Anesthesia Fundamentals – Drugs & Anesthetic Phases

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AIMS OF LECTURE

Anesthesia in both human and veterinary medicine is a multifaceted specialty of medicine & requires the anesthetist to be knowledgeable in all aspects of anesthesia. This lecture will discuss the basics or fundamental aspects of the pharmacology of anesthetic drugs & the phases of anesthesia that all anesthetists should understand at a minimum to ensure your patient receives adequate and successful anesthetic care.

ANESTHETIC DRUGS & PHARMACOLOGY

All medical professionals should understand the purpose, the good & bad effects, and how to mitigate the negative effects of each pharmaceutical drug used in practice - *particularly for anesthetic agents*. Understanding the receptor profile of each drug will aid the anesthetist in choosing an anesthetic drug protocol effectively & aid in identifying and mitigating certain negative side effects.

- Opioids – *understand the difference between the main opioid receptors (mu-μ vs kappa-κ) and stimulation type (partial vs full, agonism vs antagonism), understand the pros & how to troubleshoot the cons of each opioid available in veterinary medicine*
    - **morphine** – PRO = great analgesic particularly through epidural route, CON = histamine release & pro-emetic
    - **hydromorphone** – PRO = great sedation and analgesia, CON = pro-emetic
    - **methadone** – PRO = multifactorial analgesia & non-pro-emetic, CON = less sedation
    - **fentanyl** – PRO = potent analgesia & sedation, CON = short duration of action
    - **buprenorphine** – PRO = less likely to cause dysphoria, CON = less analgesic properties
    - **butorphanol** – PRO = safe & effective sedative, CON = no analgesic properties
- dexmedetomidine (alpha/α2-agonist) – *understand where alpha/α2 receptors are located in the body & their effects (particularly to the CV system and CNS), how to troubleshoot the negative effects of dexmedetomidine (particularly the cardiovascular/CV effects)*
    - Located centrally in the brain/spinal cord (provides sedative & mild analgesic properties) and peripherally in the vasculature (provides vasoconstriction when stimulated/agonized)
    - CV effects are biphasic – Phase 1 = vasoconstriction + reflex bradycardia & Phase 2 = vasodilation + maintained bradycardia that results in systemic hypotension
        - Anticholinergics should only be instituted during Phase 2
    - Endocrine effects also exist – inhibits insulin which causes hyperglycemia & inhibits antidiuretic hormone which increases urine production / dilutes urine
        - Should be avoided in patients with diabetes mellitus or renal dysfunction
- Zenalpha (central alpha/α2-agonist + peripheral alpha/α2-antagonist) – *understand the 2 agents in Zenalpha (medetomidine + vatinoxan) & how each impacts sedation vs physiologic effects, know what patients and situations Zenalpha is or is not indicated*
    - The medetomidine provides central effects (sedation & analgesia), while the vatinoxan provides peripheral vascular effects that counteracts the traditional CV changes seen with dex/medetomidine (less vasoconstriction & bradycardia seen)
    - Indicated only for intramuscular administration & short duration sedatives → contraindicated prior to general anesthesia and in cats (*only labelled for use in dogs*)

- acepromazine (alpha/α2-antagonist + dopamine/DA-agonist) – *understand where acepromazine works in the body & its effects (particularly to the CV system and CNS), how to troubleshoot the negative effects of acepromazine (particularly the cardiovascular/CV effects)*
    - Provides centrally-mediated sedation in the brain (via dopamine/DA agonism) and peripherally-mediated vasodilation (via alpha/α2-antagonism) – no analgesic properties
    - PROs = effective sedation, anti-emesis, anti-histamine, anti-dysrhythmic
    - CONs = no analgesia, peripheral vasodilation that can result in systemic hypotension
- ketamine (NMDA-antagonist + many other receptors…) – *understand where ketamine works in the body & its effects (particularly to the CV system & pain pathway), how to choose ketamine for the right patients and scenarios*
    - Provides multifaceted effective sedation/anesthesia & somatic/neuropathic/chronic analgesia (less so visceral/acute analgesia)
        - Neuroprotective properties in cases of traumatic brain injury (TBI)
    - CV effects are bispectral – increased HR & vasoconstriction in healthy patients vs direct cardiac depressant in critically ill patients (e.g. sepsis or decompensated shock)
        - REMEMBER: Low-dose boluses or infusions safe to utilize in almost all patients
- Benzodiazepines (midazolam & diazepam) – *be able to identify which patients will or will not respond well to benzodiazepine sedation, understand pros & cons of benzodiazepines*
    - Benzodiazepines heighten the current mentation/temperament of the patient – benzos provide effective sedation only in patients who are either extremely calm and/or very ill
    - PROs = sedation (in the correct individual), anti-convulsant, minimal CV effects
    - CONs = ineffective sedation / dysphoria (in the incorrect individual); diazepam has the following negative effects: only IV route, painful on injection, hypotension with fast administration, liver failure (cats)
- lidocaine (Na-channel antagonist) – *understand how lidocaine works & the pros vs cons it provides to anesthetic care, know which patients are at higher risk of lidocaine toxicity*
    - PROs = analgesia through complete inhibition of pain sensation transmission – *primary PRO*; sedation, anti-dysrhythmic, anti-oxidant/anti-inflammatory properties
        - Beneficial in inflammatory cases such as pancreatitis, parvo-virus, sepsis
    - CONs = bradycardia, nausea, and CNS/CV toxicity
        - Toxicity more likely in cats – avoid lidocaine administration or utilize lower doses
- Induction agents (propofol & alfaxalone) – *understand the purpose of these agents and the pros vs cons of each*
    - Purpose = induction of anesthesia only – should not be used as a “sedative” with the exception of alfaxalone via intramuscular administration
    - PROs = short duration of action, hepatic-function sparing (propofol only), can be used for “sedation” via intramuscular route (alfaxalone only)
    - CONs = respiratory depression (dose-dependent) & no analgesic properties – *primary CON*s; myoclonus, Heinz-body anemia (cats with repeated propofol administration)
- Inhalants / volatile anesthetics (isoflurane & sevoflurane) – *understand the purpose of these agents and the pros vs cons of each*
    - Purpose = maintenance of anesthesia only (provides only amnesia & immobility) – should not be used for induction
    - CONs = significant cardiovascular and respiratory depression, no analgesic properties
        - Always aim to utilize below MAC (i.e. MAC reduction) anesthesia techniques
- Reversal agents (naloxone, flumazenil, atipamezole) – *know when reversal agents are indicated & their expected effects*
    - Consider route of administration, duration of action, and if reversal is truly indicated

ANESTHETIC PHASES

Each phase of anesthesia serves a specific purpose & requires certain requirements to occur smoothly. Understanding each anesthetic phase will aid the anesthetist in achieving safe & effective anesthesia. Below are the 5 phases of anesthesia – *with the first phase often forgotten as an important step*:

- Case Preparation – *determine anesthesia goals based on specific patient & procedure considerations, not based on the specific drug protocol*
    - Consider Patient = signalment (life stage, temperament, breed), health & ASA Status
    - Consider Procedure = duration, invasiveness, expected risks or complications
- Sedation / Pre-Med – *determine goals for sedation & which drugs fulfill these goals*
    - Consider how oral sedatives impact your sedation goals & subsequent drug choices
    - Utilize multimodal techniques (i.e. more than one drug to achieve goals at lower doses)
- Induction – *determine goals for induction & what drugs/techniques fulfill these goals*
    - Co-induction techniques (utilization of more than 1 induction drug) are always beneficial
    - Consider if certain or additional supplies will be necessary for efficient intubation
- Maintenance – *understand how to monitor anesthetic depth & prepare for fluctuations in depth*
    - Ideal Surgical Depth = Stage 3 - Plane 2-3 (primarily depicted by medioventral eye position and loose jaw tone; additionally moist eye and loss of palpebral reflexes)
        - Monitor the patient – not just the monitor/vital signs – as best indicator of depth
    - Utilize multimodal techniques (e.g. local regional techniques/nerve blocks, infusions) to achieve MAC reduction (i.e. reduced inhalant anesthetic requirements)
- Recovery – *prioritize providing a smooth & uneventful recovery*
    - The recovery phase has the highest morbidity & mortality rates of all anesthetic phases
    - Plan ahead for additional sedatives and/or analgesics required during recovery
    - The anesthetist should ensure the patient achieves the “4 Ns” post-extubation:
        - Normoxia (normal SpO2)
        - Normotensive (normal BP)
        - Normothermic (normal temp)
        - Non-painful (determined via pain-scoring)

RESOURCES:

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Home page. North American Veterinary Anesthesia Society. *https://www.mynavas.org/*