc Endovasc Surg. 2006 Dec;32(6):730–6.
35. Urbankova J, Quiroz R, Kucher N, Goldhaber SZ. Intermittent pneumatic compression and deep vein thrombosis prevention. A meta-analysis in postoperative patients. Thromb Haemost. 2005 Dec;94(6):1181–5.
36. Cayley WEJ. Preventing deep vein thrombosis in hospital inpatients. BMJ. 2007 Jul;335(7611):147–51.
37. Limpus A, Chaboyer W, McDonald E, Thalib L. Mechanical thromboprophylaxis in critically ill patients: a systematic review and meta-analysis. Am J Crit Care. 2006 Jul;15(4):402-10, 411–2.
38. Roderick P, Ferris G, Wilson K, Halls H, Jackson D, Collins R, et al. Towards evidence-based guidelines for the prevention of venous thromboembolism: systematic reviews of mechanical methods, oral anticoagulation, dextran and regional anaesthesia as thromboprophylaxis. Health Technol Assess [Internet]. 2005 Dec;9(49):iii–iv, ix–x, 1-78. Available from: http://www.ncchta.org

39. Faustino EVS, Hanson S, Spinella PC, Tucci M, O'Brien SH, Nunez AR, et al. A multinational study of thromboprophylaxis practice in critically ill children. Crit Care Med [Internet]. 2014 May [cited 2017 Apr 6];42(5):1232–40. Available from: http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00003246-201405000-00025
40. Sharma M, Carpenter SL. Thromboprophylaxis in a pediatric hospital. Curr Probl Pediatr Adolesc Health Care. 2013 Aug;43(7):178–83.
41. Sachdeva A, Dalton M, Amaragiri S V, Lees T. Elastic compression stockings for prevention of deep vein thrombosis. Cochrane database Syst Rev. 2010 Jul;(7):CD001484.
42. Agu O, Hamilton G, Baker D. Graduated compression stockings in the prevention of venous thromboembolism. Br J Surg. 1999 Aug;86(8):992–1004.
43. Wallis M, Autar R. Deep vein thrombosis: clinical nursing management. Nurs Stand. 2001 Jan;15(18):47.
44. Massicotte P, Julian JA, Gent M, Shields K, Marzinotto V, Szechtman B, et al. An open-label randomized controlled trial of low molecular weight heparin compared to heparin and coumadin for the treatment of venous thromboembolic events in children: the REVIVE trial. Thromb Res. 2003 Jan;109(2–3):85–92.
45. Monagle P, Chan AKC, Goldenberg NA, Ichord RN, Journeycake JM, Nowak-Gottl U, et al. Antithrombotic therapy in neonates and children: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. Chest. 2012 Feb;141(2 Suppl):e737S–801S.
46. Andrew M, Mitchell L, Vegh P, Ofosu F. Thrombin regulation in children differs from adults in the absence and presence of heparin. Thromb Haemost. 1994 Dec;72(6):836–42.
47. Dix D, Andrew M, Marzinotto V, Charpentiel K, Bridge S, Monagle P, et al. The use of low molecular weight heparin in pediatric patients: a prospective cohort study. J Pediatr. 2000 Apr;136(4):439–45.
48. Andrew M, Michelson AD, Bovill E, Leaker M, Massicotte MP. Guidelines for antithrombotic therapy in pediatric patients. J Pediatr. 1998 Apr;132(4):575–88.
49. Sutor AH, Chan AKC, Massicotte P. Low-molecular-weight heparin in pediatric patients. Semin Thromb Hemost. 2004 Feb;30 Suppl 1:31–9.
50. Leung M, Ho SH, Hamilton DP, Wu JK, Dix DB, Wadsworth LD, et al. Utility of anti-xa monitoring in children receiving enoxaparin for therapeutic anticoagulation. J Pediatr Pharmacol Ther. 2005 Jan;10(1):43–50.
51. Ignjatovic V, Najid S, Newall F, Summerhayes R, Monagle P. Dosing and monitoring of enoxaparin (Low molecular weight heparin) therapy in children. Br J Haematol. 2010 Jun;149(5):734–8.

52. Schobess R, During C, Bidlingmaier C, Heinecke A, Merkel N, Nowak-Gottl U. Long-term safety and efficacy data on childhood venous thrombosis treated with a low molecular weight heparin: an open-label pilot study of once-daily versus twice-daily enoxaparin administration. Haematologica. 2006 Dec;91(12):1701–4.
53. Chow SL, Zammit K, West K, Dannenhoffer M, Lopez-Candales A. Correlation of antifactor Xa concentrations with renal function in patients on enoxaparin. J Clin Pharmacol. 2003 Jun;43(6):586–90.
54. Joint Formulary Committee. British National Formulary and medicines for Children. BMJ Group and Pharmaceutical Press; 2010. 148-150 p.
55. Barrera LM, Perel P, Ker K, Cirocchi R, Farinella E, Morales Uribe CH. Thromboprophylaxis for trauma patients. Cochrane database Syst Rev. 2013 Mar;(3):CD008303.
56. Ho KM, Tan JA. Stratified meta-analysis of intermittent pneumatic compression of the lower limbs to prevent venous thromboembolism in hospitalized patients. Circulation. 2013 Aug;128(9):1003–20.
57. Kakkos SK, Caprini JA, Geroulakos G, Nicolaides AN, Stansby GP, Tsolakis IA, et al. Can combined (mechanical and pharmacological) modalities prevent fatal VTE? Int Angiol. 2011 Apr;30(2):115–22.
58. Rousseau MC, Guillotel B. Risk factors for deep venous thrombosis in tetraparesic mentally retarded patients. Brain Inj. 2001 Dec;15(12):1041–4.
59. Lohiya G-S, Crinella FM, Tan-Figueroa L, Go S. Deep vein thrombosis in a tetraparesic patient with mental retardation: case report and review of the literature. Brain Inj [Internet]. 2005 Aug 20 [cited 2017 Apr 6];19(9):739–42. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16195188
60. Strebel N, Prins M, Agnelli G, Buller HR. Preoperative or postoperative start of prophylaxis for venous thromboembolism with low-molecular-weight heparin in elective hip surgery? Arch Intern Med. 2002 Jul;162(13):1451–6.
61. Leslie IJ, Dorgan JC, Bentley G, Galloway RW. A prospective study of deep vein thrombosis of the leg in children on halo-femoral traction. J Bone Joint Surg Br. 1981 Aug;63–B(2):168–70.
62. Uden A. Thromboembolic complications following scoliosis surgery in Scandinavia. Acta Orthop Scand. 1979 Apr;50(2):175–8.
63. Kaabachi O, Alkaissi A, Koubaa W, Aloui N, Toumi NEH. Screening for deep venous thrombosis after idiopathic scoliosis surgery in children: a pilot study. Paediatr Anaesth. 2010 Feb;20(2):144–9.
64. McBride WJ, Gadowski GR, Keller MS, Vane DW. Pulmonary embolism in pediatric trauma patients. J Trauma. 1994 Dec;37(6):913–5.

65. Vavilala MS, Nathens AB, Jurkovich GJ, Mackenzie E, Rivara FP. Risk factors for venous thromboembolism in pediatric trauma. J Trauma. 2002 May;52(5):922–7.
66. Cyr C, Michon B, Pettersen G, David M, Brossard J. Venous Thromboembolism after Severe Injury in Children. Acta Haematol [Internet]. 2006;115(3–4):198–200. Available from: http://www.karger.com/DOI/10.1159/000090935
67. Rohrer MJ, Cutler BS, MacDougall E, Herrmann JB, Anderson FAJ, Wheeler HB. A prospective study of the incidence of deep venous thrombosis in hospitalized children. J Vasc Surg. 1996 Jul;24(1):46–9; discussion 50.
68. Kotsakis A, Cook D, Griffith L, Anton N, Massicotte P, MacFarland K, et al. Clinically important venous thromboembolism in pediatric critical care: a Canadian survey. J Crit Care. 2005 Dec;20(4):373–80.
69. Joffe S. Postoperative deep vein thrombosis in children. J Pediatr Surg. 1975 Aug;10(4):539–40.
70. Ozyurek E, Besbas N, Aslan D, Gurgey A. Trauma as a risk factor for thrombosis in children: a report of three cases. Turk J Pediatr. 2003;45(2):167–9.
71. Azu MC, McCormack JE, Scriven RJ, Brebbia JS, Shapiro MJ, Lee TK. Venous thromboembolic events in pediatric trauma patients: is prophylaxis necessary? J Trauma. 2005 Dec;59(6):1345–9.
72. Grandas OH, Klar M, Goldman MH, Filston HC. Deep venous thrombosis in the pediatric trauma population: an unusual event: report of three cases. Am Surg. 2000 Mar;66(3):273–6.
73. Truitt AK, Sorrells DL, Halvorson E, Starring J, Kurkchubasche AG, Tracy TFJ, et al. Pulmonary embolism: which pediatric trauma patients are at risk? J Pediatr Surg. 2005 Jan;40(1):124–7.
74. Sobus KM, Cawley MF, Alexander MA. Pulmonary embolism in the traumatic brain injured adolescent: report of two cases. Arch Phys Med Rehabil. 1994 Mar;75(3):362–4.
75. Radecki RT, Gaebler-Spira D. Deep vein thrombosis in the disabled pediatric population. Arch Phys Med Rehabil. 1994 Mar;75(3):248–50.
76. Deep K, Jigajinni MV, Fraser MH, McLean AN. Prophylaxis of thromboembolism in spinal injuries--survey of practice in spinal units in the British Isles. Injury. 2002 May;33(4):353–5.
77. Ploumis A, Ponnappan RK, Maltenfort MG, Patel RX, Bessey JT, Albert TJ, et al. Thromboprophylaxis in patients with acute spinal injuries: an evidence-based analysis. J Bone Joint Surg Am. 2009 Nov;91(11):2568–76.
78. Ferguson REH, Critchfield A, Leclaire A, Ajkay N, Vasconez HC. Current practice of thromboprophylaxis in the burn population: a survey study of 84 US burn centers. Burns. 2005 Dec;31(8):964–6.

79. Wahl WL, Brandt M-MM, Arbor A. Potential risk factors for deep venous thrombosis in burn patients. J Burn Care Rehabil. 2001;22(2):128–31.
80. Fecher AM, O'Mara MS, Goldfarb IW, Slater H, Garvin R, Birdas TJ, et al. Analysis of deep vein thrombosis in burn patients. Burns. 2004 Sep;30(6):591–3.
81. Harrington DT, Mozingo DW, Cancio L, Bird P, Jordan B, Goodwin CW. Thermally injured patients are at significant risk for thromboembolic complications. J Trauma. 2001 Mar;50(3):495–9.
82. Germann G, Kania NM. Extensive thrombosis of the caval venous system after central venous catheters in severely burned patients. Burns. 1995 Aug;21(5):389–91.
83. Pannucci CJ, Osborne NH, Wahl WL. Venous thromboembolism in thermally injured patients: analysis of the National Burn Repository. J Burn Care Res. 2011;32(1):6–12.
84. Faucher LD, Conlon KM. Practice Guidelines for Deep Venous Thrombosis Prophylaxis in Burns. J Burn Care Res. 2007;28(5):661–3.
85. Wahl WL, Brandt M-M, Ahrns KS, Zajkowski B, Proctor M, Wakefield MD, et al. Venous Thrombosis Incidence in Burn Patients Preliminary Results of a Prospective Study. J Burn Care Rehabil. 2002;23(2):97–102.
86. Rosencher N, Bonnet M-P, Sessler DI. Selected new antithrombotic agents and neuraxial anaesthesia for major orthopaedic surgery: management strategies. Anaesthesia. 2007 Nov;62(11):1154–60.
87. Horlocker TT, Wedel DJ, Rowlingson JC, Enneking FK, Kopp SL, Benzon HT, et al. Regional anesthesia in the patient receiving antithrombotic or thrombolytic therapy: American Society of Regional Anesthesia and Pain Medicine Evidence-Based Guidelines (Third Edition). Reg Anesth Pain Med. 2010;35(1):64–101.
88. Breschan C, Krumpholz R, Jost R, Likar R. Intraspinal haematoma following lumbar epidural anaesthesia in a neonate. Paediatr Anaesth. 2001 Jan;11(1):105–8.
89. Gogarten W, Vandermeulen E, Van Aken H, Kozek S, Llau J V, Samama CM. Regional anaesthesia and antithrombotic agents: recommendations of the European Society of Anaesthesiology. Eur J Anaesthesiol. 2010 Dec;27(12):999–1015.
90. Breivik H, Bang U, Jalonen J, Vigfusson G, Alahuhta S, Lagerkranser M. Nordic guidelines for neuraxial blocks in disturbed haemostasis from the Scandinavian Society of Anaesthesiology and Intensive Care Medicine. Acta Anaesthesiol Scand. 2010 Jan;54(1):16–41.
91. Christie IW, McCabe S. Major complications of epidural analgesia after surgery: results of a six-year survey. Anaesthesia. 2007 Apr;62(4):335–41.
92. Cook TM, Counsell D, Wildsmith JAW. Major complications of central neuraxial block: report on the Third National Audit Project of the Royal College of Anaesthetists. Br J Anaesth.

2009 Feb;102(2):179–90.

93. Hammer GB, Ngo K, Macario A. A retrospective examination of regional plus general anesthesia in children undergoing open heart surgery. Anesth Analg. 2000 May;90(5):1020–4.
94. Peterson KL, DeCampli WM, Pike NA, Robbins RC, Reitz BA. A report of two hundred twenty cases of regional anesthesia in pediatric cardiac surgery. Anesth Analg. 2000 May;90(5):1014–9.
95. Horlocker TT, Wedel DJ, Benzon H, Brown DL, Enneking FK, Heit JA, et al. Regional anesthesia in the anticoagulated patient: defining the risks (the second ASRA Consensus Conference on Neuraxial Anesthesia and Anticoagulation). Reg Anesth Pain Med. 2003;28(3):172–97.
96. Green L, Machin SJ. Managing anticoagulated patients during neuraxial anaesthesia. Br J Haematol. 2010 Apr;149(2):195–208.
97. Horlocker TT, Heit JA. Low molecular weight heparin: biochemistry, pharmacology, perioperative prophylaxis regimens, and guidelines for regional anesthetic management. Anesth Analg. 1997 Oct;85(4):874–85.
98. Horlocker TT. Thromboprophylaxis and neuraxial anesthesia. Orthopedics. 2003 Feb;26(2 Suppl):s243-9.
99. Narouze S, Benzon HT, Provenzano DA, Buvanendran A, De Andres J, Deer TR, et al. Interventional spine and pain procedures in patients on antiplatelet and anticoagulant medications: guidelines from the American Society of Regional Anesthesia and Pain Medicine, the European Society of Regional Anaesthesia and Pain Therapy, the American . Reg Anesth Pain Med. 2015;40(3):182–212.
100. Neal JM, Barrington MJ, Brull R, Hadzic A, Hebl JR, Horlocker TT, et al. The Second ASRA Practice Advisory on Neurologic Complications Associated With Regional Anesthesia and Pain Medicine: Executive Summary 2015. Vol. 40, Regional anesthesia and pain medicine. United States; 2015. p. 401–30.
101. Llau J V, De Andres J, Gomar C, Gomez-Luque A, Hidalgo F, Torres LM. Anticlotting drugs and regional anaesthetic and analgesic techniques: comparative update of the safety recommendations. Eur J Anaesthesiol. 2007 May;24(5):387–98.
102. Dinsmore J, Nightingale J, Baker S. Delayed diagnosis of an epidural haematoma with a working epidural in situ. Vol. 61, Anaesthesia. England; 2006. p. 913–4.
103. Rowlingson JC, Hanson PB. Neuraxial anesthesia and low-molecular-weight heparin prophylaxis in major orthopedic surgery in the wake of the latest American Society of Regional Anesthesia guidelines. Anesth Analg. 2005 May;100(5):1482–8, table of contents.
104. Schug SA, Palmer GM, Scott DA, Halliwell R TJ. Acute Pain Management: Scientific

Evidence (4th edition). APM:SE Working Group of the Australian and New Zealand College of Anaesthetists and Faculty of Pain Medicine. 2015. 647 p.

105. Newall F, Barnes C, Ignjatovic V, Monagle P. Heparin-induced thrombocytopenia in children. J Paediatr Child Health. 2003;39(4):289–92.

11. Appendices

Appendix 1: Delphi Process Consensus Statements

Mechanical

- *Mechanical thromboprophylaxis should be used in post pubescent children who are/will be non-ambulant following major surgery*
    - *[Strongly agree or agree 75%, Disagree 13%, undecided 11%]*

Pharmacological

- *LMWH should commence within 6 hours of surgery in post pubescent children who are expected to be non-ambulant following major surgery*
    - *[Strongly agree or agree 48%, disagree 24%, undecided 27%]*

Mechanical and Pharmacological

- *Systemic AND mechanical thromboprophylaxis should commence prior to surgery in all post pubescent children unless contraindicated*
    - *[Agree 21%, undecided 31%, Disagree 47%]*

General Surgery

- *Thromboprophylaxis should be used in all children undergoing major surgery*
    - [Agree 20.4%, Undecided 16.7%, Disagree 79.7%]
- *Thromboprophylaxis should only be used in post pubescent children undergoing major surgery*
    - [Agree50.0%, Undecided 29.6%, Disagree 20.4%]
- *Thromboprophylaxis should be used in all children who are expected to be non-ambulant for more than 48 hours following major surgery*
    - [Agree 5.6%, Undecided 22.2%, Disagree 72.3%]
- *Thromboprophylaxis should only be used in post pubescent children who are expected to be non-ambulant for more than 48 hours following major surgery*
    - [Agree57.4%, Undecided 20.4%, Disagree 22.3%]
- *Thromboprophylaxis should be used in all stable children on bed rest for more than 48 hours following major blunt abdominal/thoracic trauma*
    - *[*Agree 1.9%, Undecided 39.9%, Disagree 59.2%]
- *Thromboprophylaxis should be used in stable post-pubescent children on bed rest more than 48 hours following major blunt abdominal/thoracic trauma*

- [Agree43.6%, Undecided 26.4%, Disagree 30.2*%]*
- *LMWH thromboprophylaxis should commence within 6 hours of surgery in children who are expected to be non-ambulant following major surgery*
  - *[*Agree3.7%, Undecided 35.2%, Disagree 61.1%]
- *LMWH thromboprophylaxis should commence within 6 hours of surgery in post pubescent children who are expected to be non-ambulant following major surgery*
  - [Agree48.1%, Undecided 27.8%, Disagree 24.1%]
- *LMWH thromboprophylaxis should commence at 24 hours in children who are expected to be non-ambulant following major abdominal/thoracic trauma*
  - *[*Agree5.6%, Undecided 37.0%, Disagree 57.4%]
- *LMWH thromboprophylaxis should commence at 24 hours in post pubescent children who are expected to be non-ambulant following major abdominal/thoracic trauma*
  - [Agree32.7%, Undecided 34.6%, Disagree 32.6%]
- *Mechanical thromboprophylaxis should be used in children who are/will be non-ambulant following major surgery/ major blunt abdominal/thoracic trauma*
  - *[*Agree 31.4%, Undecided 27.5%, Disagree 41.1%]
- *Mechanical thromboprophylaxis should be used in post-pubescent children who are/ will be non-ambulant following major surgery/ major blunt abdominal/thoracic trauma*
  - *[*Agree75.5%, Undecided 11.3%, Disagree 13.2%]
- *Mechanical thromboprophylaxis should be used during surgery in those children where the legs will be raised for longer than 2 hours*
  - *[*Agree 15.4%, Undecided 40.4%, Disagree 44*.2%]*
- *Mechanical thromboprophylaxis should NOT be used during surgery in those children where the legs will be raised for longer than 2 hours*
  - [Agree 22.7%, Undecided 47.2%, Disagree 30.2%]
- *Mechanical thromboprophylaxis should start before the operation in children who are expected to be non-ambulant for more than 48 hours following surgery*
  - *[*Agree 13.4%, Undecided 25.0%, Disagree 61.5%]
- *Mechanical thromboprophylaxis should start before the operation in post- pubescent children who are expected to be non-ambulant for more than 48 hours following surgery*
  - [Agree 50.0%, Undecided 15.4%, Disagree 34.6%]
- *Systemic AND mechanical thromboprohylaxis should commence prior to surgery in all children unless contraindicated*
  - [Agree 0.0%, Undecided 19.2%, Disagree 80.8%]
- *Systemic AND mechanical thromboprohylaxis should commence prior to surgery in all post pubescent children unless contraindicated*

- [Agree 21.5%, Undecided 31.4%, Disagree 47.0%]

- *I would commence systemic thromboprophylaxis at six hours following neuroblastoma excision*
  - [Agree 4.1%, Undecided 49.0%, Disagree 46.0%]
- *I would commence systemic thromboprophylaxis at six hours following excision of Wilm's tumour*
  - [Agree 6.3%,Undecided 41.7%,Disagree52.1%]

Orthopaedic Surgery

- *VTE prophylaxis is not required in pre-pubertal children with multiple injuries irrespective of their ISS*
  - [70% Strongly agreed or agreed 7.5% Disagreed]
- *VTE prophylaxis is not required in adolescent children with multiple injuries irrespective of their ISS*
  - [45% Strongly agree or agree 27.5% Undecided 27.5% Disagree]
- *Pre-pubertal children with an isolated head injury do not merit routine VTE prophylaxis*
  - [84.6% Strongly agree or agree 7.7% Disagree]
- *Adolescents with an isolated head injury do not merit routine VTE prophylaxis* Adolescent
  - [67.5% Strongly agree / agree 7.5% Disagree]
- *Lower limb fractures in isolation do not require VTE prophylaxis in prepubertal children*
  - *[97.4% Agree or strongly agree 2.6% strongly disagree]*
- *Lower limb fractures in isolation do not require VTE prophylaxis in adolescents*
  - *[92.5% Agree or strongly agree 5% disagree or strongly disagree]*
- *Pre-pubertal children with multiple limb fractures should receive VTE prophylaxis*
  - *[90% disagree 7.5% undecided 2.5% agree]*
- *Adolescent children with multiple limb fractures should receive VTE prophylaxis*
  - [47.5% disagree 25% undecided 27.5% agree]
- *Hip and Pelvic surgery in prepubertal children is not an indication for VTE prophylaxis?*
  - [97.5% agree or strongly agree 2.5% disagree]
- *Hip and Pelvic surgery in adolescent children is not an indication for VTE prophylaxis?*
  - [72.5% agree or strongly agree 17.5% undecided 10% disagree]
- *Spinal injury with paralysis is an indication for VTE prophylaxis in prepubertal children*
  - *[75% Disagree or strongly disagree 17.5% Undecided 5% Agreed]*
- *Spinal injury with paralysis is an indication for VTE prophylaxis in adolescent*

- *[62.5% Disagree or strongly disagree 25% Undecided 12.5% Agreed*

- *VTE prophylaxis is indicated in prepubertal children undergoing major spinal surgery e.g. scoliosis correction*
  - [59% disagree or strongly disagree 41% undecided]
- *VTE prophylaxis is indicated in adolescents undergoing major spinal surgery e.g. scoliosis correction*
  - [2.5% agree 52.5% undecided 45% disagree or strongly disagree]

- *The presence of obesity in prepubertal children would influence the decision to use VTE prophylaxis in procedures or scenarios already mentioned*
  - [10% agree, 15% undecided 75% disagree or strongly disagree]
- *The presence of obesity in prepubertal children would influence the decision to use VTE prophylaxis in procedures or scenarios already mentioned*
  - [45% agree or strongly agree 15% undecided 40% disagree or strongly disagree]