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SPECIAL INTEREST ARTICLE

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Prevention of perioperative venous thromboembolism in pediatric patients: Guidelines from the Association of Paediatric Anaesthetists of Great Britain and Ireland (APAGBI)

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Summary

The Association of Paediatric Anaesthetists of Great Britain and Ireland (APAGBI) Guidelines Working Group on Thromboprophylaxis in Children has reviewed the literature and where possible provided advice on the care of children in the perioperative period. Areas reviewed include the incidence of perioperative venous thromboembolism (VTE), risk factors, evidence for mechanical and chemical prophylaxis, and complications. Safe practice of regional anesthesia with anticoagulant prophylaxis is detailed. In summary, there are few areas of strong evidence. Routine prophylaxis cannot be recommended for young children. Postpubertal adolescents (approximately 13 years and over) are at a slightly increased risk of VTE and should be assessed for prophylaxis and may warrant intervention if other risk factors are present. However, the incidence of VTE is significantly lower than in the adult population. This special interest review presents a summary and discussion of the key recommendations, a decision-making algorithm and a risk assessment chart. For the full guideline, go to www.apagbi.org.uk/publications/apa-guidelines.

KEYWORDS
children, guidelines, pediatric, thromboprophylaxis, venous thromboembolism

1 | INTRODUCTION

The Association of Paediatric Anaesthetists of Great Britain and Ireland (APAGBI) Guidelines Working Group on Thromboprophylaxis in Children has reviewed the literature and where possible provided advice on the care of children in the perioperative period. Areas reviewed include the incidence of perioperative venous thromboembolism (VTE), risk factors, evidence for mechanical and chemical prophylaxis, and complications. Safe practice of regional anesthesia with anticoagulant prophylaxis was collated. This special interest review presents a summary and discussion of the key recommendations, a decision-making algorithm, and a risk assessment chart. The full guideline can be accessed and downloaded at www.apagbi.org.uk/publications/apa-guidelines.

Differences in the physiology of the coagulation system before puberty are reflected in the lower prevalence of VTE in children when compared with adults. 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 1-16 years have been shown to have a 25% lower ability to form thrombin compared with adults aged 20-45 years.[1]

National registry data suggest an incidence of 5-8 cases of symptomatic VTE per 10 000 hospital admissions (0.05%-0.08%).[2,3] The true incidence could be significantly higher as the majority of VTEs are clinically silent. More than 80% of pediatric VTE events occur in children with 1 or more risk factors (Table 1). There are 2 peaks in the incidence of VTE, 1 in infants less than 2 years old and the other at adolescence. In infants, VTE is most often associated with the use of central venous lines, sepsis, congenital disorders and malignancies. At adolescence, the physiology of the coagulation system matures and additional risk factors such as smoking, obesity, pregnancy, and estrogen-containing oral contraceptives become relevant. There is a 2:1 preponderance of females among adolescents who develop VTE.[4-6]

A multicenter study across the United States between 2001 and 2007 indicated a 70% increase in the diagnosis of VTE at children's hospitals to 58 per 10 000 admissions (0.58%). This may reflect the increased complexity of medical conditions and surgical procedures in pediatric patients in tertiary care hospitals.[7]

The Canadian registry recorded significant morbidity, with a recurrence rate of 8% and a rate of postphlebitis syndrome of 12%. Kuhle et al[8] reported an incidence of postthrombotic syndrome (a serious long-term problem resulting from damage to the deep vein valves and resulting in pain, swelling, discoloration, and ulceration of the affected limb) of 63%. Mortality ranged from 2.2% to 8.4% (all causes).[2,9]

TABLE 1 Risk factors for venous thromboembolism (VTE) in children

Age	Incidence of VTE highest if age <1 y or >13 y
Central venous line (CVL)	Present in >90% of neonatal VTE
	Present in >33% of other cases
	Risk highest if CVL in lower limb >subclavian >jugular
	Risk may be higher for PICC lines
Surgery	Present in 10%-15% of cases
Malignancy	Present in 25% of cases
	Doubles risk of VTE
	High risk with acute lymphoblastic leukemia
Infection/sepsis	Present in >33% cases
	May be related to presence of CVL
Major trauma/burns	Present in approximately 10% of cases
Drugs	Chemotherapy, eg, aspariginase
	Estrogen contraceptive pill (3-fold increase in risk)
	Parenteral nutrition (may be related to presence of CVL)
Immobility	Present in 25% of cases of prolonged bed rest
Pregnancy	2-fold increase
Congenital thrombophilia	Factor V Leiden
	Antithrombin III deficiency
	Protein C/S deficiency
	Increased F VIII
Acquired thrombophilia	Nephrotic syndrome
	Antiphospholipid syndrome
	Connective tissue disease
Obesity	Increased incidence of VTE
Cardiac disease	Congenital heart disease and its surgery
Inflammatory bowel disease	Ulcerative colitis greater than Crohn's disease
Sickle cell disease	

2 | METHOD OF GUIDELINE DEVELOPMENT (SEE SECTIONS 3 AND 11 OF FULL GUIDELINES)

The Association of Paediatric Anaesthetists of Great Britain and Ireland convened a working group to develop advice on thromboprpohylaxis in children. The key questions are listed in Table 2. A systematic literature review was carried out for evidence in Medline, Embase, Cinhal, and the Cochrane library. This was supplemented by material identified by the individual members of the group. Any relevant current adult and pediatric guidelines were also reviewed including those from the Scottish Intercollegiate Guidelines Network (SIGN), the National Institute for Health and Care Excellence (NICE), the American College of Chest Physicians (ACCP), and the British Society of Clinical Haematology (BSCH).[10-13] The evidence was assessed where possible using SIGN methodology[11] to grade the recommendations (see Table 3). 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. There were many areas lacking evidence for VTE prophylaxis in children and so a list of consensus statements was drawn up by the working group with sections on risks, prophylaxis, pediatric surgery, orthopedics, and trauma. Each section was circulated to the relevant peer group via the APAGBI, British Association of Paediatric Surgeons, British Society for Children's Orthopaedic Surgery, and British Society of Haematology. A Delphi questionnaire was used to assess levels of agreement with the consensus statements. A final draft was submitted to the APAGBI Council for editorial input and quality checks.

3 | RESULTS OF EVIDENCE SYNTHESIS

Evidence to support routine prophylaxis in under 13 year olds undergoing surgery was lacking and therefore cannot be recommended even for major general or orthopedic surgery. Where there were areas of concern or in higher risk patients, we have tried to present the evidence and a recommendation. The majority of the available evidence was evaluated as level 2 in the adult literature but level 3 or 4 in children and thus the usual grade of recommendation was D.

TABLE 2 Key questions addressed by APAGBI Guidelines Working Group on Thromboprophylaxis in Children

What is the incidence of VTE in children?
Which age groups (excluding neonates) are at risk of VTE?
What are the main risks factors in terms of patient characteristics and types of operation or injury?
What is the evidence for efficacy of different types of thromboprophylaxis in children?
What is the evidence for and against thromboprophylaxis in children?
What is the evidence of the risks of thromboprophylaxis (especially bleeding, osteoporosis, and heparin induced thrombocytopenia
What is safe practice of regional anesthesia when anticoagulant prophylaxis is used?

TABLE 3 SIGN levels of evidence and grades of recommendation

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 derived from professional consensus process

Good practice points were added where clinical consensus suggested best practice. A risk assessment algorithm to guide decision-making was developed (Figure 1), dosing schedules for low molecular weight heparin were summarized (Table 4), and a risk assessment checklist for adolescent patients age 13 years + was constructed (Table 5).

4 | THROMBOPROPHYLAXIS: SPECIAL GROUPS AND CONSIDERATIONS (SEE SECTION 6 OF FULL GUIDELINES)

4.1 | Surgical patients

Reconstructive hip surgery represents a significant proportion of children's orthopedics. 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 recognized 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.[14]

TABLE 4 Low molecular weight heparin dosing in children by weight or age

Enoxaparin			
<5 kg or <2 mo	0.75 mg kg^{-1}	Subcutaneous	12 hourly
5-45 kg or 2 mo+	0.5 mg kg^{-1}	Subcutaneous	12 hourly
>45 kg	40 mg	Subcutaneous	Once daily
Tinzaparin			
>1 mo	50 units kg^{-1}	Subcutaneous	Once daily

Elective spinal surgery in children is mostly to correct scoliosis but there is no consensus among spinal surgeons regarding VTE prophylaxis. In a survey of Scandinavian scoliosis centers between 1963 and 1976, deep venous thrombosis was reported in 8 of 1229 cases (0.65%)[15] with only 3 cases between age 15 and 18 years. In a recent article, 40 successive pubertally mature adolescents undergoing posterior spinal instrumentation for nonsyndromic scoliosis underwent regular ultrasonography to look for deep venous thrombosis. Two minor transient thromboses were identified which resolved spontaneously. Although a small, unique study, the authors concluded that prophylaxis should not be recommended.[16]

4.2 | Trauma patients

Up to 50% of adults with trauma may develop deep venous thrombosis and 0.5%-10% may develop pulmonary embolism.[17] 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 will be asymptomatic.[18-21] It has been suggested that minor pulmonary embolism may be a lot more common in children than is currently appreciated.[22] Patients with inherited thrombophilic defects do present following trauma and, in the 3 cases of VTE reported in 158 injured children by Ozyurek et al[23], 2 had a factor V Leiden mutation. Clearly where there is a family history of an inherited thrombophilic defect the risks for VTE are increased.

4.3 | Age

Age is an important modulator of the incidence of VTE in children subjected to injury. An overall incidence of 0.08% has been reported in 58 716 pediatric patients from the USA.[18] When stratified for age, the incidence was 0.02% at age <5 years, 0.04% at age 5-9 years, and 0.13% at age 10-15 years. In a 10-year survey from a single-level, 1 trauma center,[24] there were no cases reported in 1192 children age <13 years with 2/1021 (0.2%) at age 13-17 years. Thus, they suggested that the risk for VTE in children <13 years is negligible. This is supported by a further survey in a level 1 trauma center in which there were 3 cases of VTE in 2746 pediatric trauma cases (0.1%) all of whom were >14 years.[25] More recent surveys have reported higher incidence of VTE with figures from the American National trauma data bank suggesting incidences of 0.1% in

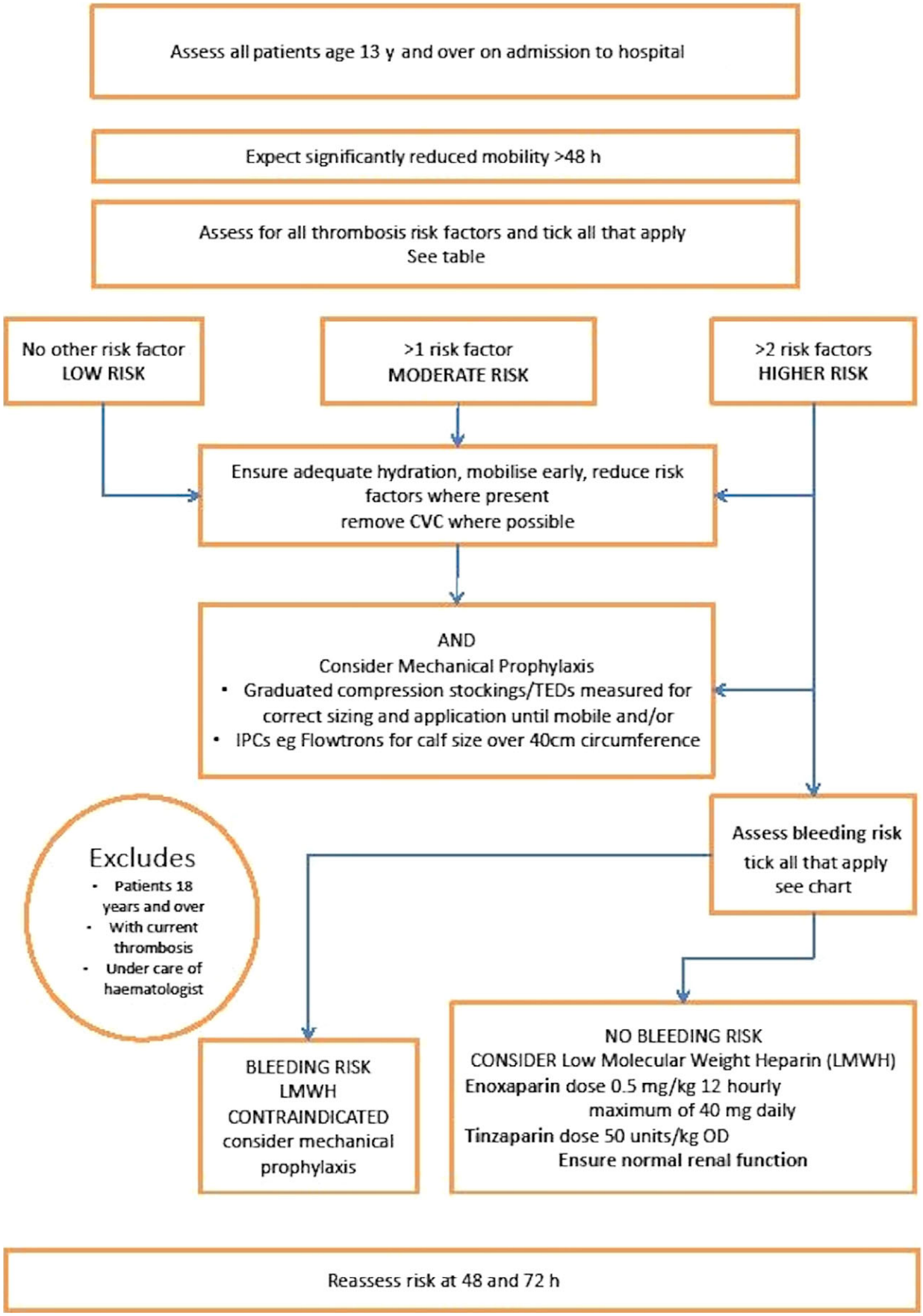

FIGURE 1 Decision-making algorithm for thromboprophylaxis in children [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 5 Risk assessment form for venous thromboembolism (VTE) for adolescents age 13 years +

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 :**			

children <12 years of age, 0.3% in 13- to 15-year olds, and 0.8% in children over age 16 years.[26] The critical age remains a matter for debate as demonstrated by a guideline constructed from available literature by the American Paediatric Trauma Society and Eastern Association for the Surgery of Trauma who concluded that 15 years was the watershed age.[27] It would thus seem appropriate to subdivide children into preadolescent and adolescent. The exact age at which this transition occurs varies widely but it would seem reasonable to take 13 years as an appropriate age at which to make this distinction.

4.4 | Injury Severity Score

The Injury Severity Score (ISS) is used in many articles as an identifiable risk factor for VTE. The Injury Severity Score (ISS) is an anatomical scoring system that provides an overall score for patients with multiple injuries. Each injury is assigned an Abbreviated Injury Scale (AIS) score and is allocated to 1 of 6 body regions (Head, Face, Chest, Abdomen, Extremities (including Pelvis), and External). Only the highest AIS score in each body region is used. The 3 most severely injured body regions have their score squared and added together to produce the ISS score. The maximum ISS score is 75.

In a 3-year survey of pediatric intensive care admissions at 2 Canadian trauma centers, VTE was found in 11/3291 (0.33%) admissions.[19] An ISS>9 was identified as a significant risk factor for VTE (OR 5.3, 95% CI: [1.6 to 17.3]). In an audit of 58 716 patients treated in nonspecialist trauma centers, 45 cases of VTE were reported (0.08%) with a mean ISS of 17.1 in patients with VTE compared with a mean ISS of 8.5 in those without VTE.[18] In 28 692 trauma victims up to the age of 19 years, 2 cases of pulmonary embolism were observed both of whom had ISS >25.[17] Similarly in the 3 VTEs observed in 3637 patients by Truitt et al, all had an ISS >25 and the 2 adolescents reported by Azu et al in his survey of 1021 cases both had an ISS of >24.[24,28] In a recent review, The Pediatric Trauma Society and Eastern Association for the Surgery of Trauma identified an ISS >25 as a significant risk factor.[27]

4.5 | Isolated fractures

In children with isolated fractures, 2.5 cases of VTE were observed per 1000 patients (0.25%) (relative risk 3.8), compared with 3.2/1000 (0.32%) in pelvic injuries (relative risk 4.4).[25] Internal fixation of lower limb fractures is often quoted as a risk factor for VTE[18] but there is no specific information regarding which procedures are a particular risk.

4.6 | Burns

Burns are often associated with multiple other injuries which increases VTE risk.[12] Prospective studies have shown an incidence of symptomatic VTE of 2.4%, and asymptomatic VTE of 23% on screening.[29,30] Increased total body surface area of burn increases VTE risk, as does the presence of central venous catheters, wound infection, and increased body weight.[29,31-34] Most evidence pertains to adults.[35,36] Where adolescents are extensively injured with >20% burns, consideration of an increased risk of thrombosis may be warranted and prophylaxis should be considered.

4.7 | Central venous catheters

Central venous catheters are the commonest risk factor associated with pediatric VTE and should be removed as early as possible when no longer required. Catheter placement in the internal jugular vein is associated with a lower risk of thrombosis than the subclavian or femoral sites. PICC lines may present a higher risk but this is hard to quantify based on current evidence.

5 | METHODS OF PROPHYLAXIS (SEE SECTION 5 OF FULL GUIDELINES)

5.1 | Mechanical prophylaxis

No pediatric sizes of antiembolism stockings or intermittent pressure compression boots are available. Their use therefore is limited to older and larger children, teenagers, and those weighing >40 kg. Standard size calf intermittent pressure compression boots are effective in those with a calf circumference of up to 43 cm. Accurate measurement and safe fitting of stockings are paramount and correct wearing should be monitored regularly.[10,37] Poorly fitted or worn stockings could produce a tourniquet effect and increase the risk of thrombosis.[11,38] The top must not be rolled down, which is more likely to occur with thigh length stockings.[39] They should be removed daily for hygiene and skin inspection purposes. Contraindications include massive leg edema or pulmonary edema (congestive heart failure), severe peripheral vascular disease or neuropathy, any local condition which could be exacerbated by the intermittent pressure compression boots (eg, dermatitis, recent skin graft/poor tissue viability, leg wound infection), and extreme leg deformity.

5.2 | Pharmacological prophylaxis

Low molecular weight heparins have become the mainstay of treatment and pharmacological prophylaxis in both adults and children. They offer several potential benefits over unfractionated heparin 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.[40,41] There is less heparin-induced thrombocytopenia and osteoporosis.[40,42,43] Low molecular weight heparin has been shown to be as effective as an anticoagulant in VTE as unfractionated heparin.[44,45] Studies have shown a variable dose 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.[43] In a retrospective study of 87 treatment courses and 60 courses of prophylaxis of enoxaparin, the conclusion was that neither dose nor anti-Xa level predicted treatment success and therefore suggested caution in using anti-Xa levels as a guide for therapeutic dosing in children.[46]

The REVIVE study was the first randomized controlled trial comparing low molecular weight heparin (reviparin-sodium) with unfractionated heparin for VTE treatment in children and, although

underpowered, did show a better safety profile for low molecular weight heparin.[40] The bleeding rate for treatment was 9.2% as was the rate of recurrence of VTE. Studies of prophylactic dosing in children have not noted bleeding. Dose finding studies have shown that newborn infants have an increased dose requirement for low molecular weight heparin.[40] 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[47] also demonstrated significant variation in dosing requirements for children less than 5 years of age. Schobess et al[48] looked at once and twice daily dosing in children and found no difference in efficacy. 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 40 kg, once daily dosing may be simpler, better tolerated, and sensible especially when regional anesthesia techniques are to be used. Dosing for low molecular weight heparins in children is given in Table 2. Low molecular weight heparins are excreted via the renal system and so reduced clearance occurs with renal impairment.[49] The dose and time interval will need adjusting in those patients with altered creatinine clearance and these patients should be discussed with a hematology specialist. Anti-Xa trough levels may need closer monitoring to ensure clearance and therefore safety. The target range for anti-Xa is not well defined for efficacy but taken as 0.1-0.4 Units mL^{-1}.[49,50] Administration is via a low dead space subcutaneous catheter (eg, Insuflon™) to reduce the number of needle sticks.

Combining mechanical and pharmacological prophylaxis lowers the overall risk of VTE compared with either single modality alone.[51-53]

5.3 | Adverse Effects of Pharmacological Prophylaxis

In prophylactic trials in adults, there was no detectable increase in bleeding from the use of low molecular weight heparin. In a prospective cohort study of low molecular weight heparin in pediatric patients, 146 courses of therapeutic low molecular weight heparin and 31 courses for prophylaxis were administered. They found no major bleeds and 2 minor bleeds at the Insuflon™ site in the prophylaxis group.[43] Severe heparin-induced thrombocytopenia 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 heparin-induced thrombocytopenia 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 low molecular weight heparin.[9,54]

We could find no evidence in the literature regarding osteoporosis associated with the prophylactic use of low molecular weight heparin in children.

6 | SAFE PRACTICE OF REGIONAL ANESTHESIA AND ANTICOAGULANT PROPHYLAXIS (SEE SECTION 7 OF FULL GUIDELINES)

The use of low molecular weight heparin thromboprophylaxis in patients at risk is not a contraindication to the performance of neuraxial anesthesia in the absence of a coagulopathy. Timing must be carefully planned in relation to low molecular weight heparin administration. The placement of a needle or epidural catheter, or removal or repositioning of the catheter should occur at least 12 hours after standard prophylactic low molecular weight heparin doses. If a bloody tap occurs during needle or catheter placement, low molecular weight heparin should be delayed for 24 hours. In patients with indwelling catheters, it is recommended that the first dose of low molecular weight heparin 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 low molecular weight heparin. Those on twice daily dosing, 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 low molecular weight heparin should be given at least 4 hours after the removal of the epidural catheter. In patients with an epidural indwelling catheter on low molecular weight heparin thromboprophylaxis, concomitant treatment with drugs that affect hemostasis (eg, NSAIDs) or antiplatelet medication should be used with caution. Any patient with an epidural infusion presenting significant leg weakness should have the epidural infusion stopped and no further low molecular weight heparin until recovery. If there is no recovery of leg strength within 4 hours, a MRI scan should be performed to exclude spinal hematoma.

Bleeding may be the most serious complication of nonneuraxial regional techniques in the anticoagulated patient. Therefore, in high-risk procedures, the same advice on timing of low molecular weight heparin and performance of the regional anesthesia technique (including insertion and removal of plexus catheters) should be applied.

7 | CONCLUSIONS

Although the evidence base for current practice of perioperative thromboprophylaxis in children is of low quality, we think it has been possible to bring together useful information to guide safe practice. We hope the decision-making algorithm and risk assessment form will be of practical use and the key recommendations will help improve the perioperative care of children.

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ETHICAL APPROVAL

No ethics approval was required for the writing of this guideline.

CONFLICT OF INTEREST

The authors report no conflict of interest.

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APPENDIX 1

KEY RECOMMENDATIONS (FOR THE FULL GUIDELINE GO TO WWW.APAGBI.ORG.UK/PUBLICATIONS/APA-GUIDELINES)

1. Risk assessment (Table 4) (see section 4 of full guideline)
   - **1.1.** Most pediatric surgical patients do not require thromboprophylaxis. (Good Practice Point)
   - **1.2.** The risk of developing VTE should be assessed on admission to hospital, prior to any operative procedure and throughout the inpatient stay. (Good Practice Point)
   - **1.3.** This assessment should focus on adolescents (>13 years) particularly those with 1 or more risk factor who are or will be immobile during their inpatient stay. (Good Practice Point)
   - **1.4.** Prophylactic measures should be used to prevent VTE in those considered at risk. (Grade C recommendation)
2. Methods of venous thromboembolism (VTE) prophylaxis (see section 5 of full guideline)
   - **2.1.** Early mobilization and good hydration should be encouraged in all immobilized patients. (Good Practice Point)
   - **2.2.** The use of mechanical methods (intermittent pressure compression boots and antiembolism stockings) for VTE risk reduction should be considered in at risk children age 13 years and over where size is appropriate. (Grade C recommendation)
   - **2.3.** Antiembolism stockings reduce VTE in surgical patients and are recommended where size is appropriate. Antiembolism stockings are only useful in children or adolescents who weigh >40 kg. (Grade B recommendation)
   - **2.4.** Intermittent pneumatic compression (IPC) devices are effective and recommended for intraoperative use in children age 13 years and over who weigh >40 kg and who are expected to have surgery lasting >60 minutes. (Grade B recommendation)
   - **2.5.** Antiembolism stockings may be combined with pharmacological prophylaxis or intermittent pneumatic compression in surgical patients, to increase efficacy of prophylaxis against deep vein thrombosis. (Grade D recommendation)
   - **2.6.** Children age 13 years and over with multiple risk factors for thrombosis should be considered for thromboprophylaxis with LMWH (Grade C recommendation)
   - **2.7.** In postpubertal 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. (Good Practice Point)

3. Central Venous Catheters (see section 4.1 of full guideline)

   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. (Good Practice Point)
   3.2. Catheter placement in the Internal jugular vein is associated with a lower risk of thrombosis (Grade B recommendation)

4. Surgery, Orthopedics and Trauma (see section 6 of full guideline)

   4.1. Prophylaxis is not normally necessary in prepubertal children, even after major surgery in the absence of other risk factors for VTE. (Good Practice Point)
   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. (Grade D recommendation)
   4.3. In postpubertal children undergoing major surgery preventing early mobilization, mechanical prophylaxis should be considered. (Good Practice Point)
   4.4. In patients with multiple other risk factors for VTE, LMWH prophylaxis should be considered. (Good Practice Point)

5. Burns (see section 6.4 of full guideline)

   5.1. There is no evidence for routine prophylaxis in children. (Good Practice Point)
   5.2. Adolescents with extensive injury and an increased risk of thrombosis may be considered for prophylaxis. (Grade D recommendation)

6. Regional Anesthesia and Anticoagulant Prophylaxis (see section 7 of full guideline)

   6.1. The use of LMWH (low molecular weight heparin) thromboprophylaxis in patients at risk is not a contraindication to the performance of neuraxial anesthesia in the absence of a coagulopathy. Timing must be carefully planned in relation to LMWH administration. (Grade D recommendation)
   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. (Good Practice Point)
   6.3. If a bloody tap occurs during needle or catheter placement, LMWH should be delayed for 24 hours. (Grade D recommendation)
   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. (Good Practice Point)
   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. (Grade D recommendation)
   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. (Good Practice Point)
   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. (Good Practice Point)
   6.8. In patients with an epidural indwelling catheter, on LMWH thromboprophylaxis, concomitant treatment with drugs that affect hemostasis (eg, NSAIDs) or antiplatelet medication should be used with caution. (Good Practice Point)
   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 hematoma. (Good Practice Point)

7. Nonneuraxial Blocks (see section 7.3 of full guideline)

   7.1. Bleeding may be the most serious complication of nonneuraxial 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 anesthesia technique, including insertion and removal of plexus catheters, should be applied. (Good Practice Point)

8. Screening (see section 4.3 of full guideline)

   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 (Grade A recommendation)

A flowchart to guide the decision-making process is provided (see Figure 1) and a risk assessment form (see Table 5) for VTE in adolescents age 13 years + based upon the NICE guidelines[8] can be completed and included in the patient's case records.