Hematology Review

CCRN Review
October 2013
Department of Critical Care Nursing

CCRN exam

- Hematology is 2% of the exam
- Focus on coagulation cascade, DIC, and HIT

Anatomy of the hematologic system

- Bone marrow
  - Spongy center of bones
  - Hematologic and immunologic cell lines originate and mature
  - Most active are vertebrae, ribs, sternum, pelvis, femur, and humerus
- Liver
  - Synthesizes various plasma proteins (esp. clotting factors & albumin)
  - Removes nonfunctioning RBC's from circulation

Functions of the hematologic system

- Oxygenation
  - RBC's transport oxygen
- Hemostasis
  - Dynamic process
  - Blood coagulation is initiated and terminated in a regulated fashion
  - 3 components of hemostasis
    - Vascular wall
    - Platelets
    - Coagulation cascade

The Coagulation Cascade

- Components include:
  - Intrinsic pathway
  - Extrinsic pathway
  - Common pathway

The Coagulation Cascade
Intrinsic Pathway

- Cascade of protease reactions initiated by factors that are present in the blood
- Roman numerals identify the factors
- Lowercase “a” indicates that a factor is in the activated form

Extrinsic Pathway

- Initiated by the activation of Tissue Factor on a cell’s surface and Factor VII that is located outside the vascular system
- Injury to the endothelium allows TF to come into contact with and activate Factor VII
- This TF-VII(a) complex activates Factor X to initiate the common pathway

Common Pathway

- Begins with the activation of Factor X
- Factor X(a) and Factor V require calcium and other phospholipids to convert prothrombin to thrombin
- Thrombin causes:
  - fibrinogen to form fibrin
  - Activates Factor XIII allowing the fibrin threads to mesh forming a fibrin clot

Disseminated Intravascular Coagulation

DIC-pathophysiology

- Hypercoagulable state
- Overstimulation of the coagulation cascade resulting in simultaneous thrombosis and hemorrhage
- Always secondary to another pathologic process

DIC-etiology

- Shock
- Trauma
- Crush injury
- Burns
- Abruptio placenta
- Sepsis
- Malignancy
- Acute tumor lysis syndrome
- Transfusion reaction
- Aortic aneurysm
- Snakebite
- Transplant rejection
DIC-signs & symptoms

- New onset of a bleeding disorder
- New onset of blood coagulation abnormalities
- Spontaneous bleeding
- Hematomas
- Epistaxis
- Spontaneous bleeding from venipuncture sites, wounds, lines, incisions, etc...

DIC-radiologic evaluation

- Non-specific findings
- Radiology used to evaluate and treat the underlying pathologic process

DIC-laboratory values

- Increased
  - PT
  - INR
  - Fibrin split products
  - D-dimer
  - PTT
  - ACT
- Decreased
  - Fibrinogen level
  - Platelets
  - Factor V levels
  - Factor VIII levels
  - Hemoglobin
  - Hematocrit

D-Dimer

- One of the identifiable fragments of fibrin breakdown
- Specific for fibrinolysis
- Normal: < 250ng/mL or <250 mcg/Liter

Fibrin Split Products

- Fragments from the normal breakdown of a fibrin clot
- Fragments contain mild anticoagulation properties
- Normal: < 10mcg/mL

DIC-Treatment

- Treat the underlying cause
- Treat the signs & symptoms that the patient displays
- Transfusions
Blood Products

- Types of blood products used when there is a diagnosis of DIC
  - PRBC’s
  - FFP
  - Cryoprecipitate
  - Platelets

Packed Red Blood Cells (PRBC’s)

- Contains erythrocytes
- Separated from plasma by centrifugation and sedimentation
- Hematocrit between 55%-65%

Packed Red Blood Cells (PRBC’s)

- Increases recipients oxygen carrying capacity
- Contains enough hemoglobin to raise the hemoglobin concentration in the average size adult by approximately 1gm/dL or hematocrit by 3 percentage points
- ABO identical to the recipient

Fresh Frozen Plasma (FFP’s)

- Contains Factors V and VIII
- Frozen at – 18°C
- Each ml of FFP contains 1 IU of each coagulation factor
- ABO Compatible
- Thawed in a water bath
- Infused immediately after thawing

Cryoprecipitate

- Prepared by thawing FFP and recovering the precipitate
- Contains Factor VIII, Factor XIII, Fibrinogen, VonWillebrand’s Factor
- Contains greater than 80 IU of Factor VIII
- Greater than 150mg of Fibrinogen

Cryoprecipitate

- ABO compatible is preferred
- Rh factor irrelevant
- Thawed in a water bath
- Transfused as soon as possible after thaw
Platelets

- A unit of platelets is a concentrate separated from a single unit of whole blood
- Contains no fewer than 5.5 x 10^{10} platelets suspended in 40 – 70ml of plasma
- May contain leukocytes
- May contain trace amounts of RBCs

Platelets

- Compatibility testing only necessary when transfusing large volumes or transfusing to infants
- One unit increase platelet count by 5,000µL - 10,000µL
- Usual dose is 4-8 units
- Lifespan of transfused platelets 3-4 days
- Administer as fast as tolerated
- Must remain at room temperature

DIC-Treatment (cont)

- Medications
  - Unfractionated Heparin
    - inactivates thrombin and prevents the conversion of fibrinogen to fibrin
  - Vitamin K
    - necessary for the hepatic synthesis of prothrombin (factor II), proconvertin (factor VII), plasma thromboplastin component (factor IX), and Stuart factor (factor X).
  - Isotonic IV fluids
  - Hypovolemia

DIC-nursing management

- nursing management focuses on:
  - assessment of the patient
  - monitoring of the effects of the condition
  - Treatment, prevention, and minimization of complications

DIC-nursing interventions

- Prevent the occurrence of new bleeding sites
- Secure all invasive lines to prevent dislodgement
- Provide adequate support to invasive lines and endotracheal tubes to prevent trauma to tissues
- Meet hygiene requirements with non-abrasive methods
- Avoid shaving nicks
- Avoid intramuscular or subcutaneous injections
- Apply pressure bandages to achieve hemostasis
- Monitor ventilatory and oxygen parameters
- Identify hypovolemia
DIC-potential complications

- Hypovolemic shock due to uncontrolled bleeding
- Multiple organ system dysfunction due to ischemia & necrosis caused by microthrombi
- All other potential complications of critically ill patients who spend extended time periods in the ICU

Transfusion complications

- **transfusion-related acute lung injury (TRALI)**
- **transfusion-associated circulatory overload (TACO)**

Transfusion complications - TRALI

**Definition**

- No acute lung injury (ALI) risk factor(s) other than transfusion
- Patients without ALI immediately before a transfusion
- A temporal association of transfusion and ALI is made if:
  - (A) New ALI and (B) onset of symptoms or signs is during or within 6 hours of transfusion completion of 1 or more plasma-containing blood products.
  - As there is no other ALI risk factor, the new ALI is inferred to be mechanistically related to the transfusion


Transfusion complications - TACO

- The clinical presentation of TACO is similar to other causes of hydrostatic pulmonary edema.
  - dyspnea
  - tachypnea
  - jugular venous distension
  - elevated systolic blood pressure is usually present


Heparin Induced Thrombocytopenia

- New onset hypoxemia: PaO2/FiO2 <300 or arterial oxygen saturation <90% on room air
- Chest X-ray: new or worsening bilateral infiltrates consistent with pulmonary edema
- Symptoms related within 5h of transfusion

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dic-potential complications

- hypovolemic shock due to uncontrolled bleeding
- multiple organ system dysfunction due to ischemia & necrosis caused by microthrombi
- all other potential complications of critically ill patients who spend extended time periods in the icu

transfusion complications

- transfusion-related acute lung injury (trali)
- transfusion-associated circulatory overload (taco)

transfusion complications - trali

**definition**

- no acute lung injury (ali) risk factor(s) other than transfusion
- patients without ali immediately before a transfusion
- a temporal association of transfusion and ali is made if:
  - (a) new ali and (b) onset of symptoms or signs is during or within 6 hours of transfusion completion of 1 or more plasma-containing blood products.
  - as there is no other ali risk factor, the new ali is inferred to be mechanistically related to the transfusion


transfusion complications - taco

- the clinical presentation of taco is similar to other causes of hydrostatic pulmonary edema.
  - dyspnea
  - tachypnea
  - jugular venous distension
  - elevated systolic blood pressure is usually present


heparin induced thrombocytopenia

- new onset hypoxemia: pao2/fio2 <300 or arterial oxygen saturation <90% on room air
- chest x-ray: new or worsening bilateral infiltrates consistent with pulmonary edema
- symptoms related within 5h of transfusion

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HIT-pathophysiology

- Platelet activation occurs when IgG, unfractionated heparin, and platelet factor interact to form procoagulant particles
- Immune-mediated process
- Formation of anti-platelet antibodies

HIT-etiology

- 30-50% decrease in platelet count 5-14 days after exposure to unfractionated heparin
- Results in clot formation and the appearance of thromboembolic events

HIT-signs & symptoms

- Decreasing platelet count by 50% or more that begins 5 to 10 days after a proximate immunizing exposure to heparin
- Often accompanied by venous or arterial thrombosis, and without another clinical explanation
- All signs & symptoms of thrombocytopenia

HIT-diagnosis

- Decreasing platelet count
- Platelet aggregation assay
- Platelet factor IV assay
HIT-treatment

• Stop all forms of heparin
• Begin a direct thrombin inhibitor:
  • Argatroban (Argatroban)
  • lepirudin (Refludan)
  • bivalirudin (Angiomax)
• are the three FDA-approved DTIs for the treatment of HIT
• Direct thrombin inhibitors disrupt the generation of thrombi

HIT treatment

• LMWH with less frequency has been shown to cause HIT, and presents an 80% to 100% chance of cross-reacting with the HIT-IgG antibody.
• It is necessary to use an alternate nonheparin antithrombin anticoagulant in order to prevent new thrombosis following heparin cessation.
• HIT is a consumptive process, which may deplete the natural anticoagulant Protein C.
• Premature warfarin administration will exacerbate this protein C depletion at a time when the patient is at great thrombotic risk.

Questions

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References:


References