PATIENT EXAMINATION, ANESTHETICS

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Definitions

- Premedication
  - Pharmacological intervention prior to induction of general anesthesia (see later)
- Sedation (sedativum, e.g. phenothiazines)
  - Calming
- Anxiolysis (anxyolyticum, e.g. benzodiazepines)
  - Reduction of fear
- Analgesia (analgeticum, e.g. opioids, NSAIDs)
  - Pain relief

Definitions

- Hypnosis (hypnotikum, e.g. propofol)
  - Pharmacologically induced ‘sleep’
- Catalepsy (e.g. ketamine)
  - Myoclonic jerking of the extremities
  - Palpebral, corneal, pharyngeal, laryngeal reflexes are retained

Definitions

- Neuroleptanalgesia (NLA)
  - Superficial ‘sleeping’ and analgesia
  - Phentothiazine (or butyrophenone) and opioid combination
- Ataranalgesia
  - Superficial ‘sleeping’ and analgesia
  - Benzodiazepam and opioid combination

Definitions

- Anesthesia
  - Local, regional, general anesthesia
  - Absence of sensation in a certain body region or the entire body
- General Anesthesia
  - Hypnosis + analgesia + muscle relaxation
    (alternatively: a reversible state of unconsciousness and insensitivity, which features analgesia, muscle relaxation, and hyporeflexia)
Definitions

- **Balanced anesthesia**
  - Achievable with combination of drugs; the following states may be ‘steered’ with variations in their doses:
    - Consciousness altered via anesthetics;
    - Pain controlled via analgesics;
    - Muscle relaxation modified using muscle relaxants

- **Dissociative anesthesia**
  - Catalepsy, peripheral analgesia, alteration in consciousness
  - Dissociation: thalamus, limbic system, cortex

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Nationale (Signalement)

**Species**
- Dog, cat

**Breed**
- Greyhounds
  - Thiopental? (relative overdose, delayed awakening)
  - Recumbency (decubitus, nerv damage)
  - Dobermann
  - DCMP, blood clotting disorder
  - Staffordshire terrier, greyhounds, Haflinger horse
  - Alfa2-agonists?
  - Boxers
  - Phenothiazines? (hypotension)

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**Breed**
- Brachycephalic breeds
  - Preoxygenation, short induction, fast intubation, late extubation (suffocation)
- Large breeds and individuals
  - Sensitive to hypoxia
  - 'Warm blood' types and individuals
  - Decreased effect of sedatives
  - Higher metabolic rate
**Sex**
Male
- Cryptorchid?
- Castrated?

Female
- Pregnant?
- Spayed?

**Age**

**Newborn and young patients**
- Metabolism and excretion undeveloped
- Hypoglycaemia
- Hypoxia
- Hypothermia
- Sensitive fluid homeostasis

**Elderly patients**
- Lengthened circulation time (delayed anesthetic effect)
- Water content of cells decreased, fat content increased
- Lower compensation capacity (stress, load, hypoxia)

**Body Mass (Weight)**

**Dose:** mg/kg or mg/m² (bs m² ≈ 0.1 x bwkg²/₃)

**Recommended doses of alpha₂-agonists depending on bwkg**

**Anamnesis (Patient History)**

**Body weight measuring or calculation**
- ie. Equimax measuring tape (equine chest circumference behind the withers strongly correlates with body weight)

**Dose calculation based on body weight or body surface area?**
- ie. medetomidine (m² = 0.1 x bwkg²/₃)

**Abnormal body weight**
- Obese (smaller dose per bwkg)
- Cachectic (reduced liver function, TPP ↓, drug metabolism ↓)
Patient History

- Prior illness?
- Surgery, anesthesia? Complications, consequences?
- Recent general state?
- Epilepsy?
- Coughing? Performance decrease?
- Feeding? Vomiting, diarrhea?
- Urinary complaints?
- Pruritus?

Prescribed Medication

- Continuation of drug courses!
  - Heart disease, endocrine disorder, epilepsy, etc.
- Interactions?
  - I.e. certain antibiotics: increase the duration of some anesthetics
- Known drug sensitivity, allergy?
- Previous anesthesia during administration of medication?

Status Praesens (Physical Exam.)

General state, Nutritional state

Examination of the general and nutritional state
- Neurological disturbances, shock?
- Determination of consciousness
- Sedation required?

Respiration

Circulation, heart function

Respiratory examination
- Auscultation, X-Ray
  (thrills, oedema, inflammation, pneumothorax /PTX/, diaphragmatic hernia, hemothorax, tumor)

Circulatory examination
- Capillary refill time /CRT/ (peripheral circulation)
- Mucous membranes (cyanosis, anemia, hemorrhage, shock)
- Pulse (frequency, quality, pulse deficit, hypovolaemia, shock, blood pressure determination)
- Skin tension (dehydration, kidney function)
Heart function examination
- Auscultation, ECG, US (murmurs, valvular insufficiency, arrhythmia, other anomalies)
Lymph nodes, temperature

Lymph node examination
- Inflammation, tumor/metastasis

Body temperature examination
- Hypothermia, hyperthermia (excitation), fever

Laboratory

Minimal Examination
- White blood cell (WBC)
- Hematocrit (HT)
- Total plasma protein (TPP)
- Creatinine (Crea)
- Carbamide (Urea)
- Alanine-transaminase (ALT)
- Asparagine-transaminase (AST)

Laboratory

Expanded examination
- Large blood count (e.g. leukopenia, leucocytosis, eosinophilia)
- Blood clotting (ie. bleeding of unknown origin, disseminated intravasal coagulopathy /DIC/, certain tumors, dobermann congenital coagulation problems
- Blood-gas analysis (ie. shock state, lung alteration, hyperventilation due to cranial or brain trauma)

Laboratory

Expanded Examination
- Electrolyte metabolism (ie. frequent vomiting, diarrhea, kidney failure)
- Blood glucose
- Urine examination

Anesthesia Plan

ASA Risk Categories (small animals)

American Society of Anesthesiologists

ASA 1
- Healthy, symptom-free state
- And/or: 6 weeks - 5 years

ASA 2
- Mild systemic disease, no functional disorder apparent
- And/or: 3 days - 6 weeks, 5-8 years
ASA Risk Categories (small animals)

ASA 3
- Severe systemic disease with visible functional impairment, but non life threatening status
- And/or: 8-10 years

ASA 4
- Severe systemic disease, constant threat to patient’s life
- And/or: 0-3 days, over 10 years of age

ASA 5
- Moribund status, the patient is very likely to die within 24 hours, with or without the surgery
- E (Emergency)
- No time for classification (CEPOD I.)

ASA Risk Categories (small animals)

ASA 4
ASA 2
ASA 1
ASA 2
ASA 3
ASA 4

CEPOD emergency classification

Confidential Enquiry into Perioperative Deaths

CEPOD I: immediate, life-saving intervention
CEPOD II: urgent intervention
CEPOD III: intervention planned for near future
CEPOD IV: delayable intervention

Planning the Surgery

- Written permission from owner
- Time and duration of intervention
- Type of anesthesia and analgesia
- Preparations for emergencies
Fasting, withholding water

Fasting
- 6 hours before anesthesia/surgery
  (exception: very young, very small, emergency,...)

Stabilization

Compensation of anomalies
- Dehydration, electrolyte imbalance, acidosis
  (infusion therapy)
- Anemia, coagulation disturbances, severe blood loss
  (transfusion)

Antibiotics

Application
- 1 day prior to surgery im., sc.
- or 1 hour prior to surgery iv.

Prophylactic antibiotics
- Antibiotics that reach high concentration in sc.
  tissues (lower risk of contamination)

General anesthesia

Premedication
Induction
Maintenance
Recovery

Premedication

Positive effects:
- ↓: pain, stress, fear, aggression, O₂-demand,
  accident risk
- ↓: anesthetic dosage, side effects, material expenditure,
  costs
- Elimination of excitation stage, balanced anesthesia

Induction

Intravenous access (vein cannulation)
- Reasons: drug administration, fluid therapy, emergencies
- Routes in small animals: v. cephalica, v. saphena
  (or possibly v. jugularis)

Induction using injectable (or inhalant) anesthetics
- Anesthetics with moderate (or NO) side effects, rapid
  onset of action, short duration or counteractable
- The patient reaches an unconscious, intubatable status
- Endotracheal tube introduction
Maintenance

Possibilities
- Injectable (IM., IV./TIVA), inhalational or combination

Goals
- Minimal drug expenditure, surgical tolerance (unconsciousness, lack of perception, analgesia, muscle relaxation)

The main role of the anesthesiologist
- Control the depth of anesthesia, patient monitoring, maintain homeostasis

Recovery

Ending anesthetic administration
- Elimination

Extubation
- After the return of the swallowing and coughing reflexes

Stages of Narcosis (Stadium)

I. St. analgesiae = induction phase
II. St. excitationis = excitatory phase
III. St. tolerantiae = surgical narcosis
   (Stage III. was formerly divided into four substages)
   - III/1. Superficial anesthesia
   - III/2. Surgical tolerance
   - III/3. Deep anesthesia
IV. St. asphyxiae = overdose, asphyxia (suffocation)

Ether Narcosis (Guedel 1951)

Halothan Narcosis
### I. Stadium analgesiae = induction phase
- Strongly influenced by condition and temperament
- Transition towards an unconscious state
- Increasing immobilization, ataxia, lying down
- At the end of the stage pain sensation ceases
- Excitation, resistance, increased heart rate
- Irregular breathing pattern, increased respiration rate
- Dilated pupils, salivation, urination, defecation
- Prolapsed third eyelid, yawning, vocalization
- Reflexes retained, reaction may be delayed
- Coughing reflex present, intubation not possible
- Only lasts a few seconds during IV induction

### II. Stadium excitationis = excitatory phase
- Loss of conscious control
- Uncontrolled, unpredictable reactions
- Tachycardia, arrhythmia, hypertension
- Increased respiratory rate, irregular respiration
- Dilated pupils, delayed ocular reflex, nystagmus
- Coughing reflex and swallowing reflex retained, intubation not possible
- Phase is very short during IV induction; only characterized by: muscle tremor, muscle rigidity

### III. Stadium tolerantiae = surgical narcosis
#### III/1. Superficial anesthesia
- Calm, relaxed recumbency
- No reaction to minor pain or provocation
- Uncoordinated reaction to surgical manipulation
- Pulse and blood pressure normalizes, arrhythmias disappear
- Respiratory rate normalizes, returns to normal rhythm
- Pupillary diameter normal or slightly constricted; other eye reflexes not present
- Eyeball turned inward (abrotation)
- Muscle tone reduced or absent
- Patient may be intubated

#### III/2. Surgical narcosis stage
- The signs of superficial anesthesia strengthen
- No visible reaction to surgical manipulation or pain provocation

### IV. Stadium asphyxiae = suffocation
- Maximum inhibition of central nervous system
- Cardiopulmonary depression, shock
- Decreasing blood pressure and pulse rate
- Barely palpable, weak pulse
- Pale mucous membranes
- Capillary refill time over three seconds
- Irregular heart function, heart failure
- Completely dilated pupils
- No turgor in the cornea
IV. Stadium asphyxiae = suffocation

- Immediate resuscitation required!!!
- Resuscitation unsuccessful if after 5 minutes:
  - pupils do not constrict,
  - the cornea has no turgor,
  - heart function is unsatisfactory,
  - blood pressure cannot be measured,
  - etCO₂ is beneath 10 mmHg

“An ideal anesthetic”

- Usable in all species and breeds
- Wide therapeutic index and application spectrum
- Rapid onset of action
- Short duration of action or antagonizable
- Usable with patients in all risk categories
- Strong analgesic
- Calming, hypnotic, muscle relaxant (dose dependent)
- Long shelf life, easily obtained, cheap
- Does not exist 😞 (combination required!)

Anesthetics

- Anticholinergs (atropine, glycopyrrolate)
- Phenothiazines (ACP)
- Benzodiazepines (diazepam, midazolam)
- α₂-agonists (xylazine, medetomidine,…)
- Opioids (fentanyl, morphine, butorphanol, tramadol)
- Barbiturates (thiopental)
- Steroid anesthetics (alfaxalone)
- Intravenous hypnotics (propofol, etomidate)
- Dissociative anesthetics (ketamine)
- Inhalant anest. (sevoflurane, isoflurane, halothane)
- NSAID’s (carprofen, meloxicam)
- Local anesthetics (lidocaine, bupivacaine)
- Muscle relaxants (rocuronium, …)

Anticholinergs

- Atropine
  - Not used routinely (0.01-0.02 mg/bwkg iv.)
  - If bradycardia present (in case of opioids: OK, in case of α₂-agonists: after normalisation of blood pressure)
  - For treatment of AV- and SA-blocks
  - Reduces gland secretion and bronchospasm
- Glycopyrrolate
  - See: atropine
  - Delayed onset and longer duration of effect (0.005-0.01 mg/bwkg iv.)
  - Blood/brain and placenta barrier: no getting through

Phenothiazines

- Acepromazine (ACP) po., sc., im., iv.
  - good general state, young/adult restless/aggressive patients
  - 0.02-0.051 mg/bwkg im. (dose ↑ - duration ↑ 4–48 h)
  - Calming, vasodilation, blood pressure ↓ (boxer), tachycardia
  - Negative inotrope, antiarrhythmic
  - Anticholinergic, antiemetic, antihistamine effect
  - Platelet function ↓ (dobermann)
  - Resp. frequency ↓, volume ↑, minute volume ↔
  - Thermoregulation ↓, threshold to seizures ↓ (neur. NO!)
  - No hypnotic or analgetic effect
  - Neuroleptanalgesia (NLA) in combination with opioids
**Benzodiazepines**

- Diazepam iv., midazolam im., iv.
  - Small animals: 0.5 mg/bwkg iv.; old, bad general condition, risk patients
  - Antagonist: 0.03 mg/bwkg flumazenil (Anexate)
  - Calming, fear reduction
  - Anticonvulsive, antiepileptic, m. relaxant (catalepsy ↓), recommended for neurological patient
  - Minimal circulatory depression, in high doses respiratory depression
  - Paradox symptoms in healthy, young animals, salivation
  - Ataralgesia in combination with opioids
  - Diazepam not for liver patients

**α2-agonists**

- Dexametomidine, medetomidine, xylazine im. (iv.)
  - Sedation 1-10 µg/bwkg im., not for high risk patients
  - Medetomidine im. (surface area more precise) dog 10-40 µg/bwkg, cat 20-80 µg/bwkg (up to 30 µg/bwkg effect ↑; higher dose: duration ↑)
  - Xylazine 0.5 mg/bwkg (dog ↓, cat ↑)
  - For sedation / induction / maintenance in combination
  - Recommended in combination (e.g. ketamine) may be dosed to effect
  - Antagonist: atipamezol 0.05-0.2 mg/bwkg im.

**α2-agonists**

- Sedation (1-10 h), relaxation, short analgesia
- Circulatory depression, xylazine respiratory depr.
- Vasoconstriction, 5-10 min hypertension, reflex bradycardia, hypotension, HMV ↓, peripheral hypoperfusion
- I-II. degree AV-block
- Myocardium sensitized to catecholamines
- Emetic, uterine constrictor
- Swallowing reflex eliminated
- Stomach bloat (swallowing air, motility ↓)
- Thermoregulation ↓
- Catecholamine ↓, cortisol ↓, insulin ↓, blood G ↑

**Opioids**

- Fentanyl (15-30 minutes)
  - Pure agonist
  - 2-5-20 µg/bwkg iv. (20 µg/bwkg/hour) small animals
  - Somatic analgesia
  - Moderately sedative, may be combined well
  - Resp. depression, sinus bradycardia may occur
  - No histamine release
  - Hyperacusia rare

- Morphine (4-6 h)
  - Pure agonist
  - 0,1-0,3 mg/bwkg im.,sc.
  - Onset of action: iv. 15-30 (im. 90) min
  - Metabolism in liver (longer effect in liver- and kidney-failure)
  - Histamine release after high dose iv. appl.
Opioids

- **Buprenorphine (3-8 h)**
  - Partial µ-agonist, strong affinity (difficult to antagonise)
  - 10-20 µg/bwkg im., iv., sc. (oral mucous membr.)
  - Onset of action: 30-40 min

- **Butorphanol (1-5 h)**
  - Partial µ-agonist and κ-antagonist
  - 0.1-0.3 mg/bwkg iv. (sc.)
  - Moderate analgesia, visceral
  - Potentiates, antiemetic, antitussive

- **Tramadol**
  - Metabolism in liver → opioid agonist metabolite
  - Mild analgesia (dog, cat)
  - 2-4 mg/bwkg iv., im.
  - 2-3 x 2-10 mg/bwkg po. (long treatment possible)

- **Naloxon**
  - Pure antagonist
  - Warning: analgesia stops and rebound effect
  - Duration of action: 30-40 min
  - 40 µg/bwkg im., iv.

Barbiturates

- **Thiopental iv.**
  - Ultrashort acting barbiturate (10-20 sec → 5-10 min)
  - Small animals 20-25 mg/bwkg iv.
  - Rapid redistribution (brain, muscles → fatty tissue)
  - Cumulative, deposits in fatty tissue
  - Slow metabolism in liver
  - Neg. inotropic, vasodilatation, reflex tachycardia
  - Resp. frequency and TV ↓
  - Brain volume and IC pressure ↓, O₂ demand ↓
  - Use carefully (not recommended in patients with: unstable circulation, reduced plasma protein-binding, limited metabolism)

Steroid anesthetics

- **Alfaxalone for small animals slowly iv.**
  - Cat sedation: 5-10 mg/kg im.!
  - Unconscious: 5 mg/kg, intub.: 10 mg/kg iv. (10-15 m)
  - 0,5 mg/kg diazepam + 5 mg/kg alfaxalone
  - 0,05-0,1 mg/kg ACP + 3-4 mg/kg alfaxalone
  - Excitation poss. at awakening
  - Resp. frequency ↓, tidal volume ↑, minute volume ↔
  - Cardiovasc. side effects minimal

  - **Alfaxalone + alfadolone (analgetic)**
    - With cremophore: not for dog! (His release)
    - In cat combination with ACP (antihistaminic)
**Iv. hypnotics – Alkyl-phenoles**

- Propofol slowly iv.
  - 5 mg/bwkg iv. (with premedication ↓, without ↑)
  - In every patient group (induction + maintenance)
  - Alone (no analgesia!) or in combination
  - Before 2001: use within 6 h
  - Excitation free, hypnosis, muscle relaxation
  - Rapid onset, short (few minutes) duration, wide therapeutic range, not cumulative, may be re-dosed or continuously applied (CRI)
  - Respiratory depression: frequency and TV ↓
  - Brain volume and IC pressure ↓, O₂ demand ↓

**Iv. hypnotics – Imidazoles**

- Etomidate iv.
  - 2-3 x 0.2 mg/bwkg to effect iv.
  - Propilen-glycol solution / lipid emulsion
  - Rapid onset, short duration of action
  - Non cumulative
  - Cardiovascular effect minimal (vasodilation, myocardial depression), for hearth patients!
  - Respiratory depression minimal
  - Brain volume and IC pressure ↓, O₂ demand ↓
  - Pararenal gland cortisol production ↓ (8 h), 1 mg/bwkg prednisolone may be applicated
  - Excitation, vomitus possible

**Dissociative anesthetics**

- Ketamine im., iv.
  - Induction: 2-10 mg/bwkg iv. (0,5 mg/bwkg NMDA block)
  - Catalepsy (may be counteracted by benzodiazepines)
  - Wide th. range, analgesic (weak on serous membr.)
  - Sympathetic tone ↑, blood pressure ↑, hearth frequency ↑, hearth min. vol. ↑, O₂-demand ↑
  - Thalamocort. dissoc., reticular and limbic stim., dysphoria, salivation
  - Liquor- and intraocular pressure ↑
  - Eyelid/cornea reflex +, open eye (cream, eyedrops)
  - Pharyngeal/laryngeal reflex + (no intub.), apnoe poss.
  - NO!: dogs with liver failure, cats with kidney failure, hearth failure, intraocular op., perf. cornea, neur. patient

**Inhalational anesthetics**

- Sevoflurane, isoflurane, halothane
  - MAC (Minimal Alveolar Concentration): 50% of patients sleeping, relaxed (ED₅₀)
  - MAC halo: 0.76%, iso: 1.15%, sevo: 2%
  - 2x MAC and 33-100% O₂ 1-2 l/min (small an.)
  - For interventions longer than 15 minutes
  - Hypnosis and muscle relaxation, not analgesic
  - Bronchodilation, dosis dependent resp. depression and hypotension
  - Short induction and recovery

- Sevoflurane
  - Extremely short induction and recovery
  - At least 1-2 l/min O₂-flow (otherwise reacts with soda lime, kidney damage)

- Isoflurane
  - Wide therapeutic range, total CNS inhibition,
  - Slight circulatory depr., vasodilation, hypotension
  - Myocardium not sensitized to catecholamines
  - 0.2 % metabolised by liver
  - Mucosal irritant, bronchospasm may occur

- Halothane
  - Respiratory, circulatory, and thermoregulatory depr.
  - Heart muscle contraction ↓, blood pressure ↓
  - Heart muscle sensitization to catecholamines, arrhythmias
  - Formation-reticular-activated-system depr.
  - Antitussive, antiemetic
  - 15-50% metabolised by liver, liver damage ("H"-hepatitis)
  - Intracranial pressure ↑
  - Malignant hyperthermia (MH) poss.
  - Environmentally toxic (ozone layer degr.) ↑
**NSAID's**

Most NSAIDs are not usable prior to and during anesthesia for analgesia! (kidney perfusion ↓)

- **Carprofen**
  - dog: 4 (next days 2) mg/bwkg
- **Meloxicam**
  - (prior anest.: not labeled)
    - dog: 0,2 (next days 0,1) mg/bwkg
    - (cat): 0,1-0,2 (next days 0,05-0,1) mg/bwkg

**Local Anesthetics**

- **Lidocaine, bupivacaine**
  - Non depolarizing block of nerve cells
  - Action potential amplitude ↓, depolarization threshold ↑, conduction speed ↓, refractory time ↑, excitatory phase eliminated, pain sensitivity ↓
  - Cardiovascular (heart muscle sensitivity ↓, contractility ↓, arrhythmia, blood pressure ↓)
  - Central nervous system (tremor, restlessness, epileptiform seizures)
  - Cell toxicity (irritation, lysis)

**Muscle Relaxants**

Grouping

- **Central (GGE, benzodiazepines)**
- **Peripheral**
  - Depolarizing (succinyl-chloride)
  - Non depolarizing (pancuronium, atracurium, vecuronium, rocuronium) antagonizable (with AcCh-esterase blockers)

**Local Anesthetics**

- **C₇-value**
  - Minimal blocking concentration

- **LA techniques**
  - Terminal anest. (superficial, ‘freezing’, infiltration, iv.)
  - Conductive
  - Paravertebral
  - Epidural
  - Spinal (subarachnoideal)

**Muscle Relaxants**

Indications (only with artificial ventilation!)

- Downing of large animals
- Interventions requiring great precision
- Superficial narcosis allowable with muscle relaxation
- Setting of dislocations and bone fractures
- Eye operations
- Laryngospasm