CLINICAL REPORT Guidance for the Clinician in Rendering Pediatric Care

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™

# Evaluation for Bleeding Disorders in Suspected Child Abuse

James Anderst, MD, MSCI, FAAP,[a] Shannon L. Carpenter, MD, MS, FAAP,[b] Thomas C. Abshire, MD,[c] Emily Killough, MD, FAAP,[a] AAP SECTION ON HEMATOLOGY/ONCOLOGY, THE AMERICAN SOCIETY OF PEDIATRIC HEMATOLOGY/ONCOLOGY, THE AAP COUNCIL ON CHILD ABUSE AND NEGLECT

Bruising or bleeding in a child can raise the concern for child abuse. Assessing whether the findings are the result of trauma and/or whether the child has a bleeding disorder is critical. Many bleeding disorders are rare, and not every child with bruising/bleeding that may raise a concern for abuse requires an evaluation for bleeding disorders. However, in some instances, bleeding disorders can present in a manner similar to child abuse. Bleeding disorders cannot be ruled out solely on the basis of patient and family history, no matter how extensive. The history and clinical evaluation can be used to determine the necessity of an evaluation for a possible bleeding disorder, and prevalence and known clinical presentations of individual bleeding disorders can be used to guide the extent of laboratory testing. This clinical report provides guidance to pediatricians and other clinicians regarding the evaluation for bleeding disorders when child abuse is suspected.

## STATEMENT OF PROBLEM

Significant variability exists in the evaluation of suspected child abuse, including the evaluation for bleeding disorders.[1–4] The purpose of this clinical report is to reduce variability by providing guidance to pediatricians and other clinicians regarding the evaluation for bleeding disorders when suspicious bruising or intracranial hemorrhage (ICH) is present (Fig 1).

## NEW INFORMATION

On the basis of recent data, this clinical report provides updated recommendations for:

1. Evaluating bleeding disorders in suspected child abuse (Fig 1);
2. Identifying bruising that is suspicious for child abuse;

## abstract

[a]*Division of Child Adversity and Resilience, Children's Mercy Hospital, Department of Pediatrics, University of Missouri Kansas City School of Medicine, Kansas City, Missouri;* [b]*Division of Hematology/Oncology/BMT, Children's Mercy Hospital, Department of Pediatrics, University of Missouri Kansas City School of Medicine, Kansas City, Missouri; and* [c]*Senior Investigator Emeritus, Versiti Blood Research Institute, Department of Pediatrics, Medicine, and the CT SI of Southeast Wisconsin, Emeritus, Medical College of Wisconsin, Milwaukee, Wisconsin*

*Drs Anderst and Killough created the initial and subsequent drafts of the document; Drs Carpenter and Abshire provided editing to the initial and subsequent drafts; and all authors conceptualized and outlined the manuscript.*



**DOI:** https://doi.org/10.1542/peds.2022-059276

**To cite:** Anderst J, Carpenter SL, Abshire TC; AAP Section on Hematology/Oncology, American Society of Pediatric Hematology/Oncology, AAP Council on Child Abuse And Neglect. Evaluation for Bleeding Disorders in Suspected Child Abuse. *Pediatrics*. 2022;150(4):e2022059276

3. Identifying bruising that may commonly be seen in children with congenital bleeding disorders;
4. Testing for factor XIII deficiency in children with ICH;
5. Testing for deficiencies of factor VIII and factor IX in children with subdural hemorrhage (SDH) on the basis of history of trauma;
6. Testing for deficiencies of factor VIII and factor IX in females; and
7. The utility of whole blood-clotting assays for testing for bleeding disorders.

## INTRODUCTION

Children often present for medical care with bleeding or bruising that can raise a concern for child abuse. Most commonly, this occurs with cutaneous bruises and ICH, particularly SDH, but other presentations, such as hematemesis,[5] hematochezia,[6] and oronasal bleeding can be caused by child abuse and/or bleeding disorders.[7–9] When bleeding or bruising is suspicious for child abuse, careful consideration of medical and nonmedical causes is important. Mistaken diagnosis, whether an inappropriate finding of abuse, a missed case of abuse, or overlooking of a medical cause, can cause harm to the child and his or her family.[10–13] Infants, in particular, are at high risk of abusive bruising/bleeding; however, bleeding disorders may also present in infancy in a similar manner to abusive bruising or bleeding.[13–18]

The patient's medical and family history of bleeding/bruising, no matter how thorough, cannot completely eliminate a bleeding disorder as the cause of a patient's findings.[19,20] For instance, male infants who have had a circumcision with no significant bleeding issues may still have a bleeding disorder.[21] As such, laboratory evaluations are often necessary to detect bleeding disorders. However, the presence of a bleeding disorder does not rule out abuse as the etiology for bruising or bleeding. Similarly, the presence of a history of trauma (accidental or nonaccidental) does not exclude the presence of a bleeding disorder or other medical condition.

## RECOMMENDED EVALUATION FOR BLEEDING DISORDERS IN SUSPECTED CHILD ABUSE: SCIENTIFIC RATIONALE AND SUPPORTING EVIDENCE

Recommendations in this report are based on data summarized in the accompanying technical report.[22]

To determine the need for testing for bleeding disorders in children with suspicious bruising, recommendations are based on evidence that distinguishes accidental bruising from abusive bruising in children without bleeding disorders and evidence that characterizes bruising in children with congenital bleeding disorders. For suspicious bruising, the testing strategy was determined by the prevalence of the bleeding disorder. For suspicious ICH, the

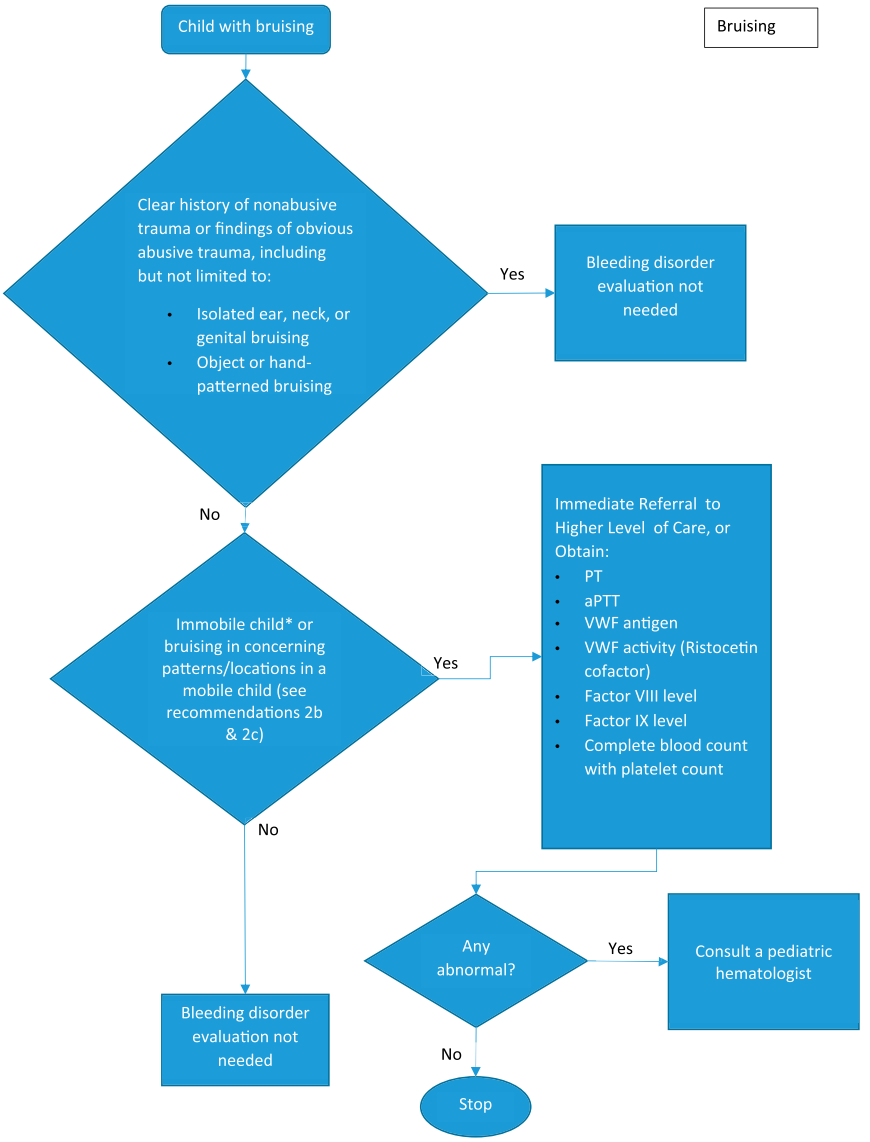


**FIGURE 1**
Recommended pathway for evaluation of possible bleeding disorders when child abuse is suspected. *Child with age or developmentally related immobility.

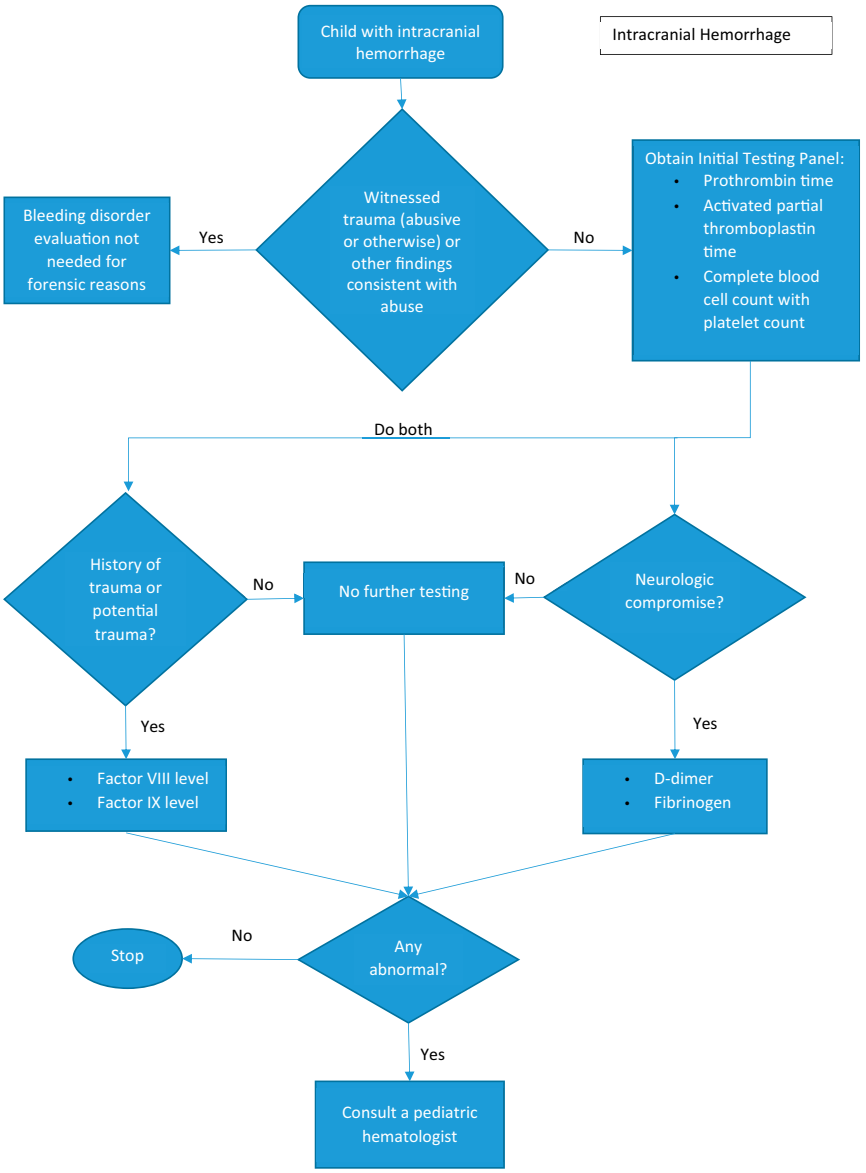


**FIGURE 1**
Continued.

recommended testing strategy was based on the prevalence of specific bleeding disorders and evidence detailing the probability of ICH and, if possible, SDH, in certain clinical situations.

## CHILD MEDICAL AND FAMILY HISTORY

Recommendation 1: If a child has bruising/bleeding concerning for abuse, a thorough medical history of the child and family history should be obtained. However, the lack of a history of bruising/bleeding symptoms does not rule out the possibility of a bleeding disorder.[19–21]

Although a medical history of signs suggestive of a bleeding disorder, such as significant bleeding after a circumcision or other surgery, epistaxis, bleeding from the umbilical stump, or excessive bleeding after dental procedures, increases the possibility of a bleeding disorder, the absence of such a history does not rule out the presence of a bleeding disorder. If there is a family history of a specific bleeding disorder, testing for that specific disorder should be completed. Additionally, certain bleeding disorders have higher prevalence within specific populations, which may guide testing. Caregivers might state that their child "bruises easily." These statements are difficult to assess during an evaluation for possible abuse because they can be a sign of a bleeding disorder, a reflection of the child's (fair) skin tone, or a falsification to mask abuse. If children can provide a history, such a history should be obtained from them away from potential offending caregivers, if possible.

The child's medications should be documented, because certain drugs, such as nonsteroidal antiinflammatory drugs, some antibiotics, antiepileptics, and herbal medications, can affect the results of some tests that might be used to detect bleeding disorders, such as the platelet function analyzer (PFA-100 [Siemens Healthcare Diagnostics, Tarrytown, NY]) and platelet aggregation testing. In addition to bleeding disorders, the possibility of other medical causes of easy bruising or bleeding, such as Ehlers-Danlos syndrome, scurvy, cancer and other bone marrow infiltrative disorders, glutaric aciduria, and arteriovenous malformations, should be considered, as should a history of use of any restrictive or unusual diets, ingestions, or alternative therapies that may increase the likelihood of bleeding/bruising. Comprehensive descriptions of medical conditions that could be confused with child abuse and alternative therapies that may predispose to bleeding/bruising are beyond the scope of this report and can be found elsewhere.[23–26]

## ASSESSING THE NEED FOR AN EVALUATION FOR BLEEDING DISORDERS: BRUISING AND ICH

### Bruising

Recommendation 2: If a child has bruising that is concerning for abuse, the assessment of the need for laboratory testing for bleeding disorders should focus on:

- the specific history offered to explain the bruising;
- the location and pattern of bruising; and
- mobility and developmental status of the child.[13,17,27–30]

Any bleeding disorder can cause cutaneous bruising, and sometimes this bruising can be mild, can appear in locations that are considered suspicious for abuse,[18] and can appear at any age. Children with inherited bleeding disorders have more and larger bruises than children without bleeding disorders.[16]

Recommendation 2a: If a child has any of the following factors, then an evaluation for a bleeding disorder is generally not needed:

- the caregivers' description of trauma sufficiently explains the bruising;
- the child or an independent witness can provide a history of abuse or nonabusive trauma that explains the bruising;
- object or hand-patterned bruising is present (highly consistent with abuse); or
- bruising to the ears, neck, or genitals (highly consistent with abuse).[16,17,27,29,30]

Clinicians should consider that the injury history offered by caregivers might be purposefully misleading if the caregivers have caused the bruising by abusive means. In some cases, the constellation of findings, taken in conjunction with the clinical history and physical examination, can be so strongly consistent with an abusive injury that further laboratory investigation for medical conditions is not warranted. For instance, a child with a patterned slap mark who describes being hit with an open hand does not require a laboratory evaluation for a bleeding disorder.

Recommendation 2b: If a nonmobile child has bruising, and there is no history of an independently witnessed accidental cause or a known medical cause, an evaluation for bleeding disorders should be conducted simultaneous to a child abuse evaluation.[13,14,17,18,27,29]

Any bruising in a nonmobile child is highly concerning for abuse. Additionally, bruising in a young infant could also be the first presentation of a bleeding disorder. As such, in young infants or children with developmental delays with minimal or no mobility, who present with bruising, it is recommended that an evaluation for bleeding disorders occur simultaneous to an abuse evaluation. In nonmobile children, bleeding disorders can present with bruising or petechiae in sites of normal handling or pressure. Examples of this include:

- petechiae at clothing line pressure sites;
- bruising at sites of object pressure, such as in the pattern and location of infant seat fasteners; and
- excessive diffuse bruising/bleeding if the child has a severe bleeding disorder.

Absence of these examples does not rule out a bleeding disorder; however, their presence might increase the probability of a bleeding disorder.

Recommendation 2c: If a mobile child has bruising, then the possibility of abuse should be assessed using the locations and patterns of the bruising (Table 1).

In mobile children, bleeding disorders can cause bruising in areas generally considered suspicious for abuse, such as the buttocks or torso. Bruising to the ears, neck, or genitals is rarely seen in either accidental injuries or in children with bleeding disorders and is highly concerning for abuse.[16,17,27,29,30]

**TABLE 1** Suspicion of Child Abuse in Ambulatory Children on the Basis of Characteristics of Bruises[16,17,27–30,43]

| Less Suspicious for Child Abuse | More Suspicious for Child Abuse |
|---|---|
| Forehead/nose/chin (facial T) | Location |
| Elbows | Cheeks |
| Lower arms | Angle of the jaw |
| Hips | Ears |
| Shins | Neck |
| Ankles | Upper arms |
| | Torso |
| | Hands |
| | Genitalia |
| | Buttocks |
| | Pattern |
| | Slap or hand marks |
| | Object marks |
| | Bite marks |
| | Bruises in clusters |
| | Multiple bruises of uniform shape |
| | Large cumulative size of bruising |
| | Petechial bruising[a] |

[a] Petechial bruising may also be suggestive of a bleeding disorder, particularly platelet function disorders.

### ICH

Recommendation 3: If a child has ICH concerning for abuse, then an evaluation for bleeding disorders should be conducted (see Recommendation 9). Exceptions to required evaluation can include:

- independently witnessed or verifiable trauma (abusive or nonabusive); or
- other findings consistent with abuse, such as fractures, burns, or internal abdominal trauma.

The decision to conduct an evaluation for bleeding disorders can be made on a case-by-case basis depending on case specific factors. Excepting obvious known trauma, ICH, particularly SDH, in a nonmobile child is highly concerning for child abuse.

Children can suffer ICH, such as a small SDH or an epidural hematoma underlying a site of impact, from a short fall. However, short falls rarely result in significant brain injury.[31] Birth trauma and some medical conditions can also result in ICH, including SDH, in infants. No studies have systematically compared the presentation, clinical findings, patterns or locations of ICH, or presence of retinal hemorrhages found in children with bleeding disorders to those found in children in whom abusive head trauma (AHT) is diagnosed. However, bleeding disorders can cause ICH in any part of the cranial contents and can cause spontaneous ICH, including SDH.[15] Up to 12% of children and young adults with bleeding disorders have had ICH (traumatic, spontaneous, or otherwise) at some time.[32,33]

### Other Bleeding Symptoms

Recommendation 4: Children with conditions such as hematemesis, hematochezia, or oronasal bleeding as presenting signs should be evaluated on a case-by-case basis for possible abuse.

Caregiver-fabricated illness in a child, inflicted trauma, and/or medical conditions can cause any of these findings. A hematologist may be consulted to determine the necessity of an evaluation for bleeding disorders in a specific circumstance.

## LABORATORY TESTS FOR BLEEDING DISORDERS

Recommendation 5: If performing tests for bleeding disorders in a child who has findings concerning for abuse, tests should be chosen on the basis of their ability to detect specific bleeding disorders that may cause the findings. Whole blood clotting assays, such as the thromboelastograph or rotational thromboelastography, should not be used as part of a testing strategy for bleeding disorders in the setting of possible abuse. Bleeding time is not a helpful test for diagnosing specific bleeding disorders.[22]

Bleeding disorders that can produce patterns of bruising or bleeding that may mimic abuse include coagulation factor deficiencies/abnormalities, fibrinolytic defects, defects of fibrinogen, and platelet disorders. Table 2 contains a listing of the most common bleeding disorders in children and characteristics of potential testing strategies for each disorder. Most factor deficiencies can be detected by the prothrombin time (PT) and activated partial thromboplastin time (aPTT). However, von Willebrand disease (VWD) and factor XIII deficiency are not reliably detected by these tests. Additionally, mild deficiencies in factor VIII or factor IX (mild hemophilia) might not cause abnormalities in the aPTT, and, if testing for these conditions is desired, a specific factor level is necessary. Fibrinolytic defects can cause significant bleeding/bruising but are extremely rare and require specific testing. Defects of fibrinogen are also rare and can be detected by the fibrinogen concentration and thrombin time.

Mild platelet disorders are those that typically result in mild mucocutaneous bleeding/bruising, menorrhagia, and/or postsurgical bleeding.[22] The prevalence of mild platelet disorders is unknown, and testing for mild platelet disorders is challenging. The most common clinical presentations include bruising and mucocutaneous bleeding. The prevalence of ICH in mild platelet disorders is unknown but is likely to be low. Platelet aggregation testing, best performed by a specialized laboratory and interpreted by a pediatric hematologist, requires a relatively large volume of blood.[34] A PFA-100 can evaluate for many platelet function disorders, including more severe types, such as Bernard Soulier syndrome and Glanzmann thrombasthenia, as well as many types of VWD. However, the PFA-100 is not an effective test for some types of VWD and milder platelet abnormalities. Individual patient characteristics, such as hematocrit, platelet count, pregnancy, age, multisystem trauma, sepsis, and medications, can affect the results of the PFA-100. Accurate diagnosis often requires additional testing, such as specific VWD testing or platelet aggregation testing.[34,35] Assessment of the results of a PFA-100 and the need for further testing are best accomplished in consultation with a pediatric hematologist.

### Vitamin K Deficiency

Recommendation 6: If an infant, typically younger than 6 months, has bleeding/bruising findings concerning for abuse and a prolonged PT, provision of vitamin K at birth should be confirmed and/or testing for vitamin K deficiency should be performed.

**TABLE 2** Common Testing Strategies for Bleeding Disorders

| Condition | Frequency | Inheritance | Initial Tests | Sn and Sp (%) | PPV, NPV (%) | Confirmatory Test |
|---|---|---|---|---|---|---|
| Factor abnormalities/efficiencies | | | | | | |
| VWD type 1 | 1 per 1000 | AD | PFA-100[a] | Sn = 79–96,[b] Sp = 88–96[b] | PPV = 93.3, NPV = 98.2 | VWantigen,[c] VWF activity, vW multimer analysis, factor VIII activity |
| VWD type 2A | Uncommon | AD or AR | PFA-100[a] | Sn = 94–100,[b] Sp = 88–96[b] | PPV = 93.3, NPV = 98.2 | VWantigen,[c] VWF activity, vW multimer analysis, factor VIII activity |
| VWD type 2B | Uncommon | AD | PFA-100[a] | Sn = 93–96,[b] Sp = 88–96[b] | PPV = 93.3, NPV = 98.2 | VWantigen,[c] VWF activity, vW multimer analysis, factor VIII activity |
| VWD type 2M | Uncommon | AD or AR | PFA-100[a] | Sn = 94–97,[b] Sp = 88–96[b] | PPV = 93.3, NPV = 98.2 | VWantigen,[c] VWF activity, vW multimer analysis, factor VIII activity |
| VWD type 2N | Uncommon | AR, or compound heterozygote | aPTT | NA | NA | VWF-factor VIII binding assay |
| VWD type 3 | 1 per 300 000–1 000 000 | AR, or compound heterozygote | PFA-100[a] | Sn = 94–100,[b] Sp = 88–96[b] | PPV = 93.3, NPV = 98.2 | VWantigen,[c] ristocetin cofactor, vWF multimer analysis, factor VIII activity |
| Factor II deficiency (prothrombin) | Estimated 1 per 1–2 million | | aPTT, PT (may be normal) | Sn = variable | NA | Factor II activity ± antigen levels |
| Factor V deficiency | 1 per 1 million | AR | aPTT, PT | Sn = variable | NA | Factor V activity |
| Combined Factor V/ factor VIII deficiency | 1 per 1 million | AR | aPTT > PT | Sn = variable | NA | Factor V and factor VIII activities |
| Factor VII deficiency | 1 per 300 000–500 000 | AR | PT | Sn = variable | NA | Factor VII activity |
| Factor VIII deficiency | 1 per 5000 male births | X-linked | aPTT | Sn = variable | NA | Factor VIII activity |
| Factor IX deficiency | 1 per 20 000 male births | X-linked | aPTT | Sn = variable | NA | Factor IX activity |
| Factor X deficiency | 1 per 1 million | AR | aPTT, PT, RVV | Sn = variable | NA | Factor X activity |
| Factor XI deficiency | 1 per 100 000 | AR | aPTT | Sn = variable | NA | Factor XI activity |
| Factor XIII deficiency | 1 per 2–5 million | AR | NA | NA | NA | Factor XIII activity |
| Fibrinolytic defects | | | | | | |
| α-2 antiplasmin deficiency | ~40 reported cases | AR | TEG/ROTEM | Sn = variable | NA | α-2 antiplasmin activity |
| (PAI-1) | Very rare | AR | NA | NA | NA | PAI -1 antigen and activity |
| Defects of fibrinogen | | | | | | |
| Afibrinogenemia | 1 per 500 000 | AR | PT, aPTT | Sn = high | NA | Fibrinogen level |
| Hypofibrinogenemia | Less than afibrinogenemia | AD | PT, aPTT | Sn = variable | NA | Thrombin time, fibrinogen activity |
| Dysfibrinogenemia | 1 per million | AD; occasionally AR | Thrombin time, fibrinogen level | Sn = variable | NA | Thrombin time, fibrinogen antigen and activity level comparison, reptilase time |

**TABLE 2** Continued

| Condition | Frequency | Inheritance | Initial Tests | Sn and Sp (%) | PPV, NPV (%) | Confirmatory Test |
|---|---|---|---|---|---|---|
| Platelet disorders | | | | | | |
| ITP | Age-related | NA | CBC | Sn = high | NA | Antiplatelet Ab (rarely needed) |
| Glanzmann thrombasthenia | Very rare | AR | PFA-100[a] | Sn = 97–100 | NA | Platelet aggregation testing flow cytometry |
| Bernard Soulier syndrome | Rare | AR | PFA-100[a] | Sn = 100 | NA | Platelet aggregation testing flow cytometry |
| Platelet release/storage disorders | Unknown, more common than other platelet function disorders | Variable | PFA-100[a] | Sn = 27–50 | NA | Platelet aggregation and secretion, electron microscopy, molecular and cytogenetic testing |

AD, autosomal dominant; AR, autosomal recessive; CBC, complete blood count; ITP, immune thrombocytopenia; NA, not available or not applicable; NPV, negative predictive value; PAI-1, plasminogen activator inhibitor-1; PPV, positive predictive value; ROTEM, rotational thromboelastometry; RVV, Russell viper venom (test); Sn, sensitivity; Sp, specificity; TEG, thromboelastography; vW, von Willebrand; VWantigen, von Willebrand antigen; VWF, von Willebrand factor.

[a] PFA-100 sensitivity and specificity provided for informational purposes. Testing may miss some forms of VWD and mild platelet abnormalities.

[b] Values derived from data before 2008 National Institutes of Health consensus guidelines. Sensitivity and specificity using current diagnostic cutoffs unknown but would be expected to have higher specificity with lower sensitivity.

[c] May be reasonable to proceed directly to diagnostic testing depending on availability. See accompanying technical report for detailed discussion.[22]

Vitamin K deficiency in younger infants can result in bleeding in the skin or from mucosal surfaces from circumcision, generalized ecchymoses, large intramuscular hemorrhages, or ICH. Because of the widespread provision of vitamin K at birth, vitamin K deficiency bleeding (VKDB) is rare; however, not all states require vitamin K to be administered at birth, refusal of vitamin K by parents has increased, and some medical conditions predispose to VKDB.[22] In VKDB, there is a prolonged PT and possibly aPTT for age. In patients who have already received vitamin K, fresh-frozen plasma, or specific factor replacement as treatment, measurement of proteins induced by vitamin K absence can confirm the diagnosis.[36,37]

## COAGULATION TESTS: BRUISING AND ICH

Recommendation 7: Physicians who do not have the necessary resources available or who are not comfortable with evaluating for bleeding disorders in the context of possible child abuse should refer to a child abuse pediatrician, pediatric hematologist, or other physician who is capable of completing the evaluation.

The extent of laboratory evaluations performed by a physician may be affected by the availability of such tests to the physician and the physician's comfort or skill in interpreting the test(s) in the context of the child's findings. Additionally, because coagulation testing results can be altered by delay of processing after drawing the sample or by relative inexperience in running the assay, it may be better to have testing performed at a reference laboratory. For cases in which the recommended tests are not readily available, the authors recommend referral.

### Coagulation Tests in the Setting of Suspicious Bruising

Recommendation 8: If a child has bruising concerning for abuse that necessitates an evaluation for bleeding disorders, the following tests should be obtained:

- PT;
- aPTT;
- VWF antigen;
- VWF activity (Ristocetin cofactor);
- Factor VIII activity level;
- Factor IX activity level; and
- complete blood count with platelet count.

### IF TEST RESULTS ARE ABNORMAL OR EXPANDED/DETAILED TESTING IS NECESSARY OR PREFERRED, CONSULTATION WITH A PEDIATRIC HEMATOLOGIST IS RECOMMENDED (FIG 1).

The initial testing panel in a patient who presents with bruising evaluates for idiopathic thrombocytopenic purpura, all factor deficiencies (except factor XIII deficiency), and VWD (Fig 1). It does not evaluate for extremely rare conditions, including factor XIII deficiency, defects of fibrinogen, and fibrinolytic defects. This strategy also does not test for extremely rare platelet disorders and more common, but relatively more difficult to diagnose, platelet function disorders.

Recommendation 8a: If a child who has bruising suspicious for abuse is removed from a potentially dangerous setting where the abuse likely occurred, a thorough physical examination should be performed in the weeks after removal. If that examination reveals minimal bruising and/or bruising only in locations of common accidental bruises, abuse is supported as the cause of the original suspicious bruising.

Each case should be evaluated individually, considering the totality of findings, and with the understanding of the need to balance safety with the emotional trauma of removing a child from his or her home. Bleeding disorders are generally permanent conditions that do not result in abatement after a change in caregivers. One exception to this is immune thrombocytopenia which is a transient, often self-resolving bleeding disorder. Testing for immune thrombocytopenia with a platelet count is necessary at the time of presentation with bruises.

### Coagulation Tests in the Setting of ICH

Specific data regarding the prevalence of bleeding disorders in the population of children with ICH are not available. However, there are data regarding the probability of specific bleeding disorders to cause ICH, and in some cases, specifically SDH. If the prevalence of a condition and the frequency of a presentation of that condition are known, the probability of that specific condition (bleeding disorder) resulting in the specific presentation (ICH or, more specifically, SDH) can be determined (Table 3). Some probabilities are so low as to preclude calculation. Data summarizing the prevalence and probability of SDH in children younger than 2 years with mild, moderate, and severe deficiencies of factors VIII and IX on the basis of history of trauma are in Table 4.

Recommendation 9: If a child has ICH concerning for abuse and testing for bleeding disorders is conducted, then the following initial testing panel is recommended (Fig 1):

- PT;
- aPTT; and
- complete blood count with platelet count.

The initial testing panel for ICH evaluates for most factor deficiencies. Although the prevalence of severe hemophilia in females is significantly lower than that in males, it does occur, and will be detected by aPTT. This panel does not include testing for mild and moderate deficiencies of factors VIII and IX. This panel also does not test for factor XIII deficiency. Consideration should be given to prevalence in certain populations because it is estimated that one-third of the human population with severe congenital deficiency of factor XIII deficiency is in Iran.[22] The most frequent type of ICH in factor XIII deficiency is intraparenchymal hemorrhage.[22] Other conditions for which testing is not included in the suggested initial panel include VWD, fibrinolytic defects, and disorders of fibrinogen. These conditions either have not been associated with ICH or they are so rarely the cause of ICH that testing for the conditions is generally not helpful.

Recommendation 9a: In ICH concerning for abuse, testing for mild and moderate hemophilia, d-dimer, fibrinogen, and VWD may be necessary on the basis of specific clinical scenarios. If there is a history of trauma, testing for mild hemophilia (levels of factor VIII and factor IX) should be performed. If there is neurologic compromise, testing for d-dimer and fibrinogen should be performed (Fig 1).

Mild or moderate hemophilia may result in SDH after trauma but is not a reasonable explanation for spontaneous SDH. Mild hemophilia, which might be missed if only a PTT test is ordered, can be detected by measuring specific activity levels of factor VIII and factor IX. If there is concern that a history of trauma may be offered at a time subsequent

**TABLE 3** Probabilities for Congenital Coagulopathies to Cause ICH

| Condition | Prevalence of Condition | Prevalence of ICH | Probability[a] |
|---|---|---|---|
| VWD | 1 per 1000 | Extremely rare | Low[b] |
| Factor II deficiency | 1 per 1 million | 11% | 1 per 10 million |
| Factor V deficiency | 1 per 1 million | 8% of homozygotes | 1 per 10 million homozygotes |
| Combined factors V and VIII deficiencies | 1 per 1 million | 2% | 1 per 50 million |
| Factor VII deficiency | 1 per 300 000 | 4%–6.5% | 1 per 5 million |
| Factor VIII deficiency (all)[c] | 1 per 9500 males | 7.0% | 1 per 140 000 |
| Severe | 1 per 20 000 males | 9.1% | 1 per 220 000 |
| Moderate | 1 per 40 000 males | 4% | 1 per 1 million |
| Mild | 1 per 30 000 males | 2.8% | 1 per 1.1 million |
| Factor IX deficiency (all)[c] | 1 per 34 000 males | 7.6% | 1 per 450 000 |
| Severe | 1 per 95 000 males | 10.7% | 1 per 885 000 |
| Moderate | 1 per 110 000 males | 3.4% | 1 per 3.1 million |
| Mild | 1 per 120 000 males | 8% | 1 per 1.5 million |
| Factor X deficiency | 1 per 1 million | 21% | 1 per 5 million |
| Factor XI deficiency | 1 per 1 million | Extremely rare | Low[b] |
| Factor XIII deficiency | 1 per 2 million | 33% | 1 per 6 million |
| α-2 antiplasmin deficiency | Extremely rare | Not reported | Low[b] |
| Plasminogen activator inhibitor-1 deficiency (PAI-1) | Extremely rare | Common | Low[b] |
| Afibrinogenemia | 1 per 500 000 | 10% | 1 per 5 million |
| Dysfibrinogenemia | 1 per 1 million | Single case report | Low[b] |

The probability of having a specific bleeding disorder increases in the setting of a family history of that specific-named bleeding disorder or if the patient is from an ethnicity in which a specific bleeding disorder is more common (eg, Ashkenazi Jewish people and factor XI deficiency). PAI-1, plasminogen activator inhibitor-1.

[a] "Probability" indicates the probability that an individual in the general population would have the following specific coagulopathy causing an ICH.

[b] It is not possible to calculate a probability on the basis of the rarity of the occurrence.

[c] Age-adjusted prevalence of all, severe, moderate, and mild deficiencies of factor VIII and IX were used. Probability is calculated for children younger than 4 years.

to the medical evaluation, consideration should be given to evaluating for deficiencies of factors VIII and IX at the time of the medical evaluation. The prevalence of mild and moderate hemophilia in females is unknown, and therefore, the recommendations for testing in the case of ICH do not differ on the basis of gender.[22] If the child is acutely neurologically compromised, a d-dimer and fibrinogen are recommended because of the potential of disseminated intravascular coagulation (DIC). Because DIC can cause any type of bruising/bleeding, including ICH, the finding of DIC in the context of suspected child abuse could significantly change the clinical approach to a patient. In children with DIC and bleeding symptoms as the only finding concerning for abuse, consideration should be given to the multitude of primary causes of DIC, including trauma, and sepsis, among many others. Although not specifically included in the recommended testing panel, VWD has been associated with SDH after minor trauma in children who return to neurologic baseline.[38] VWD has not been demonstrated to cause spontaneous SDH and/or accompanying persistent neurologic compromise that may be confused with AHT.[15] In some select cases, particularly those involving young children with SDH and no neurologic compromise in the setting of possible trauma, testing for VWD may be considered.

**TABLE 4** Probabilities for Hemophilia A (Factor VIII deficiency) and B (Factor IX deficiency) to Cause SDH in Children Younger Than 2 Years

| Condition | Prevalence of Condition[a] | Prevalence of Traumatic SDH | Probability[b] of Traumatic SDH | Prevalence of Spontaneous SDH | Probability[b] of Spontaneous SDH |
|---|---|---|---|---|---|
| Factor VIII deficiency (all) | 1 per 9500 males | 1% | 1 per 1.2 million | 1.1% | 1 per 860 000 |
| Severe | 1 per 20 000 males | 1% | 1 per 2.2 million | 1.8% | 1 per 1.1 million |
| Moderate | 1 per 40 000 males | 1% | 1 per 5.7 million | 0% | Low[c] |
| Mild | 1 per 30 000 males | 1% | 1 per 3 million | 0% | Low[c] |
| Factor IX deficiency (all) | 1 per 34 000 males | 0.9% | 1 per 3.8 million | 0.9% | 1 per 3.8 million |
| Severe | 1 per 95 000 males | 0% | Low | 2% | 1 per 4.8 million |
| Moderate | 1 per 110 000 males | 3% | 1 per 4.4 million | 0 | Low[c] |
| Mild | 1 per 120 000 males | 0% | Low | 0 | Low[c] |

[a] Age-adjusted prevalence of all, severe, moderate, and mild deficiencies of factor VIII and factor IX were used.

[b] "Probability" indicates the probability that an individual in the general population would have the following specific coagulopathy causing an ICH.

[c] It is not possible to calculate a probability on the basis of the rarity of the occurrence.

Recommendation 9b: If blood products have been given to the patient, the definitive evaluation for bleeding disorders should be postponed until the transfused blood components are no longer in the patient's system (Table 5).

In general, waiting 7 half-lives until testing for a specific factor deficiency should be sufficient for depletion of transfused product. However, the clinical status of the patient should also be considered. In some cases, testing may be able to be performed sooner, if clinical suspicion is exceptionally high and need for treatment is paramount. Assistance from a pediatric hematologist should be considered in addressing the possibility of factor deficiencies after a transfusion has occurred.

### When Testing Indicates a Possible Bleeding Disorder in the Context of an Abuse Evaluation

Abnormal laboratory test results require further evaluation for the possibility of false-positive results and/or the necessity for further testing. The aPTT can be falsely prolonged in certain circumstances, such as in the presence of a lupus anticoagulant, or can be prolonged and might not indicate a true bleeding disorder, such as in factor XII deficiency or other contact factor deficiencies. In addition, patients who experience a traumatic brain injury often have a transient coagulopathy that does not reflect an underlying congenital disorder.[39] Coagulation tests are very sensitive to specimen handling and should be performed in laboratories experienced with these assays. Inappropriate collection and handling commonly lead to false-positive results, and one should consider careful repeat testing. It may be reasonable to obtain a sample in a sodium citrate tube before transfusion. Clinical scenarios that may affect the results of testing should also be noted.

**TABLE 5** Half-Lives of Coagulation Factors

| Factor | Half-Life Postinfusion (h) |
|---|---|
| Fibrinogen | 96–150 |
| II | 60 |
| V | 24 |
| VII | 4–6 |
| VIII | 11–12 |
| IX | 22 |
| X | 35 |
| XI | 60 |
| XIII | 144–300 |
| VWF | 8–12 |

Republished with permission of McGraw Hill LLC, from Goodnight S, Hathaway W. *Disorders of Hemostasis and Thrombosis: A Clinical Guide*, second ed. New York, NY: McGraw-Hill Professional; 2001:497; permission conveyed through Copyright Clearance Center, Inc. VWF, von Willebrand factor.

Additionally, consideration should be given to the likelihood of a preexisting bleeding disorder as the primary cause of a child's bleeding/bruising. For example, given the relatively high prevalence of VWD, it is inevitable that some children with VWD will be abused and present with bleeding/bruising symptoms. Determining the causative factor in these situations is challenging. Bruising is a common finding in VWD. If a child has test results consistent with VWD and bruising concerning for abuse, an absence of new concerning bruising in a different care setting over time is supportive of abuse as the cause of the previous concerning bruises. Most reported ICH in children with VWD would not be confused with typical abusive ICH.[15,39–42] Given the rarity of ICH in VWD, particularly spontaneous ICH, testing consistent with VWD does not mean that ICH is definitively attributable to VWD.

### Evidence Quality and Strength of Recommendation

The prevalence of a bleeding disorder (greater than 1 per 500 000) used for testing in cases of suspicious bruising is based on expert opinion of the authors of this report. This level was chosen to detect reasonably common bleeding disorders. Similarly, the level of probability (greater than 1 per 5 million) for the initial testing for ICH was based on expert opinion to detect bleeding disorders that were extremely unlikely to cause an ICH. Using this level of probability minimizes the chances of misdiagnosing a bleeding disorder as AHT. Expert opinion was used for the testing recommendations for DIC and VWD on the basis of case-specific information. If more extensive testing is desired, a pediatric hematologist may be consulted. Although testing for some bleeding disorders may be costly, testing is necessary because bleeding disorders may manifest in ways that are difficult to otherwise distinguish from abuse.

## CONCLUSIONS

Children who present with bleeding and bruising concerning for abuse require careful evaluation for the potential of bleeding disorders as a cause. No single panel of tests rules out every possible bleeding disorder. Given the rarity of most bleeding disorders and the possible presence of specific clinical factors that decrease the likelihood of a bleeding disorder causing a child's findings, extensive laboratory evaluation is usually not necessary. If a laboratory evaluation is conducted, tests should be chosen on the basis of the prevalence of the condition, patient and family history, blood volume required for testing, and in the case of ICH, probability of a bleeding disorder causing ICH. Testing can be further tailored on the basis of specific patient factors. Further consultation with a pediatric hematologist is recommended if expanded testing is necessary, if preliminary testing suggests the presence of a bleeding disorder, if testing is needed to rule

out a specific bleeding disorder, or if testing for very rare conditions is preferred.

### Guidance for Pediatricians

Data used for recommendations in this report are summarized in the accompanying technical report.[22] Specifically, evidence was used that distinguishes abusive from accidental bruising and that characterizes bruising in children with congenital bleeding disorders. Additionally, for ICH and, when possible, SDH, evidence was used that characterized the probability of ICH and/or SDH in certain clinical scenarios. Specific recommendations were included in this report to increase clarity. Below is guidance for pediatricians, each followed by its corresponding recommendations(s) within the report.

In children who have bruising or bleeding that is suspicious for abuse:

1. Complete medical, trauma, and family histories, screening for unusual or restrictive diets, and a thorough physical examination are critical tools in evaluating for the possibility of abuse or medical conditions that predispose to bleeding/bruising. However, family and patient medical history alone have not been shown to effectively predict the presence of a bleeding disorder. ***(Recommendation 1)***
2. In each case, careful consideration of the possibility of a medical condition causing the bleeding/bruising is essential. Specific elements of the history, developmental status of the child, and characteristics of the bleeding/bruising can be used to determine the need for a laboratory evaluation for bleeding disorders. ***(Recommendations 2, 2a, 2b, 2c, 3, 4)***
3. If the evaluation indicates a need for laboratory testing for bleeding disorders, initial testing is focused on the prevalence of the condition and potential of each specific condition to cause the specific findings in a given child (Fig 1). Tests should be chosen on the basis of their ability to detect specific bleeding disorders that may cause the findings. In some cases, testing may be tailored on the basis of the history, findings, and patient characteristics. ***(Recommendations 5, 6, 8, 9, and 9a)***
4. Consultation with child abuse pediatricians and/or pediatric hematologists should be strongly considered in children with bruising/bleeding concerning for abuse, including ICH and particularly in cases of SDH. ***(Recommendation 7)***
5. Laboratory testing suggesting or indicating the presence of a bleeding disorder does not eliminate abuse from consideration. In children with bruising and laboratory testing suggestive of a bleeding disorder, a follow-up evaluation after a change in home setting can provide valuable information regarding the likelihood of a bleeding disorder causing the concerning findings. ***(Recommendation 8a)***
6. Children with ICH often receive blood product transfusions. It is suggested that testing for bleeding disorders in these patients be delayed until elimination of the transfused blood clotting elements. ***(Recommendation 9b)***
7. The discovery of new information regarding condition prevalence, laboratory testing, and clinical presentations of bleeding disorders is to be expected. Close collaboration with a pediatric hematologist may be necessary. ***(Recommendation 7)***


### LEAD AUTHORS

James D. Anderst, MD, MS, FAAP
Shannon L. Carpenter, MD, MS, FAAP
Emily Killough, MD, FAAP
Thomas Abshire, MD

### CONSULTANTS

Eneida A. Mendonca, MD, PhD, FAAP, FACMI
Stephen M. Downs, MD, MS, FAAP, FACMI

### SECTION ON HEMATOLOGY/ONCOLOGY EXECUTIVE COMMITTEE, 2020–2021

Cynthia Wetmore, MD, PhD, FAAP, chairperson
Carl Allen, MD, PhD, FAAP
David Dickens, MD, FAAP
James Harper, MD, FAAP
Zora R. Rogers, MD, FAAP
Juhi Jain, MD, FAAP
Anne Warwick, MD, MPH, FAAP
Amber Yates, MD, FAAP

### PAST EXECUTIVE COMMITTEE MEMBERS

Jeffrey Hord, MD, FAAP
Jeffrey Lipton, MD, PhD, FAAP
Hope Wilson, MD, FAAP

### STAFF

Suzanne Kirkwood, MS

### COUNCIL ON CHILD ABUSE AND NEGLECT, 2020–2021

Suzanne B. Haney, MD, MS, FAAP, chairperson
Andrea Gottsegen Asnes, MD, FAAP
Amy R. Gavril, MD, MSCI, FAAP
Rebecca Greenlee Girardet, MD, FAAP
Nancy Heavilin, MD, FAAP
Amanda Bird Hoffert Gilmartin, MD, FAAP
Antoinette Laskey, MD, MPH, MBA, FAAP
Stephen A. Messner, MD, FAAP
Bethany Anne Mohr, MD, FAAP

Shalon Marie Nienow, MD, FAAP
Norell Rosado, MD, FAAP

### PAST COUNCIL ON CHILD ABUSE AND NEGLECT EXECUTIVE COMMITTEE MEMBERS

Sheila M. Idzerda, MD, FAAP
Lori A. Legano, MD, FAAP
Anish Raj, MD
Andrew P. Sirotnak, MD, FAAP

### LIAISONS

Heather C. Forkey MD, FAAP, Council on Foster Care, Adoption and Kinship Care
Brooks Keeshin, MD, FAAP, American Academy of Child and Adolescent Psychiatry
Jennifer Matjasko, PhD, Centers for Disease Control and Prevention
Heather Edward, MD, Section on Pediatric Trainees

### STAFF

Müge Chavdar, MPH

### AMERICAN SOCIETY OF PEDIATRIC HEMATOLOGY/ONCOLOGY BOARD OF TRUSTEES, 2020–2021

Jorge Di Paola, MD (president)
Patrick Leavey, MD, FAAP
Doug Graham, MD, PhD
Caroline Hastings, MD
Nobuko Hijiya, MD
Jeffrey Hord, MD, FAAP
Dana Matthews, MD
Betty Pace, MD
Maria C. Velez, MD, FAAP
Dan Wechsler, MD, PhD

### PAST BOARD MEMBERS

Amy Billett, MD, FAAP
Linda Stork, MD

### STAFF

Ryan Hooker, MPT

### ABBREVIATIONS

AHT: abusive head trauma
aPTT: activated partial thromboplastin time
DIC: disseminated intravascular coagulation
ICH: intracranial hemorrhage
PFA-100: platelet function analyzer
PT: prothrombin time
SDH: subdural hemorrhage
VKDB: vitamin K deficiency bleeding
VWD: von Willebrand disease

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).



**FINANCIAL/CONFLICT OF INTEREST DISCLOSURES:** None.

**COMPANION PAPER:** A companion to this article can be found online at www.pediatrics.org/cgi/doi/1542/peds.2022-059277.

### REFERENCES

1. Wood JN, French B, Song L, Feudtner C. Evaluation for occult fractures in injured children. *Pediatrics*. 2015;136(2):232–240
2. Lindberg DM, Beaty B, Juarez-Colunga E, Wood JN, Runyan DK. Testing for abuse in children with sentinel injuries. *Pediatrics*. 2015;136(5):831–838
3. Paroskie A, Carpenter SL, Lowen DE, Anderst J, DeBaun MR, Sidonio RF Jr. A two-center retrospective review of the hematologic evaluation and laboratory abnormalities in suspected victims of non-accidental injury. *Child Abuse Negl*. 2014;38(11):1794–1800
4. Jackson J, Miller M, Moffatt M, Carpenter S, Sherman A, Anderst J. Bruising in children: practice patterns of pediatric hematologists and child abuse pediatricians. *Clin Pediatr (Phila)*. 2015;54(6):563–569
5. Howsam FZ, Perera L, Trounce J. 'Oral injury in child abuse'. *Arch Dis Child*. 2014;99(3):207
6. Ulinski T, Lhopital C, Cloppet H, et al. Munchausen syndrome by proxy with massive proteinuria and gastrointestinal hemorrhage. *Pediatr Nephrol*. 2004;19(7):798–800
7. Starr M, Klein EJ, Sugar N. A perplexing case of child abuse: oral injuries in abuse and physician reporting responsibilities. *Pediatr Emerg Care*. 2015;31(8):581–583
8. Dorfman MV, Metz JB, Feldman KW, Farris R, Lindberg DM. ExSTRA Investigators. Oral injuries and occult harm in children evaluated for abuse. *Arch Dis Child*. 2018;103(8):747–752
9. Walton LJ, Davies FC. Nasal bleeding and non-accidental injury in an infant. *Arch Dis Child*. 2010;95(1):53–54
10. Anderst J, Kellogg N, Jung I. Is the diagnosis of physical abuse changed when Child Protective Services consults a child abuse pediatrics subspecialty group as a second opinion? *Child Abuse Negl*. 2009;33(8):481–489
11. Scimeca PG, Cooper LB, Sahdev I. Suspicion of child abuse complicating the diagnosis of bleeding disorders. *Pediatr Hematol Oncol*. 1996;13(2):179–182
12. McGuire L, Martin KD, Leventhal JM. Child abuse consultations initiated by child protective services: the role of expert opinions. *Acad Pediatr*. 2011;11(6):467–473
13. Sheets LK, Leach ME, Koszewski IJ, Lessmeier AM, Nugent M, Simpson P. Sentinel injuries in infants evaluated for child physical abuse. *Pediatrics*. 2013;131(4):701–707
14. Harper NS, Feldman KW, Sugar NF, Anderst JD, Lindberg DM. Examining Siblings To Recognize Abuse Investigators. Additional injuries in young infants with concern for abuse and apparently isolated bruises. *J Pediatr*. 2014;165(2):383–388.e1

15. Anderst JD, Carpenter SL, Presley R, et al. Relevance of abusive head trauma to intracranial hemorrhages and bleeding disorders. *Pediatrics*. 2018;141(5): e20173485

16. Collins PW, Hamilton M, Dunstan FD, et al. Patterns of bruising in preschool children with inherited bleeding disorders: a longitudinal study. *Arch Dis Child*. 2017;102(12):1110–1117

17. Pierce MC, Kaczor K, Aldridge S, O'Flynn J, Lorenz DJ. Bruising characteristics discriminating physical child abuse from accidental trauma. *Pediatrics*. 2010;125(1):67–74

18. Jackson J, Carpenter SL, Anderst JD. Challenges in the evaluation for possible abuse: presentations of congenital bleeding disorders in childhood. *Child Abuse Negl*. 2012;36(2):127–134

19. Bowman M, Riddel J, Rand ML, Tosetto A, Silva M, James PD. Evaluation of the diagnostic utility for von Willebrand disease of a pediatric bleeding questionnaire. *J Thromb Haemost*. 2009;7(8):1418–1421

20. Bidlingmaier C, Grote V, Budde U, Olivieri M, Kurnik K. Prospective evaluation of a pediatric bleeding questionnaire and the ISTH bleeding assessment tool in children and parents in routine clinical practice. *J Thromb Haemost*. 2012;10(7): 1335–1341

21. Rodriguez V, Titapiwatanakun R, Moir C, Schmidt KA, Pruthi RK. To circumcise or not to circumcise? Circumcision in patients with bleeding disorders. *Haemophilia*. 2010;16(2):272–276

22. Carpenter SL, Abshire TC, Killough EF, Anderst JD. American Academy of Pediatrics, Section on Hematology/ Oncology, Council on Child Abuse and Neglect. Technical report: evaluation for conditions that predispose to bleeding when child abuse is suspected. *Pediatrics*. 2022;150(4):e2022059276

23. Brambilla A, Pizza C, Lasagni D, Lachina L, Resti M, Trapani S. Pediatric scurvy: when contemporary eating habits bring back the past. *Front Pediatr*. 2018;6:126

24. Lake MB, Birmaher B, Wassick S, Mathos K, Yelovich AK. Bleeding and selective serotonin reuptake inhibitors in childhood and adolescence. *J Child Adolesc Psychopharmacol*. 2000;10(1):35–38

25. Sirotnak AP. Medical disorders that mimic abusive head trauma. In: Frasier L, Rauth-Farley K, Alexander R, Parrish R, eds. *Abusive Head Trauma in Infants and Children*. St Louis, MO: G W Medical Publishing; 2006:191–214

26. Dinehart SM, Henry L. Dietary supplements: altered coagulation and effects on bruising. *Dermatol Surg*. 2005; 31(7 Pt 2):819–826, discussion 826

27. Kemp AM, Dunstan F, Nuttall D, Hamilton M, Collins P, Maguire S. Patterns of bruising in preschool children–a longitudinal study. *Arch Dis Child*. 2015;100(5):426–431

28. Hibberd O, Nuttall D, Watson RE, Watkins WJ, Kemp AM, Maguire S. Childhood bruising distribution observed from eight mechanisms of unintentional injury. *Arch Dis Child*. 2017;102(12): 1103–1109

29. Maguire S, Mann M. Systematic reviews of bruising in relation to child abuse-what have we learnt: an overview of review updates. *Evid Based Child Health*. 2013;8(2):255–263

30. Maguire S, Mann MK, Sibert J, Kemp A. Are there patterns of bruising in childhood which are diagnostic or suggestive of abuse? A systematic review. *Arch Dis Child*. 2005;90(2):182–186

31. Chadwick DL, Bertocci G, Castillo E, et al. Annual risk of death resulting from short falls among young children: less than 1 in 1 million. *Pediatrics*. 2008;121(6):1213–1224

32. Mishra P, Naithani R, Dolai T, et al. Intracranial haemorrhage in patients with congenital haemostatic defects. *Haemophilia*. 2008;14(5):952–955

33. Nelson MD Jr, Maeder MA, Usner D, et al. Prevalence and incidence of intracranial haemorrhage in a population of children with haemophilia. The Haemophilia Growth and Development Study. *Haemophilia*. 1999;5(5):306–312

34. Hayward CPM, Rao AK, Cattaneo M. Congenital platelet disorders: overview of their mechanisms, diagnostic evaluation and treatment. *Haemophilia*. 2006;12(Suppl 3):128–136

35. Nichols WL, Hultin MB, James AH, et al. von Willebrand disease (VWD): evidence-based diagnosis and management guidelines, the National Heart, Lung, and Blood Institute (NHLBI) Expert Panel report (USA). *Haemophilia*. 2008;14(2):171–232

36. Shearer MJ. Vitamin K deficiency bleeding (VKDB) in early infancy. *Blood Rev*. 2009;23(2):49–59

37. Miyasaka M, Nosaka S, Sakai H, et al. Vitamin K deficiency bleeding with intracranial hemorrhage: focus on secondary form. *Emerg Radiol*. 2007; 14(5):323–329

38. Labarque V, Stain AM, Blanchette V, Kahr WH, Carcao MD. Intracranial haemorrhage in von Willebrand disease: a report on six cases. *Haemophilia*. 2013;19(4):602–606

39. Talving P, Lustenberger T, Lam L, et al. Coagulopathy after isolated severe traumatic brain injury in children. *J Trauma*. 2011;71(5):1205–1210

40. Ragni MV, Bontempo FA, Hassett AC. von Willebrand disease and bleeding in women. *Haemophilia*. 1999;5(5): 313–317

41. Ziv O, Ragni MV. Bleeding manifestations in males with von Willebrand disease. *Haemophilia*. 2004;10(2):162–168

42. Mizoi K, Onuma T, Mori K. Intracranial hemorrhage secondary to von Willebrand's disease and trauma. *Surg Neurol*. 1984;22(5):495–498

43. Nayak K, Spencer N, Shenoy M, Rubithon J, Coad N, Logan S. How useful is the presence of petechiae in distinguishing non-accidental from accidental injury? *Child Abuse Negl*. 2006;30(5):549–555