Never Too Young or Too Old For Drugs – Pediatric & Geriatric Anesthesia

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AIMS OF LECTURE

The impact of concurrent disease(s) is typically an obvious consideration when performing anesthesia, however this consideration should also be applied to various life-stages for veterinary patients receiving anesthesia. Many veterinary practices care for patients of all life-stages & this requires veterinary teams to be well-versed in how each life-stage adds specific challenges to performing successful anesthesia.

LIFE-STAGE

The young life-stage includes neonates (< 6 weeks of age) & pediatrics (3-6 months of age), while the old life-stage includes geriatrics (> 7 years of age). Each age group has varying physiologic variables specific to their life-stage & is fluctuant as the animal ages; thus it is important the anesthetist consider how physiologic variables may be altered in an anesthetized animal based on their life-stage. Given the variety of animals seen in veterinary medicine, the breed and species of animals makes classification of what is considered "geriatric" difficult. For example - a 7 year old Chihuahua is not experiencing the same age-related physiologic changes as a 7 year old Great Dane. With the older population, rather than considering age alone, it is more accurate to consider whether the geriatric animal exhibits signs of ***frailty*** which is "a clinical syndrome depicted by decreased physiologic reserve & function across multiple organ systems that leads to increased adverse health outcomes". A geriatric patient may or may not be frail, which alters how the anesthetist considers anesthetic goals. Geriatrics have been shown to have a 7 times increase in peri-anesthetic morbidity & mortality, thus we should provide more anesthetic support.

KEY ORGAN SYSTEMS

While there is a plethora of changes occurring throughout various parts of the body depending on an individual's life-stage, there are a few key systems of notable alteration that the anesthetist should be mindful of: *cardiovascular, respiratory, nervous, hepatic, renal, and tissue compartments.* Below are key alterations that occur for each of the above organ systems & how these changes are either similar or vastly different for each life-stage:

- CARDIOVASCULAR
    - Pediatrics = immature contractility (inotropy) & vascular tone function (SVR), limited stroke volume (SV), reliant on heart rate (HR) to maintain cardiac output (CO)
        - Maintain normal-high HR → *avoid or quickly treat bradycardia*
        - Ensure adequate preload → *only provide fluid therapy if hypovolemia present*
        - Expect lower blood pressure → *MAP 55-65 mmHg is normal at this life-stage*
    - Geriatrics = reduced contractility & vascular tone function, reduced stroke volume capacity, reliant on atrial kick to maintain cardiac output, predisposed to dysrhythmias
        - Maintain contractility → *reduce inhalant (negative inotrope), supplement with positive intrope agents (e.g. beta-agonist drugs like dobutamine or dopamine)*
        - Ensure adequate preload → *only provide fluid therapy if hypovolemia present*

- RESPIRATORY
    - Pediatrics = higher oxygen (O2) consumption from metabolic needs, limited functional residual capacity (FRC), high respiratory muscle & rib compliance results in resp. fatigue
        - Preoxygenate always → *provide O2 supplementation at all phases of anesthesia*
        - Assist ventilation → *provide PPV (IPPV or CMV) to prevent ventilatory fatigue*

    - Geriatrics = reduced lung volume capacities, reduced gas exchange function, +/- obesity
        - Preoxygenate always → *provide O2 supplementation at all phases of anesthesia*
        - Assist ventilation → *provide PPV (IPPV or CMV) to prevent ventilatory fatigue, utilize a peak-end-expiratory-pressure (PEEP) valve to prevent atelectasis*

- NERVOUS
    - Pediatrics = increased blood-brain barrier permeability, caudal termination of spinal cord
        - Utilize lower doses → *less anesthetic needed due to increased brain access (i.e. MAC reduction)*
        - Careful with neuraxial techniques → *more likely to perform spinal (rather than epidural) local anesthetic technique*
    - Geriatrics = reduced neurotransmitter production, release, and affinity
        - Utilize lower doses → *less anesthetic needed due to less excitatory neurotransmission present (i.e. MAC reduction)*

- HEPATIC
    - Pediatrics = immature albumin production, limited enzyme activity, limited glucose stores
        - Expect lower blood pressure → *MAP 55-65 mmHg is normal at this life-stage due to reduced oncotic pressure secondary to lower albumin levels*
        - Expect profound & prolonged drug effects → *low albumin allows for more free/active drug to circulate & lower hepatic metabolic abilities prolongs effects*
        - Monitor blood glucose (BG) → *avoid fasting neonates & provide palm-sized meal morning of anesthesia for pediatrics, monitor BG every 30-60 min peri-anesthetically & supplement as needed*
    - Geriatrics = reduced albumin production, reduced metabolic clearance function
        - Anticipate lower blood pressure → *hypoalbuminemia will predispose to systemic hypotension due to reduced oncotic pressure & should be treated accordingly*
        - Expect profound & prolonged drug effects → *low albumin allows for more free/active drug to circulate & lower hepatic clearance abilities prolongs effects*

- RENAL
    - Pediatrics = immature renal function & glomerular-filtration rate (GFR)
        - Expect prolonged drug effects for actively-excreted drugs → *applies to ketamine*
        - Higher IV fluid requirements → *peri-ax maintenance IVF rates = 10 mL/kg/hr*
    - Geriatrics = reduced GFR, reduced response to anti-diuretic hormone (ADH)
        - Expect prolonged drug effects for actively-excreted drugs → *applies to ketamine*
        - Anticipate electrolyte & fluid-status abnormalities → *assess & treat accordingly*

- TISSUE COMPARTMENTS
    - Pediatrics = limited body fat content, higher body water content, high surface area:mass
        - Expect variable drug effects & dose requirements → *pharmacokinetics altered – low fat content = dose-reductions vs. high water content = dose-increases*
        - Higher IV fluid requirements → *peri-ax maintenance IVF rates = 10 mL/kg/hr*
        - Assist thermoregulation → *institute warming measures to prevent hypothermia*
    - Geriatrics = +/- higher body fat content with obesity, reduced body water content
        - Expect prolonged drug effects → *higher fat content prolongs pharmacokinetics*
        - Utilize lower doses → *less anesthetic needed due to lower water content allowing quicker brain access & rapid drug response (i.e. MAC reduction)*

OTHER CONSIDERATIONS

Thorough and appropriate case preparation is vital to ensure a pediatric or geriatric patient experiences a safe & successful anesthetic event. It is important that the anesthetist consider if any pre-anesthetic diagnostics are worthwhile - *e.g. PCV for a puppy OVH or thoracic radiographs in a geriatric*. Utilization of multimodal anesthesia techniques, such as locogregional / nerve blocks, will reduce the inhalant requirements & any negative side effects these physiologically-sensitive patients may experience. Given how physiologically altered each life-stage is, these individuals will require more assistance during the recovery period & the anesthetist should ensure the patient receives attentive care for a smooth & uneventful recovery period. With the geriatric population, it is important to distinguish between body condition score (BCS) vs muscle condition score (MCS), as both provide different information regarding the individual's fat content (i.e. ax challenges secondary to obesity) vs metabolic & muscular function (i.e. ax challenges secondary to muscles of respiration). One very important aspect to ensure is addressed prior to anesthesia is indications of pain. Many geriatric patients often suffer from chronic pain - which may or may not have been identified (e.g. osteoarthritis is often missed in geriatric cats) - and the anesthetist must work to either treat or prevent worsening of any present pain. Finally, considering a step-wise approach to a geriatric animal's care is important – it may be prudent to consider staging care procedures to reduce the higher risk that comes with longer duration anesthesia events (i.e. > 4 hours).

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