Chapter 19

Special Considerations: Pregnancy, Pediatrics, Geriatrics, and Renal Failure

Learning Objectives

- Explain how physiologic changes in pregnancy can alter pharmacologic mechanisms of a drug
- Differentiate five categories in Pregnancy Safety Category system: A, B, C, D, and X

Learning Objectives

- Discuss medications used for treatment of asthma during pregnancy:
  - Albuterol (Proventil, Ventolin)
  - Terbutaline (Brethine)
  - Ipratropium bromide (Atrovent)
  - Prednisone
  - Methylprednisolone sodium succinate (Solu-Medrol)
  - Hydrocortisone sodium succinate (Solu-Cortef)
Learning Objectives

- Explain the difference between chronic hypertension and gestational hypertension.
- Discuss medications used in the treatment of hypertensive conditions during pregnancy:
  - Labetalol (Normodyne, Trandate)
  - Hydralazine (Apresoline)
  - Magnesium sulfate

Learning Objectives

- Explain the impact of diabetic ketoacidosis in pregnant patients.
- Explain why BP is not a good early indicator of perfusion in pediatric patients in shock.
- Discuss why intraosseous lines are a beneficial alternative to IV lines in gaining vascular access in pediatric patients.

Learning Objectives

- Explain why pediatric drug dosages are often determined by weight.
- Discuss medications used in the treatment of pediatric bradycardia:
  - Epinephrine
  - Atropine sulfate
Learning Objectives

- Discuss medications used in treatment of pediatric tachycardia:
  - Adenosine (Adenocard)
  - Amiodarone (Cordarone)

- Define polypharmacy and its impact on the treatment of elderly patients

Learning Objectives

- Explain hemodialysis and peritoneal dialysis in treatment of patients in end-stage renal disease

Introduction

- Drug therapy in certain groups requires special considerations regarding:
  - Route of administration
  - Dosage
  - Adverse effects
  - Drug metabolism
  - Elimination
Introduction

- Pregnant patient
  - Caring for two patients
  - Drugs administered to mother go to fetus
    - Ensure medication does not adversely affect physiology or development of unborn child

- Pediatric patients
  - IV access is more difficult
  - Require dose adjustment

- Elderly patients
  - Have gradual to profound deterioration in function of:
    - Heart
    - Lungs
    - Kidneys
    - Liver
  - Polypharmacy

- Renal failure
  - Unable to excrete drugs that require excretion by kidneys
    - Require smaller doses
    - Must be monitored closely for toxicity
Special Consideration in Pregnancy

- Physiologic changes
  - Can alter medication through:
    - Absorption
    - Distribution
    - Breakdown
    - Elimination

- Morning sickness
  - Caused by hormone-induced delay in gastric emptying

- Have higher minute ventilation
  - Inhaled medications result in systemic effects more rapidly
  - Inhaled drugs are absorbed more rapidly than oral medications

- Weight gain
  - Alters body composition
  - Pregnancy increases percentage of body fat
    - Creates larger volume of distribution for fat-soluble drugs
    - Decreases concentration of albumin in the blood
  - Serum albumin is a major protein in blood plasma
    - Is important in maintaining colloid osmotic pressure of blood
    - Reduction affects drug distribution and plasma levels
Special Consideration in Pregnancy

- Decreased liver function and increased renal function
  - Breakdown of a drug by the liver can be slowed
  - Excretion of drug's byproducts can be increased by an improvement in kidney function

Special Consideration in Pregnancy

- Medication risks
  - Placenta is lifeline between mother and fetus
    - O₂, nutrients, and medications cross from mother to fetus
    - Medication may have no effect on mother, but toxic effect on fetus
  - Mother’s circulatory system delivers medication to fetus
    - Fetus must break down and excrete drug unassisted by mother
    - Because fetal liver and kidneys are immature, any dose given can potentially have toxic effects on the fetus

Special Consideration in Pregnancy

- Medication risks
  - Must assume all women of reproductive age are pregnant
  - Medication should be given to a patient who is obviously pregnant or potentially pregnant only when benefits outweigh the risks
Special Consideration in Pregnancy

- Medication risks
  - Teratogenic drugs
    - Medications that can result in characteristic set of malformations in the fetus
    - Greatest period of vulnerability is between 4th and 12th weeks after last menstrual period
    - Affect development of organ system at a period of vulnerability

- Medication risks
  - FDA classifies drugs into categories based on the risk to the fetus
    - A, B, C, D, or X
    - A is safest
    - B, C, and D are progressively more dangerous
    - X is most dangerous and should be avoided

- Medication risks
  - Drug must cross placenta and enter fetal circulation to affect fetus
    - The greater the effect on the mother, the greater the chance it will cross the placenta and act on the fetus
    - Drugs with large molecular weights are less likely to cross the placenta
      - Heparin
      - Insulin
Special Consideration in Pregnancy

- Medication risks
  - Lipophilic drugs
    - Fat-soluble
    - More likely to cross placenta
    - Diphenhydramine (Benadryl)

- Lipophobic drugs
  - Not fat soluble
  - Have more difficult time crossing placenta
  - Loratadine (Claritin)

- Drugs with short half-lives are safer
  - The longer the drug remains in the mother’s bloodstream, the greater the opportunity it will cross placenta into the fetal bloodstream

Asthma

- Can be exacerbated by pregnancy

- Untreated, can have negative results for both mother and fetus

- Safer for mother to take medications than to have exacerbation of asthma
Asthma Management

- O₂
- Bronchodilator
- β2 agonists are listed as Category C medications
- Albuterol (Proventil, Ventolin)
  - First-line therapy
  - Administered by MDI with spacer or as nebulization therapy

Asthma Management

- Sub-Q terbutaline (Brethine)
- Sub-Q epinephrine
- Ipratropium bromide (Atrovent)
  - Treats patient having severe exacerbation of asthma with PEFR more than 50%
  - Used when patient has unsatisfactory response to treatment with albuterol

Asthma Management

- Corticosteroids
  - Used in severe cases and impending respiratory failure
  - Prednisone
  - Methylprednisolone (Solu-Medrol)
  - Hydrocortisone (Solu-Cortef)
  - When PEFR less than 50% of predicted, administer after ipratropium bromide
  - When PEFR does not improve by 10% after bronchodilator therapy
  - PEFR less than 70% after 1 hour of therapy
Asthma

- Management
  - Corticosteroids
    - Benefits may take several hours after administration
    - IV preparation of steroid may be used in an emergency when oral dosing is not practical
    - Orally administered steroids are rapidly absorbed with nearly complete bioavailability
    - More is not better

Asthma

- Hypertensive crisis
  - Common in pregnancy with incidence of 10% to 15%
  - 15% of all pregnancy-related deaths

Asthma

- Hypertensive crisis
  - Chronic hypertension
    - History of hypertension that precedes pregnancy
  - Preeclampsia
    - Hypertension
    - Protein in urine
    - Edema
  - Eclampsia
    - Woman with preeclampsia has seizures
Asthma

- Hypertensive crisis
  - Gestational hypertension
    - Elevated BP that first occurs in pregnancy but does not meet diagnostic criteria of eclampsia

Management

- Use antihypertensive agents to reduce maternal complications
- Threshold for treatment: diastolic BP over 105 mm Hg or systolic BP over 160 mm Hg
  - Follow protocols or contact medical direction

- Labetalol (Normodyne, Trandate)
  - Possible fetal bradycardia

- Hydralazine (Apresoline)
  - Induces maternal hypotension
  - Should not be used as first-line treatment

- Nitroglycerin
  - Advantage: short half-life of 1 to 3 min
Asthma

- Hypertensive crisis
  - Management
    - Danger of any antihypertensive agent is dropping BP to point when placental blood flow decreases
    - Definitive treatment for eclampsia is delivery of fetus
      - Must prevent seizures
      - Magnesium sulfate is used when diastolic BP is greater than 100 mm Hg

Asthma

- Diabetic ketoacidosis
  - State of insulin deficiency that produces:
    - Hyperglycemia
    - Dehydration
    - Metabolic acidosis

Asthma

- Diabetic ketoacidosis
  - Can be fatal for fetus, with fetal mortality rates at 50%
  - Loss of circulatory blood volume and electrolyte shifts result in lowered placental blood flow and O₂ content
Asthma

- Diabetic ketoacidosis
  - Management
    - ABCs
    - Administer 1 L of isotonic fluid in 1 hour period
      - After initial fluid bolus, continue IV infusion at 250 to 500 mL/hr
      - Continue until blood glucose level is 250 mg/dL
      - After blood sugar level is less than 250 mg/dL, fluid should be changed to one containing 5% dextrose

- During interhospital transfers, initial insulin bolus of 0.1 U/kg IV should be given if ordered
  - Followed by insulin infusion running at a dose of 0.05 to 0.1 U/kg per hour

- Blood glucose should be measured every hour
  - If blood glucose level does not decrease after 2 hours, double initial insulin infusion dose
  - After blood glucose level reaches 250 mg/dL, IV fluid should be changed to one containing 5% dextrose, and insulin infusion decreased by ½
  - After blood glucose level reaches 150 mg/dL, decrease insulin infusion rate to 1 to 2 U/hr
**Special Considerations for Pediatric Patients**

- **Drug dosing**
  - In adults, 60% of the body based on total body mass is water
    - In infants, 80% is water
  - In 1st year of life, body fat doubles
  - Smaller muscle mass
  - Larger brains and livers in relation to their TBW

- **Large volumes of distribution and rapid metabolic rates**
  - Simple linear reduction in adult dose is not appropriate

- Based on age, weight, body surface area
  - Usually ordered as particular dose in mg per kg or lb
  - Weight-based dose for children is for different ages or weight groups
  - Weight-normalized dose increases as weight of child decreases

- **Hypovolemic shock**
  - BP is not primary vital sign that indicates patient status
  - In pediatric patients, drop in BP is last sign of deterioration
  - Palpate peripheral pulses and evaluate temperature and capillary refill of distal extremities
Special Considerations for Pediatric Patients

- Hypovolemic shock
  - Cardiac output = heart rate multiplied by stroke volume
  - Only mechanism that children have to improve cardiac output is increased heart rate

- Vascular access and management
  - Challenge because pediatric patients:
    - Have small blood vessels
    - Have great amount of subcutaneous fat
    - Are unwilling to cooperate
  - EMS should establish a plan for how much time should be spent attempting to obtain access to each IV site
    - If 1 or 2 lines are not obtained within 2 to 5 min, use alternative method so resuscitation is not delayed
Special Considerations for Pediatric Patients

- Hypovolemic shock
  - Vascular access and management
    - Preferred peripheral site for IV placement is antecubital fossa
      - In infants, a scalp vein or superficial vein of an extremity can be used if larger veins are not accessible

- Additional equipment needed for peripheral sites:
  - Tourniquet
  - 18- to 24-guage angiocatheter

- Disadvantages for peripheral site:
  - Line becomes dislodged
  - Occlusion of the line
  - Possible tissue injury with extravasation of irritants
Special Considerations for Pediatric Patients

• Hypovolemic shock
  ➢ Vascular access and management
    ➢ Intraosseous (IO) lines used when peripheral access is not possible
      ➢ 15- to 18-gauge bone marrow needle with stylet is placed in marrow cavity of child’s tibia
      ➢ Placement is directed perpendicular to flat part of proximal tibia
      ➢ Needle is inserted 1 to 3 cm just medial to tibial tuberosity
      ➢ Catheter is advanced through bone marrow space
Special Considerations for Pediatric Patients

- Hypovolemic shock
  - Vascular access and management
    - IO route, possible complications:
      - Osteomyelitis
      - Cellulitis
      - Infiltration of fluid
      - Anterior compartment syndrome
      - Tibial fracture
      - Fat embolus

- Hypovolemic shock
  - Vascular access and management
    - IV route
      - Not suitable for long-term use
      - Do not place needles in fractured bones or previously used sites
      - Do not place needle in patients with history of osteogenesis imperfecta

- Hypovolemic shock
  - Vascular access and management
    - After IV access is obtained, fluid management and shock treatment can begin
      - Volume expansion is based on weight
      - Give bolus of no more than 10 to 20 mL/kg at a time
      - Use crystalloids
      - After each intervention, a full reassessment of patient’s status is critical
Special Considerations for Pediatric Patients

- **Arrhythmias**
  - Abnormal heart rate
  - Symptoms are acute, usually reversible

**Treatment**
- Establish airway
- Improve circulation with IV hydration
- Thorough evaluation including history and physical assessment
  - At risk:
    - Congenital heart disease
    - Other disease that can lead to heart failure

- Symptoms:
  - Cardiogenic shock with poor perfusion
  - Pale
  - Short of breath
  - Irritability
  - Changes in mental status
  - Evaluate capillary refill in nail beds over the patella
Special Considerations for Pediatric Patients

- Arrhythmias
  - Too slow heart rate
    - Management
      - Determined by stability of patient
      - Evaluate and establish airway if required
      - Evaluate breathing
      - Determine breathing adequacy
      - If stable and not hypotensive: O₂ and IV fluids

- Too fast heart rate
  - Management
    - ABCs
    - Establish IV
    - Evaluation for dehydration
    - Fever can cause tachycardia
    - IV fluid bolus with either 0.9% normal saline or Ringer lactate at 10 to 20 mL/kg
    - Reassess vital signs after each bolus
Special Considerations for Pediatric Patients

- Arrhythmias
  - Too fast heart rate
    - Management
      - Evaluate rate and width of QRS complex to determine if arrhythmia is supraventricular or ventricular tachycardia
      - Cardioversion at a dose of 0.5 to 1.0 J/kg is warranted

- Too fast heart rate
  - Adenosine (Adenocard)
    - Used if patient is stable but has supraventricular tachycardia
    - Slows heart rate
    - Immediate onset of 10 sec or less
    - Half-life is fast
    - Causes transient atrioventricular block, which appear to be asystole for less than 10 sec

- Amiodarone (Cordarone), procainamide, lidocaine
  - Used for stable ventricular tachycardia
  - If unstable, cardioversion should be used appropriately
Special Considerations for Pediatric Patients

- Management of diabetic ketoacidosis
  - Should not receive bolus of insulin
  - Should receive insulin drip in same fashion as adult
  - Aggressive fluid administration can cause cerebral edema

Special Considerations for Elderly Patients

- Polypharmacy
  - Takes multiple medications for treatment of several medical disorders
  - Possible adverse effect or serious drug interaction

- Lose muscle mass and TBW
  - Drug dose often reduced from that of standard adult dosage
  - Certain drugs require weight-based dosing
  - Possible drug toxicity

Special Considerations for Elderly Patients

- Age-related physiologic changes in medication response are attributable to changes in:
  - Absorption
    * Decreased motility of stomach
    * Reduced production of stomach acid
Special Considerations for Elderly Patients

- Age-related physiologic changes in medication response are attributable to changes in:
  - Breakdown of metabolism
    - From active to nonactive forms by liver is less effective
  - Excretion is affected
  - Blood flow to kidney is reduced with age
  - Ability of kidneys to filtrate and concentrate urine
  - After 30 years, adults lose 6% to 10% of kidney function per decade

- Decreased kidney function results in accumulation of drugs or drug by-products

- Medications that have potential of toxicity in renal disease:
  - Digoxin
  - Antibiotics
  - Antihypertensives
  - Antiarrhythmics

Special Considerations for Elderly Patients

- Proportional increase in body fat and decrease in total body water occurs
  - Fat-soluble drugs will collect in fat stores
  - Decrease in volume of distribution of many drugs
    - Can cause toxic drug levels of water-soluble drugs such as digoxin and theophylline
Special Considerations for Elderly Patients

- Poor nutrition
  - Decreases production of albumin
    - Protein produced by liver
    - Found in blood and interstitial space
    - Many drugs bind to and are transported by albumin
    - Portion of drug that does not bind to albumin is portion that is active

Special Considerations for Elderly Patients

- Any medication administered can have unanticipated interaction and adverse drug effect

- Possible noncompliance because of:
  - Depression
  - Poor memory
  - Dementia
  - Financial restrictions

Special Considerations for Patients with Renal Failure

- Results in permanent loss of kidney function

- Require careful management of their diet, fluid intake, and drug therapy
Special Considerations for Patients with Renal Failure

- Causes of chronic renal failure:
  - Hypertension
  - Diabetes mellitus
  - Trauma
  - Pregnancy
  - Hemorrhage
  - Complications of drug therapy

- End-stage renal disease (ESRD)
  - Cannot make urine
  - Require renal replacement therapy or dialysis

- Hemodialysis
  - Removal of toxic substances from bloodstream by filtering patient’s blood through a machine, then passing blood back to patient
  - Efficient means of cleansing blood
  - Risks are hypotension and arrhythmias

- Peritoneal dialysis
  - Special solution is delivered to patient’s abdomen through catheter
  - Solution dwells in abdomen for a period, absorbing many toxic substances in the blood
  - Does not result in hypotension or require anticoagulation
  - Disadvantages:
    - Length of time required for dialysis
    - Risk for infection to abdominal cavity
Special Considerations for Patients with Renal Failure

- As kidneys fail, internal milieu changes effectiveness of various drugs
  - Patients can develop metabolic acidosis
  - Lose ability to concentrate urine
  - May not tolerate large volumes of IV fluid

- When kidney function is less than 10% of normal, potassium balance is impaired and can accumulate to dangerous and critical levels
- Kidneys have role in forming RBCs
  - Manufacture erythropoietin
  - Patients with renal failure cannot produce, become anemic
  - Epoetin alfa (Epogen) is used for increase in blood count and treat anemia

- Must question need, dosage, and possible interaction of every medication administered
  - Dosage must be reduced in patients with renal failure
Questions?