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Pharmacology Implications in Acute/Critical Care Physical Therapist Practice
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Course Description
This course, utilizing a case study approach, will look at the pharmacologic implications related to physical therapist examination and treatment of patients in acute/critical care. The course will review basic pharmacological processes and include implications related to anticoagulants, cardiac medications, and sedatives and hypnotics.
Learner Outcomes

After this course, participants will be able to:

- Describe at least three pharmacokinetic factors involved in drug therapy.
- Analyze at least one drug effect for each of the following systems and the relationship to providing physical therapy: cardiovascular, pulmonary, and neurological.
- List at least three ways the potential side/adverse effects associated with the medications described in this course, can impact the physical therapy evaluation.
- List at least three ways the potential side/adverse effects associated with the medications described in this course, can impact the physical therapy treatment.

Introduction to Pharmacology

- What are the implications to physical therapist practice
  - Impact to patients mental status
  - Indications for alternative or additional tests and measures
  - Modifications of treatment intervention
    - Timing
    - Specific treatment
Pharmacokinetics\(^1\)

› Implications to practice due to:
  - Route of administration
  - Factors that can affect drug distribution in the body
  - Drug storage
  - Biotransformation
    › Elimination
    › Half-life
    › Drug response variability

How Drugs Work

› Receptors\(^1\)
  - Affinity and Efficacy
  - Agonists and Antagonists
    › Competitive vs non-competitive antagonists
  - Regulation
Case 1 – Implications for Cardiac Medications

› 78 yo female admitted to a large academic medical center status post fall at home with complaints of generalized pain and weakness

› PMH/PSH:
  – Hypertension (HTN)
  – Elevated cholesterol levels
  – Osteoarthritis (OA) right hip and knee
  – Shingles
  – Total abdominal hysterectomy (TAH)
  – Breast cancer

Initial Work-Up

› Radiographs negative for fractures

› Lab results:
  – Blood work
    › White blood cells 8.0 10⁹/L - normal 5.0-10.0 10⁹/L
    › Platelets 280 k/ul – normal 140-400 k/ul
    › Hemoglobin 14 g/dL – normal 12-16g/dL
    › Hematocrit 42% - normal 37-47%
  – Urinalysis - normal
Medications

› Hydrochlorothiazide (HCTZ) 25mg once a day (HTN)
› Metoprolol 50mg twice a day (HTN)
› Oxycodone 10mg every 4 hours as needed (Moderate pain)
› Acetaminophen 750mg every 4 hours as needed (Mild pain)
› Atorvastatin 20mg once a day
› Vitamin D

Medication Review

› HCTZ³
  – Thiazide diuretic primary site of action is the kidneys to decrease plasma volume
  – Adverse effects
    › Fluid depletion
    › Electrolyte imbalance
      – Hyponatremia
      – Hypokalemia
    › Orthostatic hypotension
    › Weakness/fatigue
Medication Review

› **Metoprolol**
  - Beta-adrenergic blocker primary site of action beta-1 receptors located on the myocardium to decrease heart rate and force of myocardial contraction
  - **Adverse effects**
    › Excessive decrease in heart rate and force of contraction (baroreceptor response)
    › Orthostatic hypotension
    › Fatigue

Medication Review

› **Oxycodone**
  - Opioid analgesic classified as a mild-moderate agonists and listed as a Schedule III controlled substance and are effective in managing moderate pain
  › Primary site of action is the *Mu* receptor in the CNS (spinal and supraspinal)
  › Less affinity and efficacy than strong agonists such as morphine (Schedule II controlled substance)
  - **Adverse effects**
    › Sedation
    › Respiratory depression
    › Constipation
    › Orthostatic hypotension
Medication Review

› Acetaminophen
  - Analgesic and antipyretic effects due to possibly the inhibition of the cyclooxygenase enzyme and prostaglandin synthesis
  - Less gastric irritation than NSAIDs
  - Adverse effects
    › Possible liver damage which may be dose related or related to history of liver disease

Medication Review

› Atorvastatin
  - Decrease cholesterol production by inhibiting the enzyme needed for cholesterol production in liver cells, HMG-CoA reductase (3-hydroxyl-3-methylglutaryl coenzyme A)
  - Decrease total cholesterol and plasma LDL-C
  - Adverse effects
    › Myopathy
    › Arthralgia
    › Headache
Medication Review

› Vitamin D¹
  – Generally utilized to maintain serum calcium and phosphorus concentrations in individuals with vitamin D deficiency
  – Rarely noted adverse effects
    › Potential hypercalcemia

Things that should make you go hmmmmm

› Recent fall
  – Orthostatic hypotension?
    › Diuretic
    › Betablocker
  – Electrolyte imbalance?
    › Diuretic
  – Pain secondary to myopathy or arthralgia?
    › Statin
  – Other possibilities
Implications for the Physical Therapist

› Examination
  - Mental status
    - Depression screening\(^4\) – why?
  - Lab values
  - Vital signs\(^5\)
  - Pain assessment\(^6\)
  - Mobility assessment
    - Fall risk assessment
      - TUG\(^7\)
      - Tinetti\(^8\)
      - Berg\(^9\)
  - ROM
  - Strength

Lab Values\(^10\)

› Hyponatremia – normal values 135-145mEq/L (critical value < 110)
  - Hypotension
  - Tachycardia
  - Muscle weakness

› Hypokalemia – normal values 3.5-5.0mEq/L (critical value <80)
  - Hypotension
  - Muscle weakness and fatigue
  - Depression (malaise)
Vitals Signs (Blood pressure, heart rate, respiratory rate)

› History of hypertension
› Medications known to cause orthostatic hypotension
  – Diuretic
  – Betablocker
  – Opioid
› Medication known to cause respiratory depression
  – Opioid

Examination

› Pain assessment
  – Opioid
› Balance assessment
  – Complaints of weakness and fatigue
  – Medications that can cause hypotension
  – Medications that can cause weakness and fatigue
› ROM and strength
  – Complaints of weakness
  – Medications that can cause weakness
  – Medication that can cause myopathy and arthralgia
Implications for the Physical Therapist

- Interventions
  - Balance training
  - Gait training
  - Therapeutic exercise
- Monitor vital signs
- Check for medication changes
- Check lab values

Summary and Questions

- Incidence of hypertension in the US\textsuperscript{11}
- Compliance of medication use\textsuperscript{12}
- Changes in medication dose
- Role of medication and lifestyle changes (diet and exercise)\textsuperscript{1}
Patients in acute care/critical care units are often:
- At risk for the development of venous thromboembolism
  - Inactivity
  - Medical condition
  - Surgical condition
- Diagnosed with venous thromboembolism

Case 2 – Implications of Anticoagulants

Anticoagulant Therapy

- Heparins
  - Low molecular weight heparins
    - enoxaparin (Lovenox), dalteparin (Fragmin)
    - Inhibit factor Xa the active form of clotting factor X
    - Used routinely to prevent and treat deep vein thrombosis
    - Subcutaneous injections – typically daily or 2x/day
    - More predictable without the need for laboratory testing (though bleeding time is the test of choice if needed or measure clotting factor X activity)
- Warfarin (Coumadin)
  - Primarily used for long term prevention
  - Oral route of administration
  - Interferes with vitamin K which is needed in the liver to synthesis clotting factors II, VII, IX, X
  - Need for routine lab testing (INR)
Anticoagulant Therapy\textsuperscript{1,3}

› Direct thrombin inhibitors

› Factor Xa inhibitors
  - Oral Xa inhibitors – apixaban (Eliquis) and rivaroxaban (Xarelto) relatively safe with few side effects
  - Often used to prevent and treat DVT and other conditions such as atrial fibrillation

› Platelet inhibitors

› Fibrinolytics

Case 2 – Implications of Anticoagulants

› 45 yo male admitted with new onset of atrial fibrillation

› PMH
  - Diabetes (Type 2)
  - Obesity

› Medications
  - Heparin
  - Warfarin
  - Metformin
Medication Review

› Heparin\(^1,3,14\)
  - Being used to prevent embolism and achieve therapeutic anticoagulation (target INR of 2.5)
  - Adverse effects
    › Hemorrhage
    › Back and joint pain

› Warfarin\(^1,3\)
  - Once patient therapeutic to be changed over to oral medication for long term management of Afib
  - Adverse effects as above

› Metformin\(^1,3\)
  - Oral antidiabetic medication
  - Adverse effects – rare

Implications for the Physical Therapist

› Examination
  - Mental status
  - Vital signs\(^5\)
  - Lab values\(^2\)
    › INR
  - BMI calculation\(^15\)
  - Functional mobility
    › Fall risk assessment\(^7-9\)
  - ROM/Strength
  - Pain assessment\(^6\)
  - Sensation (Semmes-Weinstein monofilament examination)\(^16\)
Implications of INR

- Lab values
  - INR at initial evaluation 1.3
    - sub therapeutic
    - Physicians increased heparin
  - All other laboratory values were normal except:
    - Glucose 200 mg/dL – normal 70-100 mg/dL
    - Hgb A1C 7.2% - normal < 5.7%
  - INR day 3
    - 6.1
    - What to do???
    - Patient is at an increased risk for bleeding

Signs and Symptoms of Bleeding

- Dizziness
- Increased weakness
- Fatigue
- Tachycardia
Implications for the Physical Therapist

- Interventions
  - Functional mobility training
  - Therapeutic exercise
  - Prevention strategies as needed
- Monitor for:
  - Signs of bleeding
  - Assess vital signs\(^{17}\)
    - ACSM (American College of Sports Medicine) exercise guidelines

Summary and Questions

- Role of the physical therapist in lifestyle changes that can impact patients with type 2 diabetes\(^{18}\)
- People with type 2 diabetes and incidence of atrial fibrillation (afib)\(^{19}\)
- Incidence of peripheral neuropathy in patients with type 2 diabetes\(^{20}\)
Case 3 – Implications of Sedatives and Opioids

› 73 yo female admitted for elective right total knee replacement
  – PMH/PSH:
    › Osteoarthritis right knee
    › Parkinson’s disease
    › Anxiety

Peri-operative management

› Anticoagulation therapy
  – Lovonox while in the hospital
  – Patient was considered at low risk for DVT and was transitioned to aspirin at discharge

› Pain management
  – Epidural catheter in place for pain management immediately post op with bupivacaine
  – Morphine while in the hospital
  – Hydrocodone at discharge
Medications
- Morphine IV
- Bupivacaine via epidural
- Paroxetine (Paxil) 10mg once a day
- Carbidopa and levodopa (Sinemet) 25-100 qid
- Senokot 2-4 tabs daily

Medication Review

› **Morphine**¹
  - Opioid analgesic classified as a strong agonist and listed as a Schedule II controlled substance.
    - Used to treat severe pain primarily affects the Mu receptors
    - Clinically indicated for the treatment of post operative pain

- Adverse effects
  - Sedation
  - Respiratory depression
  - Constipation
  - Orthostatic hypotension
Medication Review

› Bupivacaine
   – Local anesthetic used as an epidural block which blocks the action potential along neurons

› Paroxetine (Paxil)
   – An antidepressant used to treat general anxiety disorders
   – Serotonin Selective Reuptake Inhibitor (SSRI)
     ‣ Selective effect in blocking serotonin
   – Adverse effects
     ‣ GI issues (nausea, vomiting, constipation or diarrhea) most common

Medication Review

› Carbidopa and levodopa (Sinemet)
   – Provides dopamine which is insufficient in the brain
   – Crosses blood-brain barrier
   – Adverse effects
     ‣ Nausea and vomiting
     ‣ Cardia arrhythmias
     ‣ Orthostatic hypotension
     ‣ Dyskinesias
     ‣ Behavioral changes
     ‣ Diminished response
Medication Review

› Senokot<sup>3</sup>
  – Stool softener
  – Often given in conjunction with opioids
  – Adverse effects
    › Nausea, vomiting or cramping
    › Fluid and electrolyte imbalances in long term use

Things that should make you go hmmmmm

› Post surgical
  – Orthostatic hypotension
    › Blood loss (check lab values)
    › Opioids
    › Parkinson’s medication (Sinemet)
  – Risk for deep vein thrombosis (DVT)
  – Pain management consequences
• Implications for the Physical Therapist

› Examination
  – Mental status
    › Impact of pain medications
  – Depression screening
    › Use of antianxiety medication
  – Lab values
    › White blood cells 4.0 \(10^9/L\) - normal 5.0-10.0 \(10^9/L\)
    › Platelets 210 k/uL – normal 140-400 k/uL
    › Hemoglobin 11 g/dL – normal 12-16g/dL
    › Hematocrit 32% - normal 37-47%
  – Pain assessment
  – Mobility assessment
  – ROM/Strength assessment

Examination

› Vital Signs
  – Post operative for TKR
  – Medications know to cause hypotension
    › Opioids
    › Sinemet
  – Change in heart rate
    › Pain
    › Blood loss
Examination

› Mobility assessment
  - Impact of pain
  - Impact of Parkinson’s Disease
  - Impact of Sinemet
  - Fall risk assessment – maybe?

Implications for the Physical Therapist

› Interventions
  - Therapeutic exercise
  - Mobility training
    › Weight bearing restrictions
    › Ability to follow commands
    › Pain control and impact to mobility
  - Monitor vital signs
  - Monitor pain levels
  - Check lab values
Summary and Questions

› Role of the therapist in DVT management

› Impact of therapy scheduling
  – Day 1 post-op
  – Timing of Sinemet administration
  – Timing of pain medication

› Role of the PT in opioid use
  – ChoosePT campaign – chronic and long term pain
  – Short term pain management

Overview – Adverse Effects

› Vital sign monitoring
  – Cardiac medications
    › Betablocker
    › Diuretic
  – Opioids
  – Sinemet
    › Anticoagulants

› Fall risk assessments
  – Orthostatic hypotension
    › Cardiac medications
    › Opioids
    › Sinemet
Overview – Adverse Effects

› Muscle strength
  – Weakness
    › Diuretics
    › Atorvastatin
    › Bleeding
      – Anticoagulants

› Depression screening
  – Anxiety medications

Final Thoughts and Questions

› Our role in understanding medications
  – Setting specific
    › Resources available
    › Acute care setting
      – More frequent medication changes
      – Impact of condition and new medications
  – Implications to our examination or intervention
    › Mental status
    › Pain
    › Altered lab values
    › Co-morbidities
    › Adverse effects of various medications
Resources

› The internet
  – For example:
    › Drugs.com
    › Medscape
    › WebMD
    › Numerous apps related to pharmacology
      – Be discerning

› Text books

› Journal articles

› American Physical Therapy Association website

› Academy of Acute Care Physical Therapy website

References


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