A Bruise is a Bruise is a Bruise: How to Evaluate for Bleeding Disorders

Janna M. Journeycake, MD, MSCS
Professor of Pediatrics
University of Oklahoma College of Medicine
Interim Division Chief
Jimmy Everest Center for Cancer and Blood

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Jimmy Everest Center for Cancer and Blood Disorders in Children
The Children's Hospital

THE UNIVERSITY OF OKLAHOMA 1890
COLLEGE OF MEDICINE
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Discolures

- No relevant disclosures

Objectives

- To become familiar with the coagulation process to help identify what testing needs to be done
- To recognize the signs and symptoms of a bleeding disorder by HISTORY and EXAM
- To be able to interpret coagulation testing results
- To understand how PCP and Bleeding Disorder Comprehensive Team can work together

Cases to Keep in Mind

- 12 month old male presents to your office for concern of bruising around rib cage
  - Social services has been contacted by his day care provider
- 7 year old male presents with frequent nose bleeds
  - Every week, only a few minutes at a time
- 14 year old female following up in your office after ER visit for severe hemorrhage with onset of menses
  - Not admitted but Hgb in ER 8.7, told to follow-up with you

Coagulation

Normal

1. Bleeding starts
2. Vasoconstriction
3. Platelet plug
4. Fibrin Clot

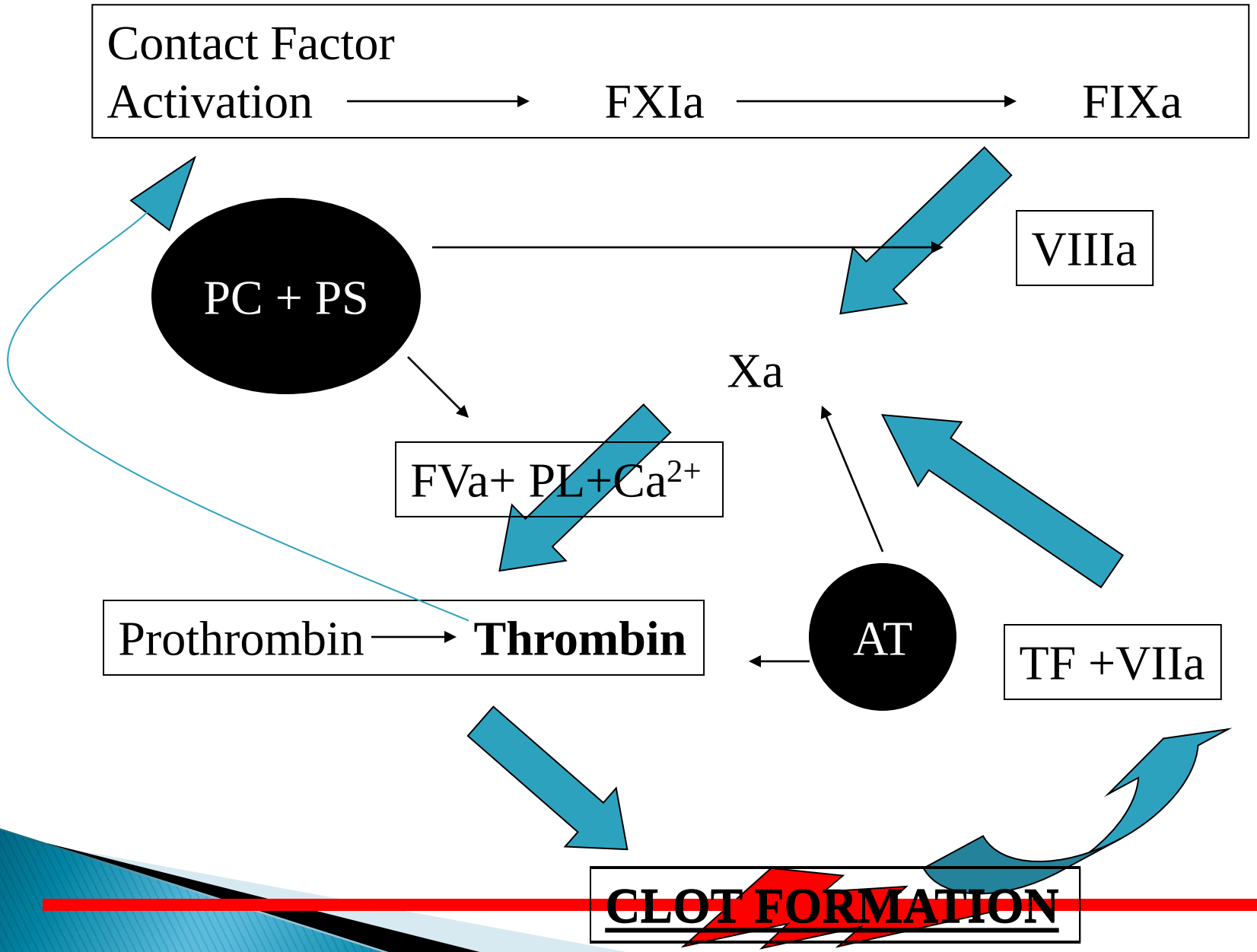
Bleeding Disorder

Basics of Hemostasis

- **Primary Hemostasis**
  - Vasoconstriction of injured vessel
    - NEED INTACT VESSELS,
    - NEED NORMAL COLLAGEN
    - NEED TISSUE FACTOR
  - Adhesion and aggregation of platelets on damaged surface
    - NEED NORMAL PLATELET NUMBER AND FUNCTION
  - Formation of primary hemostatic plug
    - Von Willebrand Factor
      - VWF is the bridge between primary and secondary hemostasis

Basics of Hemostasis

- Secondary hemostasis
  - Formation of thrombin at surface of activated platelets
    - Mediated by activated coagulation factors
  - Fibrinogen converted to fibrin
  - Fibrin clot stabilized


Contact Factor
Activation
FXIa
FIXa
PC + PS
VIIIa
Xa
FVa+ PL+Ca2+
Prothrombin
Thrombin
AT
TF +VIIa
CLOT FORMATION

Evaluation for a Bleeding Disorder

- History is best screening test!
- Personal history of bleeding
  - Where, when, how
- Family history of bleeding

Evaluation

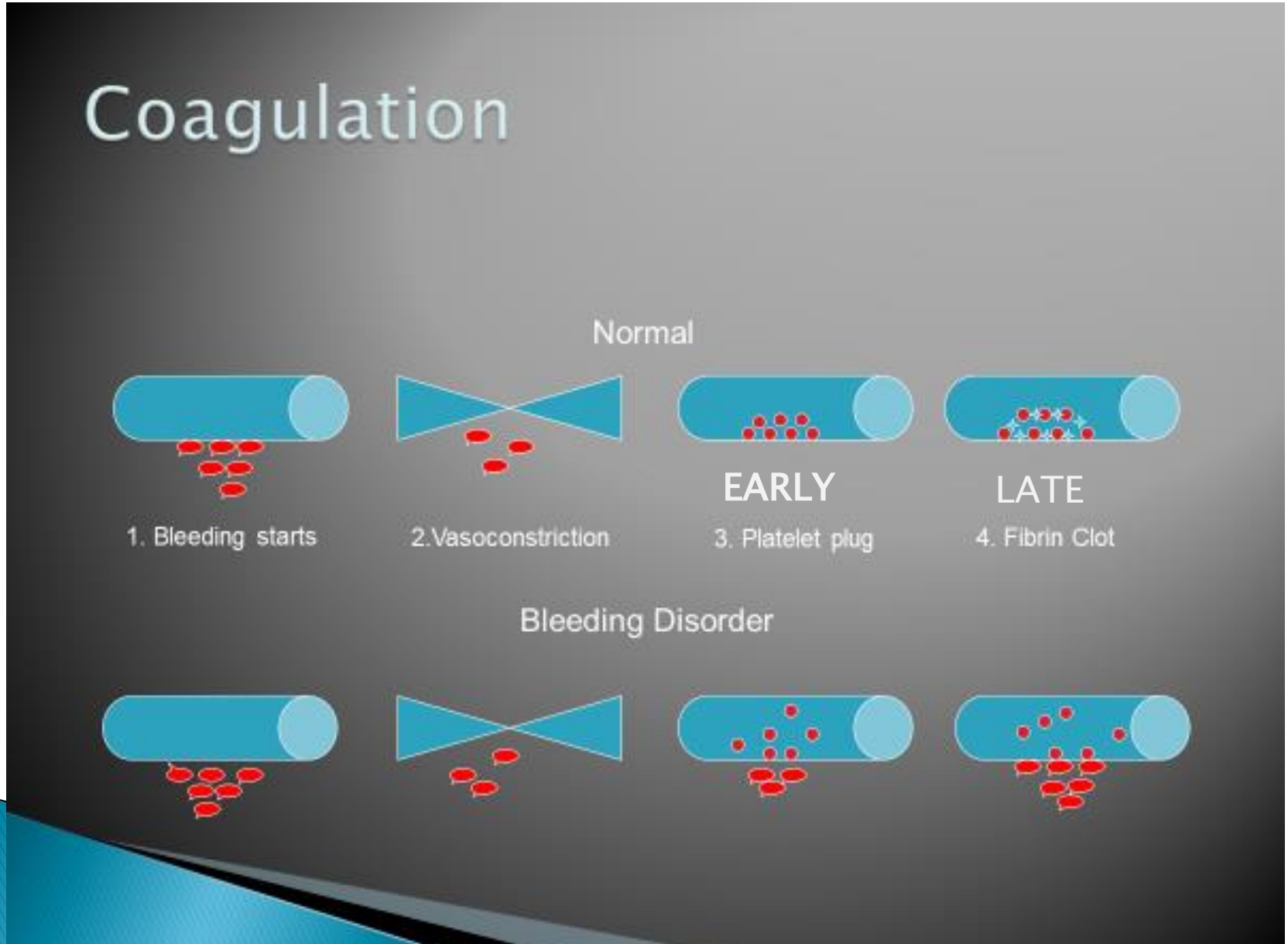
- Where is the bleeding?
  - Disorders of primary hemostasis
    - Mucocutaneous bleeding
      - Epistaxis
      - Gingiva
      - Menorrhagia
      - Ecchymosis
      - Petechiae
      - GI bleeding

Evaluation

- Where is the bleeding?
  - Secondary hemostasis
    - Soft tissue hematomas- many palpable
    - Joint bleeding
    - Muscle hematoma
    - Oral bleeding
    - Hematuria
    - Internal hemorrhage
      - Intracranial
      - Intrabdominal

Soft tissue hematoma: "goose egg"

Evaluation: When



Evaluation

- History for patient with bleeding disorder
  - Family history: up to 80% positive
  - What questions to ask?
  - What **Hemostatic Challenges** has your patient possibly had?
  - BE VERY SPECIFIC
    - "Easy bruising" and "heavy periods" is not enough
      - >50% of patients will say yes to this question

Specific Questions About the Patient

- Infants:
  - Cephalohematoma
  - ICH in non-premie
  - Circumcision (30/30/30)
  - Heel stick
  - Immunizations
  - Bruising where being picked up

Specific Questions

- Toddlers
  - Bruising
    - How does it compare with siblings/playmates?
    - Superficial or palpable (deep)?
    - Unusual location or bony prominences?
  - Nose bleeding (age they begin picking nose)
    - Both nostrils or one, how long, what do they do to try to stop it, have they been to ER to stop, anemia???
  - Unexplained swelling of joints
  - Oral bleeding: teeth eruption or frenulum tear?
  - Immunizations

Specific Questions

- School age
  - Bruises- how does it compare, what type, where?
  - Immunizations
  - Nose bleeds
  - Surgeries (TM tubes, T and A)
  - Dental work- losing deciduous teeth

Specific Questions

- Adolescents
  - Same as before, plus
  - Menstrual flow: SPECIFIC HISTORY
    - How many days?
    - How many times do you change pad or tampon?
      - Diary may help- picture charts
    - Do you change because they soak through or for cleanliness?
    - Is this similar to your sister/mom?
    - History or iron deficiency anemia?

ISTH-BAT

Journal of Thrombosis and Haemostasis, **8**: 2063–2065 DOI: 10.1111/j.1538-7836.2010.03975.x

OFFICIAL COMMUNICATION OF THE SSC

ISTH/SSC bleeding assessment tool: a standardized questionnaire and a proposal for a new bleeding score for inherited bleeding disorders

F. RODEGHIERO,* A. TOSETTO,* T. ABSHIRE,† D. M. ARNOLD,‡ B. COLLER,§ P. JAMES,¶ C. NEUNERT** and D. LILLICRAP†† ON BEHALF OF THE ISTH/SSC JOINT VWF AND PERINATAL/PEDIATRIC HEMOSTASIS SUBCOMMITTEES WORKING GROUP[1]

*Department of Cell Therapy and Hematology, San Bortolo Hospital, Vicenza, Italy; †Blood Center of Wisconsin, Milwaukee, WI, USA; ‡Michael

- https://cdn.ymaws.com/www.isth.org/resource/resmgr/ssc/isth-ssc_bleeding_assessment.pdf

SYMPTOMS (up to the time of diagnosis)	SCORE				
	0§	1§	2	3	4
Epistaxis	No/trivial	- > 5/year or - more than 10 minutes	Consultation only*	Packing or cauterization or antifibrinolytic	Blood transfusion or replacement therapy (use of hemostatic blood components and rFVIIa) or desmopressin
Cutaneous	No/trivial	For bruises 5 or more (> 1cm) in exposed areas	Consultation only*	Extensive	Spontaneous hematoma requiring blood transfusion
Bleeding from minor wounds	No/trivial	- > 5/year or - more than 10 minutes	Consultation only*	Surgical hemostasis	Blood transfusion, replacement therapy, or desmopressin
Oral cavity	No/trivial	Present	Consultation only*	Surgical hemostasis or antifibrinolytic	Blood transfusion, replacement therapy or desmopressin
GI bleeding	No/trivial	Present (not associated with	Consultation only*	Surgical hemostasis, antifibrinolytic	Blood transfusion, replacement therapy or desmopressin

Menses Diary (PBAC)

Menstrual chart and scoring system

Date of start day | month | year **Score**

Towel	1	2	3	4	5	6	7	8
								
								
								
Clots/flooding *Clots: size*								

Tampon	1	2	3	4	5	6	7	8
								
								
								
Clots/flooding *Clots: size*								

Scoring system

Towels

1 point for each lightly stained towel

5 points for each moderately soiled towel

20 points if the towel is completely saturated with blood

Tampons

1 point for each lightly stained tampon

5 points for each moderately soiled tampon

10 points if the tampon is completely saturated with blood

Clots

1 point for small clots

5 points for large clots

Source: U.K. Haemophilia Society, A Guide for Women Living with von Willebrand's

https://elearning.wfh.org/resource/pictorial-blood-loss-assessment-chart/

Family History

- Go back 1-3 generations
  - Maybe no boys in last two generations
- Ask about surgical bleeding
  - Need for transfusions
- Menstrual flow in mom/aunts
- Anemia in family

Exam

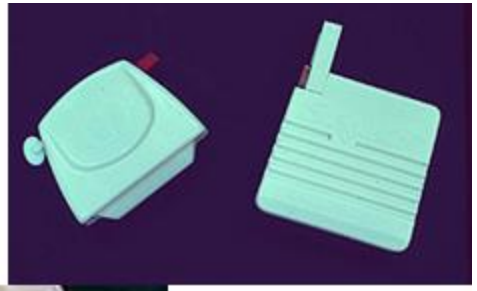
- Pallor
- Unusual location of bruising/palpable bruising
- Petechiae (in platelet disorders)
- Evidence of epistaxis or oral bleeding
- Joint swelling or decreased ROM
- Firmness in muscle tissue
- Adenopathy
- Enlarged liver/spleen

Evaluation

- Tests of Primary hemostasis
  - CBC
    - Quantitative measure of platelets
    - Identify severity of bleeding by degree of anemia
  - PFA-100®(platelet function analyzer)
    - In vitro measure of platelet function
    - Replacing bleeding time
    - Not universally available
  - Platelet aggregation studies
    - Qualitative measure of platelets
    - Difficult test to run, interpret and maintain validity
    - Must send to specialty center to obtain correctly

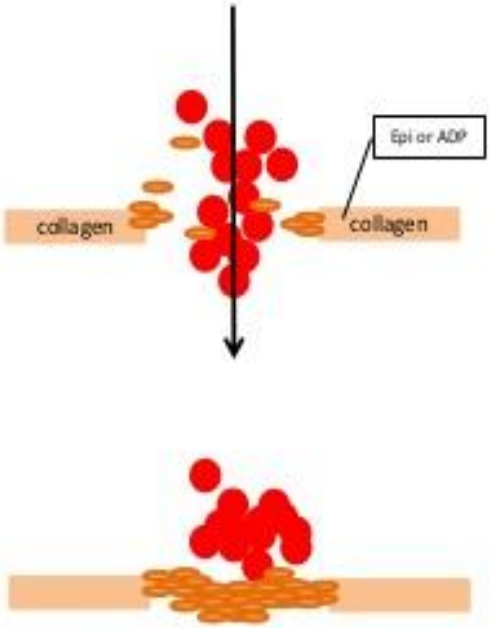
Bleeding Time

- Low sensitivity (65%) and specificity for screening patients for VWD
- Low efficacy for predicting surgical bleeding
- Operator dependent
- Scars the arms of children
- In young children, it is not very reliable



Bleeding Time

PFA-100



- Rapid, automated, general assessment of platelet and overall hemostatic function
  - Replacing bleeding time
- Citrated whole blood passed through aperture and time to closure with platelet plug is measured
  - Collagen with either epinephrine or ADP
- High negative predictive value; low specificity

Quantitative Platelet Disorders (Normal Count 150-450)

- Platelet >100: no bleeding
- Platelet 50-100: bleeding with trauma/surgery
- Platelet 30-50: easy bruising and bleeding with mild trauma
- Platelet <30: spontaneous petechiae, bruising, bleeding
- Platelet <10: severe bleeding potential

Qualitative Platelet Disorder

- Glanzmann Thrombasthenia: SEVERE and early
- Bernard Soulier: MODERATE and early
- Storage Pool Defects: MILD and later

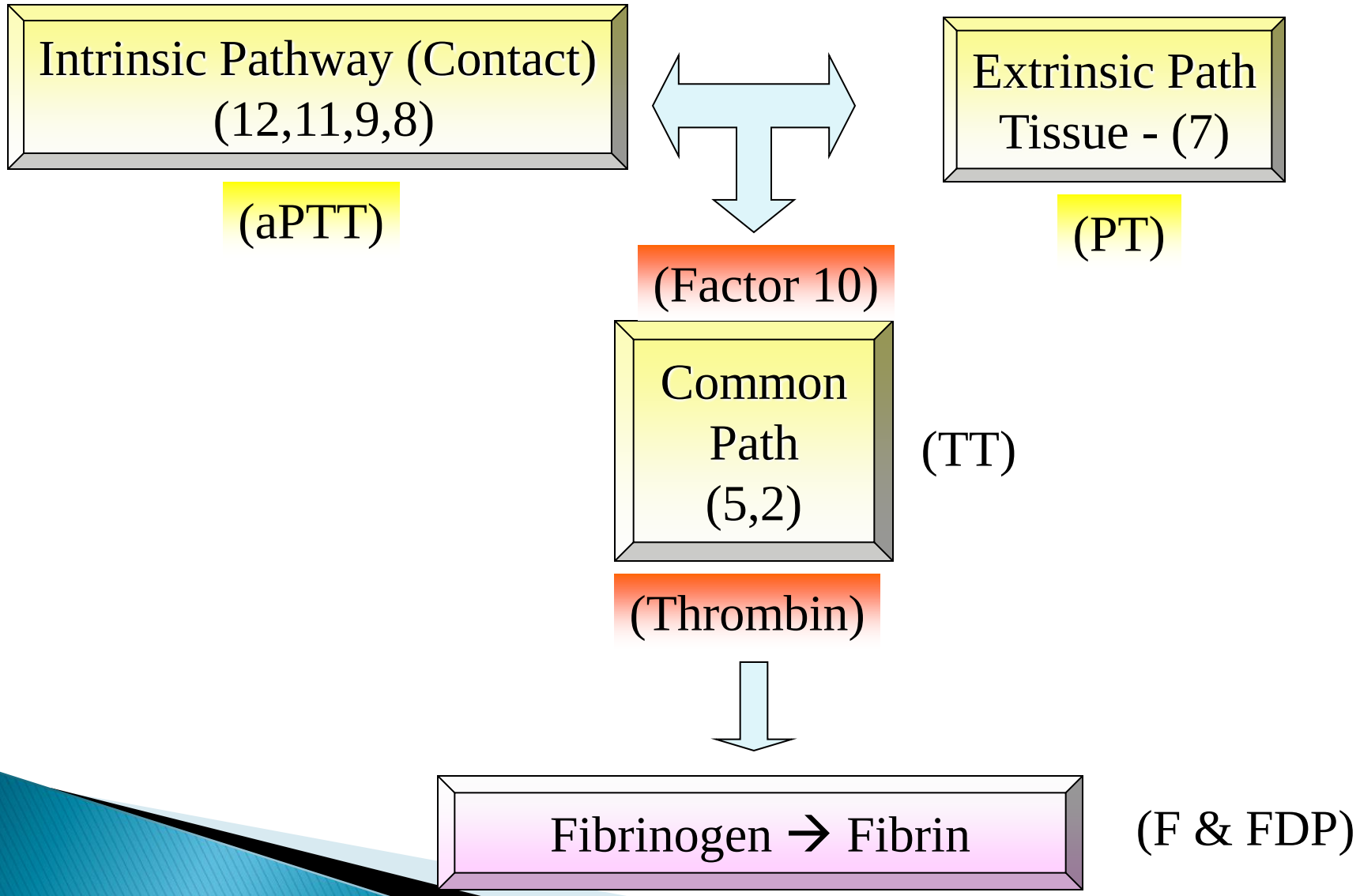
- Bleeding out of proportion to platelet number and mucocutaneous
  - Dental, nose, skin

Evaluation

- Tests of Secondary Hemostasis
  - CBC: severity of bleeding measured by degree of anemia
  - PT
  - PTT
  - Fibrinogen activity
  - Thrombin Time (TT)

  - Factor activity levels
    - Only after basic screening done

Coagulation Cascade:



PT and PTT

- Developed to diagnose patients with a bleeding disorder
  - Factor deficiencies
- In general, should not be used to assess bleeding risk in a non-bleeding patient!!
  - Should be used to consider possible bleeding disorder
- Sensitive for factor levels 30 to 45% of normal
  - Most factors effective at levels >30%

Properties of Hemostatic Factors

Factor	Site of synthesis	Levels in infancy	Half-life	Vitamin K-dependent	Other
Fibrinogen (I)	Liver	Normal	2-4 d	No	High fibrinogen increases ESR
Prothrombin (II)	Liver	Low	3 d	Yes	
Factor V	Liver Megakaryocytes	Low	36 hr	No	
Factor VII	Liver	Low	2-6 hr	Yes	
Factor VIII	Liver Endothelial Cells	Normal/ High	8-12 hr	No	Circulates with VWF Increased by DDAVP
Factor IX	Liver	Low	22 hr	Yes	
Factor X	Liver	Low	40 hr	Yes	
Factor XI	Liver	Low	80 hr	No	
Factor XIII	Liver/Macrophage	Low	10 d	No	Important in wound healing
VWF	Endothelial cells Megakaryocytes	Normal/ High	12 hr	No	Stored in Weibel-Palade bodies in endothelial cells

Causes of Isolated Prolonged PT

- Acquired
  - Coumadin therapy
  - Liver disease
  - Vit K deficiency
    - In sick, hospitalized patients
- Inherited
  - FVII deficiency

Causes of Isolated Prolonged aPTT

- Bleeding patient
  - Heparin contamination
  - Von Willebrand disease
  - Hemophilia (generally males, or female carriers)
  - FXI deficiency
- Non-bleeding
  - "Lab error"
  - Heparin contamination
  - Lupus anticoagulant
  - Contact factor deficiency
    - FXII, PK and HMWK deficiency

“lab error”

- Sample drawn from heparinized line
- Sample too dilute or too concentrated
  - Patient’s hematocrit too high or way too low
  - Incorrect quantity of blood placed into blue top
- Repeat with fresh venous stick
  - If still abnormal, look for factor deficiencies or heparin

Lupus Anticoagulant

- Inhibitor against phospholipids
  - Identified by a prolonged PTT in a non-bleeding patient
    - More likely to contribute to clotting!
  - *In vitro* prolongation of clotting time – not *in vivo*!
  - Common in children
  - Transient and related to infections

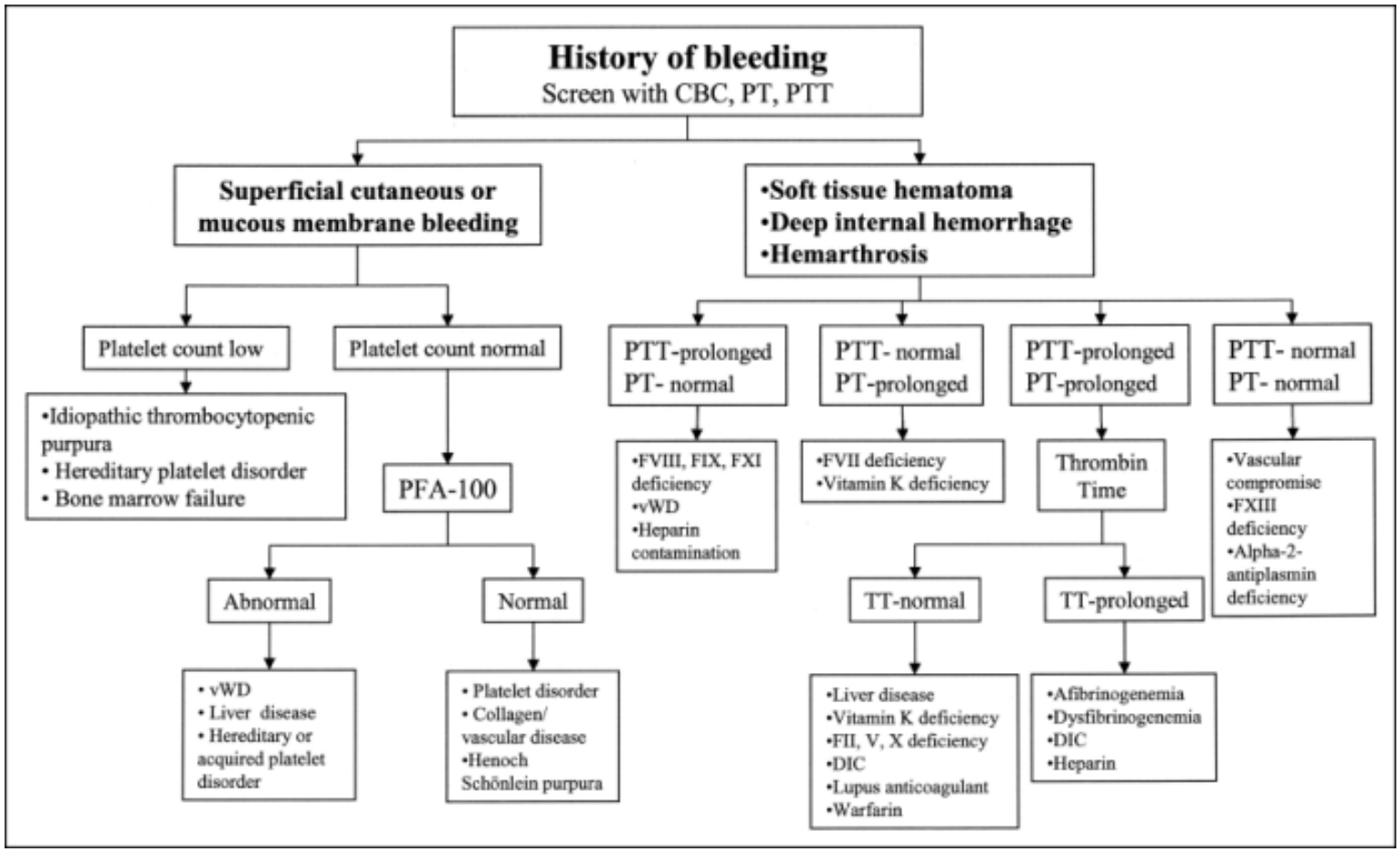
- If associated with bleeding look for hypoprothrombinemia
  - Low factor II (2) activity)

Contact Factor Deficiency

- Low factor XII, prekallikrinin, bradykinin, high molecular weight kininogen (HMWK)
  - Prolongs PTT, does not increase patient's risk of bleeding

Causes of prolonged PT and PTT

- Acquired
  - DIC
  - Severe liver disease
  - Heparin
  - FV antibody (exposure to topical thrombin)
- Inherited
  - Deficiency of FV, FX, FII
  - Dysfibrinogenemia/ Afibrinogenemia



Journeycake, J. M. et al. Pediatrics in Review 2003;24:83-91

PediatricsinReview

Common Inherited Bleeding Disorders

- Von Willebrand Disease
- Hemophilia
  - FVIII deficiency (*hemophilia A)*
  - FIX deficiency *(hemophilia B, Christmas Disease)*

Von Willebrand Disease

- VWD could affect up to 1% of population
  - Most patients have only mild symptoms
- Affects men and women
  - Women appear more symptomatic due to menstruation and childbirth
- Inherited in autosomal dominant fashion
  - Gene defect on Chromosome 12
  - Except Type 2N and Type 3 (autosomal recessive)

Role of VWF in Coagulation

- VWF acts as the glue to hold platelets at the site of vessel damage.
  - Not enough VWF: poor platelet plug formation
- VWF carries Factor VIII in the blood stream
  - Low levels of VWF: low levels of FVIII
    - Solid clot takes long time to form
- VWF produced in endothelial cells and stored in endothelial cells and platelets

Classification

- Type 1 (70 to 80%)
  - Variable clinical expression and bleeding severity
  - Decrease quantity of VWF and activity
- Type 2
  - Qualitative defects
- Type 3
  - Complete absence if VWF
    - Phenotypically identical to severe FVIII deficiency

Most Common Presentations

- Recurrent severe epistaxis associated with anemia
- Severe bleeding after T&A
  - Intervention needed
- Menorrhagia associated with anemia

- *Types 1 and 2 act like disorder of primary hemostasis*
  - *Type1 wait til >6 months old to test*
  - *Type 2 if severe may present in infancy*
- *Type 3 acts like moderate to severe hemophilia*
  - *May present in infancy*

Diagnostic Tests

- VW factor antigen (VWF: Ag)
- VW factor activity
  - VWF: RCo (ristocetin co-factor activity)
    - Ristocetin: antibiotic that induces platelet aggregation via the VWF/platelet interaction
  - Collagen binding assay (VWF:CB)
- FVIII activity level
  - Low levels of VWF lead to more free FVIII in circulation which is degraded rapidly
  - PTT will be prolonged if FVIII activity is low enough
    - NOT A SCREENING TEST FOR VWD

Variables that Influence VWD Testing

- Conditions that increase levels of VWF and FVIII
  - Adrenaline/stress and exercise
  - Inflammatory states
  - Severe liver disease
  - Hyperthyroidism
  - Pregnancy
  - OCP use
  - Birth
- May have to test more than once if still have suspicion of bleeding disorder
- Association of ABO and VWF

Table 1. Influence of ABO Blood Group on vWF:Ag Values in Volunteer Blood Donors

ABO Type	n	vWF:AG Geometric Mean	vWF:Ag Geometric Mean ± 2 SD
O	456	74.8	35.6-157.0
A	340	105.9	48.0-233.9
B	196	116.9	56.8-241.0
AB	109	123.3	63.8-238.2

The groups were statistically significantly different from each other as follows: O *v* A, B, and AB, $P < .01$; A *v* AB, $P < .01$; B *v* A, $P < .05$.

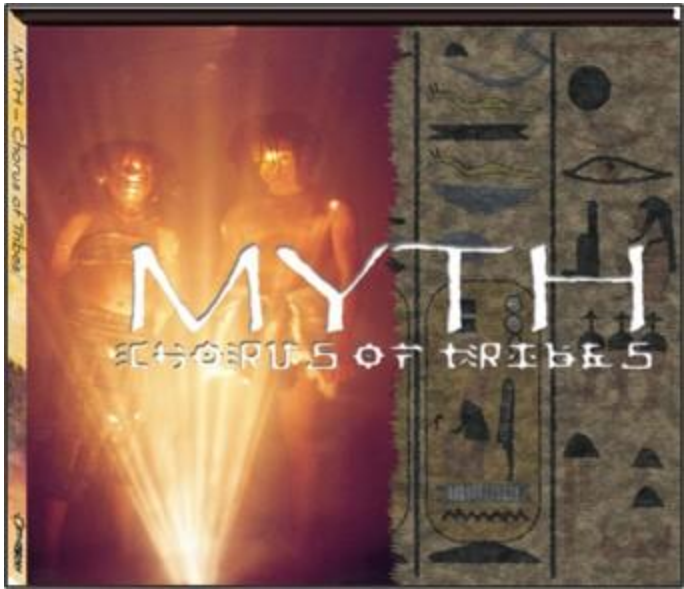
Gill et al. Blood 1987

Diagnostic Tests

	VWF: Ag	VWF: Ac	FVIII	Multimer
Type 1	↓	↓	↓	Normal
Type 2A	Low normal	↓	Low Normal	Missing HMW
Type 2B	Low normal	↓	Low normal	Missing HMW
Type 2M	Low normal	↓	Low normal	Normal
Type 2N	Low normal	↓	↓	Normal
Type 3	Not detectable	Not detectable	↓ ↓ ↓	Normal

MYTHS about Hemophilia

- Hemophiliacs will gush forth blood.
- Hemophiliacs will bleed to death right in front of you.



Hemophilia Basics

- Incidence
  - FVIII deficiency 1 in 5,000 to 10,000 births
  - FIX deficiency 1 in 40,000 births
- Inheritance
  - X linked and 20% spontaneous mutation
- Severity
  - Severe: <1% factor
  - Moderate: 1 to 5 % factor
  - Mild: >5% to 30%

Royal Disease

Severe Hemophilia (<1% factor activity)

- Bleeding may occur from birth
  - Neurologic bleeding up 2.9 to 12%
  - Excessive bleeding post-circumcision
    - 30/30/30
  - Excessive bleeding after needle sticks (NB Screen, immunizations)

- Bleeding may not be noticeable until toddler years
  - Increased mobility and bruises easily
  - Bleeding when cutting teeth
  - Goose eggs

Moderate and Mild hemophilia

- Moderate (1 to 5% factor activity)
  - Rare spontaneous hemorrhage
  - Bleeding with trauma/surgery
  - Easy bruising
- Mild (6 to 30% factor activity)
  - Bleeding with trauma/surgery
  - May not be diagnosed until late childhood or early adulthood

Treatment of Factor Deficiency

- Factor replacement
  - Recombinant or plasma derived factor concentrates
- Desmopressin
  - Non-life threatening bleeding in mild hemophilia only
    - Releases stores of VWF and FVIII
    - Tachyphylaxis can occur
    - Caution with children less than 2 years old (electrolyte problems and seizures)
  - Antifibrinolytics

How Do I Know IF My Patient is Bleeding?

- If in doubt…Treat!
  - Safer to give one dose of factor replacement and evaluate carefully than to miss a bleeding event
  - Missing a bleeding event may lead to serious injury, hospitalization and need for prolonged treatment
- TREAT before getting imaging and other tests
  - If indicated
  - Once treated you have plenty of time to confirm bleeding
  - If known diagnosis of hemophilia, DO NOT REPEAT PTT

Which Bleeds Need Treatment?

- Superficial soft tissue bleeds (bruises) do not need to be treated
- Muscle bleeding, joint bleeding, internal organ bleeding need treatment
- Correcting coagulopathy needed prior to invasive dental procedures and surgeries

Initial Treatment for Joint or Muscle Bleeding

- INFUSION
- RICE
- Non weight bearing for ankle or knee bleed; LE muscle
- Physical therapy consult
  - Isometrics if tolerated
  - Splinting for severe bleeds or in persons with inhibitors
- Ice NOT Heat

Independence!

- Goal for families with severe and mod severe hemophilia to treat minor bleeds at home
- Families learn self infusion and factor is at home
- If need to go to ER
  - Take factor with them
  - HTC to help advocate for you in ER
- WITH PORT AT RISK FOR INFECTION AND THROMBOSIS

Other Medications

- REMEMBER
  - Avoid aspirin and NSAIDS (ibuprofen)

How Do I Counsel the Family About Next Child?

- Genetics
- Prenatal testing
- Delivery
- Testing in newborn

Pregnancy and Delivery in Known Carrier of Hemophilia

- Prenatal diagnosis
  - Chorionic villus sampling- 10-12 weeks
  - Amniocentesis after 16 weeks
- Diagnosis can be made on cord blood
- Approximately 5% (up to 12%) infants can have ICH
  - Rate the same in C-section vs ***controlled*** vaginal delivery
    - Use of forceps, suction, prolonged time in birth canal increase risk

Pregnancy and Delivery

- Mom's with carrier status may have increased post-partum bleeding
  - Many carriers have lower baseline levels of FVIII or FIX activity
- Baby should get newborn screening and Vit K injection
  - Small needle, extra pressure
- Baby can be circumcised- after diagnosis made and factor given

Is there a Way to Avoid Hemophilia?

- Pre-implantation gender selection
  - Select female instead of male
  - May still have child with carrier status
- Pre-implantation selection for embryo without mutation
- Success rate: 21% per cycle
- Additional high cost over the cost of IVF for each cycle

- Oyesiku et al, *Haemophilia* 2002

What can my child do?

Can My Patient Get Immunizations?

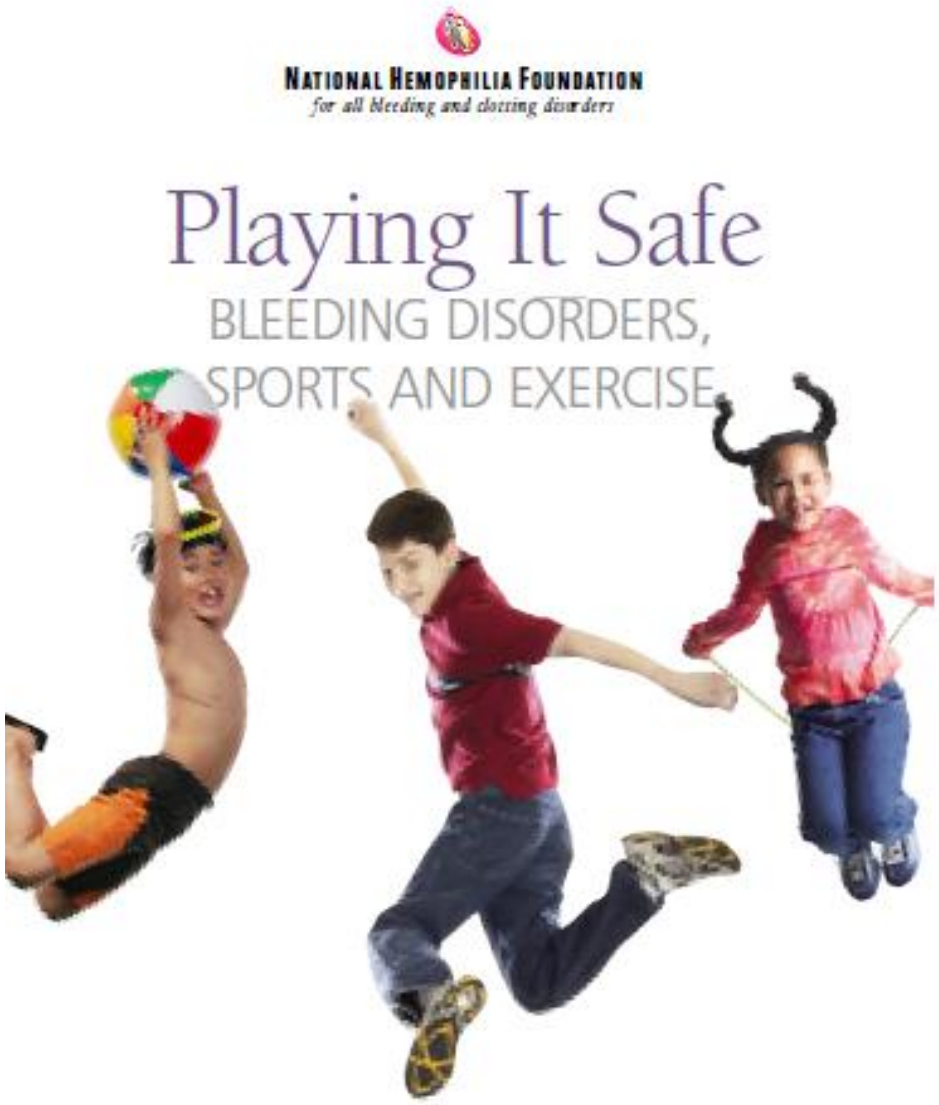
- Yes
- Subcutaneous route if available
- IM route- use smallest gauge needle, hold pressure for 1- 2 minutes
  - If history of muscle hematomas, we can give factor replacement prior to IM injection
- Hep A and B vaccines important for exposure to blood products and plasma derived factor
  - Adults with HIV, Hep C
  - None in children diagnosed and treated in US

Importance of Dental Care

- Begin early- avoid baby bottle tooth decay
- Prevention of dental problem will reduce need for dental rehab/procedures
- Dental cleaning can be done without any factor replacement
  - Avoid deep scaling and injection of anesthetic (local or nerve block)
- ANY invasive procedure needs a plan
  - Factor, antifibrinolytics, soft diet , etc

Can My Patient Play Sports?

- Yes
- Regular exercise helps strengthen joints and muscles
  - Decrease risk of injury
- Regular exercise helps prevent obesity
  - Obesity can increase joint strain



www.hemophilia.org

Table 5. Sports Ratings by Activity

Activities have been divided into five ratings:

1	1.5	2	2.5	3
Safe	Safe to Moderate risk	Moderate risk	Moderate to dangerous risk	Dangerous

Activity	Category
Aerobics	2
Archery	1
Aquatics	1
Baseball	2.5
Basketball	2.5
Bicycling	1.5
BMX Racing	3
Bowling	2
Boxing	3
Canoeing	2.5
Cardiovascular Training Equipment	
Elliptical Machine	1
Rowing Machine	1.5
Ski machine	1.5
Stationary Bike	1
Stepper	2
Treadmill	1.5
Cheerleading	2.5
Circuit Training	1.5
Dance	2
Diving/Competitive	3
Diving/Recreational	2
Exercise Classes	
Body Sculpting	1.5
Cardio Kick-Boxing	2
Physioball	1.5
Spinning	1.5
Fishing	1
Football	3
Frisbee	1
Frisbee Golf	1.5
Ultimate Frisbee	2
Golf	1
Gymnastics	2.5
Hiking	1
Hockey (Field, Ice, Street)	3
Horseback Riding	2.5
Ice-Skating	2.5

Activity	Category
Inline Skating	2.5
Jet Skiing	2.5
Jumping Rope	2
Kayaking	2.5
Lacrosse	3
Martial Arts – Karate/ Kung Fu/Tae Kwon Do	2.5
Martial Arts/Tai Chi	1
Motorcycling/ Motor Cross Racing	3
Mountain Biking	2.5
Pilates	1.5
Power Lifting	3
Racquetball	2.5
River Rafting	2.5
Rock Climbing (Indoor/Challenge Course)	2
Rock Climbing (Natural Setting)	3
Rodeo	3
Roller-skating	2
Rowing/Crew	2
Rugby	3
Running and Jogging	2
Scooter (motorized)	3
Scooter (non-motorized)	2.5
Scuba Diving	2.5
Skateboarding	2.5
Skiing/Cross Country	2
Skiing/Downhill	2.5
Skiing/Telemark	2.5
Snorkeling	1
Snowboarding	2.5
Snowmobiling	3
Soccer	2.5
Softball	2.5
Surfing	2.5
Swimming	1
T-Ball	2
Tennis	2
Track and Field	2.5
Trampoline	3
Volleyball	2.5
Walking	1
Water-skiing	2.5
Weight Lifting/Resistance Training	1.5
Weight Lifting/Power Lifting	3
Wrestling	3
Yoga	2

How Can I Prevent Allegations of Child Abuse?

- Notify school and day care of diagnosis
- Mild and moderate hemophilia the mechanism of trauma will “match” the injury
- Severe hemophilia- most are spontaneous
- Families will have the economic, emotional and stress of a child with chronic medical illness
  - At risk
  - Hemophilia Treatment Centers have social worker sensitive to these issues

School issues

- 504 plans
- Notify Hemophilia Treatment Center when child staying home for bleeds
  - Prescribed bed rest
  - Severe pain
  - Most children can continue with school with assist devices

TRUTH

- This is the best generation to have hemophilia and other bleeding disorders
- First time in history!!!
  - Normal life expectancy
    - We have good ways to control bleeding
    - No/minimal infection risk (HIV/Hep C)
  - Anticipate normal joints
  - Anticipate development of normal adult diseases

Conclusion

- Diagnosis and management of clotting disorders requires understanding the basics of coagulation
- Careful history is best screening tool for inherited clotting disorders

- Important for all caregivers to recognize bleeding episodes
- Important for caregivers to be familiar with factor replacement products

Resources

- National Hemophilia Foundation
  - 1-800-42-HANDI
  - www.hemophilia.org
- World Federation of Hemophilia
  - www.wfh.org
- CDC
  - www.cdc.gov
- Your team at your hemophilia treatment center

Questions?

- Oklahoma Center for Bleeding and Clotting Disorders at JEC
  - 405-271-4412
- TEAM
  - Osman Khan, MD (director)
  - Janna Journeycake, MD
  - Sarah Hawk, PA
  - Emily Braly, PNP
  - TJ Deaton, RN
  - Mary Sweeney, RN
  - Brittney Carder, RN
  - Peggy Brakefield, PT
  - Javey Dallas, LMSW
  - Carrick Carter, PhD
  - Cody Fisher, LVN, CRA
  - Kisa Moses, CRA