Small Mammal Anaesthesia

Kathryn Davison BVSc MRCVS Cert VA

**Anaesthetic Related Mortality**

<table>
<thead>
<tr>
<th>Species</th>
<th>Risk of Anaesthetic Related Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>1 in 50,000 (0.00002%)</td>
</tr>
<tr>
<td>Dog</td>
<td>1 in 601 (0.17%)*</td>
</tr>
<tr>
<td>Cat</td>
<td>1 in 419 (0.24%)*</td>
</tr>
<tr>
<td>Rabbit</td>
<td>1 in 72 (1.39%)*</td>
</tr>
<tr>
<td>Guinea Pig</td>
<td>1 in 26 (3.80%)*</td>
</tr>
<tr>
<td>Other Small Animal Species</td>
<td>1 in 45 (2.20%)*</td>
</tr>
</tbody>
</table>

* Confidential Enquiry into Perioperative Small Animal Fatalities (UK) 2002-2004 Brodbelt D et al

**Why are the death rates so high?**

- Small Size
  - Hypothermia leading to
    - Respiratory and circulatory collapse during anaesthesia
    - Long recovery periods
    - Development of post operative in-appetence
  - Drug overdose
    - Obtain accurate weight
  - Venous access often impracticable

Health status of the animal

- Sub clinical disease
  - Sub clinical respiratory disease is common in rabbits and rodents
- Clinical history is often limited and the disease process may be advanced at presentation
  - E.g. dehydration and malnutrition as a result of advanced dental disease

Stress

- The animal may not be used to handling
- Stress as a result of hospitalisation in unfamiliar surroundings (see, smell or hear predators)
Lack of familiarity with the species

<table>
<thead>
<tr>
<th>Species</th>
<th>Weight (g)</th>
<th>Heart rate (beats/minute)</th>
<th>Respiratory rate (breaths/minute)</th>
<th>Average life span</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mice</td>
<td>20-63</td>
<td>500-600</td>
<td>100-250</td>
<td>1.5-2.5 years</td>
</tr>
<tr>
<td>Rat</td>
<td>225-500</td>
<td>70-150</td>
<td>260-450</td>
<td>2.5-3.5 years</td>
</tr>
<tr>
<td>Syrian Hamster</td>
<td>85-150</td>
<td>280-412</td>
<td>33-127</td>
<td>1.5-2 years</td>
</tr>
<tr>
<td>Guinea Pig</td>
<td>0.75-1.2</td>
<td>190-300</td>
<td>90-150</td>
<td>4-8 years</td>
</tr>
<tr>
<td>Rabbit</td>
<td>1-10</td>
<td>180-300</td>
<td>30-60</td>
<td>5-10 years</td>
</tr>
</tbody>
</table>

General Considerations

Pre anaesthetic Preparation

Owner information
- Rodents and rabbits do not need to be starved prior to anaesthesia, they cannot regurgitate
  - Small mammals have high metabolic rates, relatively short periods of starvation will lead to hypoglycaemia
  - Starving rabbits and guinea pigs for 1 hour prior to anaesthesia will reduce the amount of food material in the oral cavity
- Make sure you have informed consent
  - Unlicensed drugs
  - Be aware of restrictions for animals destined for human consumption
- Ask the owner to bring in the animals regular diet and suitable housing to reduce stress in the post operative period

Clinical Examination
- Observe the animal quietly before handling, count respiratory rate
- Chest Auscultation (very limited in rabbits)
  - Clinical signs of respiratory disease detected, consider chest radiography to assess lung fields
  - Assume that all rodents and rabbits have a degree of respiratory compromise
- Palpate abdomen
  - Pregnancy
  - Tumours
  - Faecal impactions/ gas filled viscous
- Examine anal region, for evidence of GI disorders
  - Mucoid enteritis - young rabbits
  - Wet tail – hamsters
- Porphyrin (red/brown) staining around the eye of a rat is a sign of distress or ill health
- Assess body condition,
  - Malnutrition is not uncommon especially in animals with advanced dental disease
  - Obesity
- Obtain accurate body weight (use scales accurate to ±2g)
- Assess hydration status
  - History
  - Skin tenting
  - Blood sample
    - rabbits, ferrets - jugular vein

Malnutrition
- Consider syringe feeding
  - commercial diets available
  - Homemade pureed vegetables
  - Vegetable baby food

Fluid Therapy
- Hydrate prior to anaesthesia (fluid of choice will be dependent on animals condition, administer fluids at body temperature)
  - IV (may not be practicable/possible)
  - Oral fluids
  - IP (risk of organ perforation)
  - SC (absorbed over 6-12 hours may be too slow to be of benefit if patient is severely dehydrated)

Venous Access

<table>
<thead>
<tr>
<th>Species</th>
<th>Route for venous access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat, mouse, gerbil</td>
<td>Lateral tail vein</td>
</tr>
<tr>
<td></td>
<td>Saphenous vein</td>
</tr>
<tr>
<td>Guinea pigs</td>
<td>Medial and lateral tarsal veins</td>
</tr>
<tr>
<td>Rabbits</td>
<td>Marginal ear veins</td>
</tr>
<tr>
<td></td>
<td>Cephalic and Saphenous veins</td>
</tr>
<tr>
<td>Ferrets</td>
<td>Cephalic and Saphenous veins</td>
</tr>
</tbody>
</table>
Intraperitoneal Fluids

<table>
<thead>
<tr>
<th>Species</th>
<th>Volume intra-peritoneal fluids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouse (30g)</td>
<td>2ml</td>
</tr>
<tr>
<td>Hamster (100g)</td>
<td>3ml</td>
</tr>
<tr>
<td>Rat (200g)</td>
<td>5ml</td>
</tr>
<tr>
<td>Guinea pig (1kg)</td>
<td>20ml</td>
</tr>
<tr>
<td>Rabbit (3kg)</td>
<td>50ml</td>
</tr>
</tbody>
</table>

Blood Volume
- Calculate the circulating volume, how much can the patient afford to loose (maximum loss 30% circulating volume how many swabs, cotton buds does this volume represent)
  - Circulating volume of:
    - Mouse 1.5 - 4.5ml
    - Hamster 6 - 10ml
    - Guinea pig 52 - 84ml

Equipment
- Assemble all equipment
  - Change alarm settings on monitoring equipment if possible to a range suitable for the species to be anaesthetised
  - Assemble equipment to intubate if possible
  - Pipe anaesthetic gases in at the bottom of an anaesthetic induction chamber and scavenge from the top

Monitoring Equipment
- Thermistors (respiratory apnoea monitors) can be used in animals weighing more than 200g
- Pulse oximeters will usually work on the feet or tails of animals weighing over 200g

Drugs
- Calculate emergency drugs (dilute if required) e.g
  - Reversal agents
  - Doxapram
  - Adrenaline
Doxapram Hydrochloride

- Doxapram stimulates the CNS (analeptic drug)
- Increases minute ventilation by stimulating the carotid bodies
- Oxygen consumption is also increased
- Dose: 5-10mg/kg IV, IM, IP (Supplement O₂). Oral drops also useful.
- Duration of action 15-20 minutes

Why Does Hypothermia Occur?

- Large surface area to body mass ratio
- The use of drugs that cause vasodilation (e.g. isoflurane)
- Clipping and preparation of the surgical site
- Cold dry anaesthetic gases
- Anaesthesia depresses homeostatic mechanisms

Prevention of Hypothermia

- Keep clipping to the minimum required for asepsis
- Warm scrub fluids to 38 °C and avoid excessive wetting of the animal
- Avoid the use of alcohol based solutions
- As soon as anaesthetised wrap the patient in bubble wrap or other insulating material with a hole cut out for the surgical field
- Do not use excessive fresh gas flow rates
- External heat sources
  - Heated beds
  - Bair Hugger™
  - Heat lamp
  - Warm water bottle
- Be careful not to burn the patient
- Warm irrigation fluids to body temperature
- Increase ambient temperature in theatre
- Use warming devices
- Keep surgical time as short as possible

**General considerations when choosing an anaesthetic technique**

Inhalation Anaesthesia

- **Advantages**
  - Exact weight not required
  - Rapid induction of anaesthesia
  - Ease of control of anaesthetic depth
  - Rapid recovery
Disadvantages
- Special equipment required
- Scavenging difficult, leading to local pollution
- No intraoperative analgesia
- Gases irritate mucous membranes (especially isoflurane)
- Apnoea / stress during induction

Total Injection Anaesthesia

Advantages
- No environmental pollution
- Analgesia dependent on drug combination

Disadvantages
- Knowledge of drug combinations and injection techniques required
- Poor control without IV access
- Long recovery periods
- Expense of drugs and the reversal agents
- Supplemental oxygen required

Combination of Injection and Inhalation Techniques
- Consider maintenance with inhalation agent after induction of anaesthesia with an injectable combination
- Inhalation anaesthesia is usually safer than “topping up” an injectable combination
- Heavily sedated animals (especially rabbits) may still breath hold when exposed to inhalant agents
  - Always pre-oxygenate for 4-5 minutes

Drugs

Inhalation Agents
- Animal may struggle or become excited during induction of anaesthesia
- Provides good skeletal muscle relaxation
- Mild to moderate cardiovascular and respiratory depression
- Rapid recovery especially with isoflurane and sevoflurane
  - Avoid sevoflurane in guinea pigs
- No analgesia
Hypnorm
- Combination of Fentanyl and Fluanisone
- IM and IP administration
- As a sole anaesthetic agent produces:
  - marked respiratory depression
  - good analgesia
  - poor muscle relaxation
- Currently not available in many countries
- Often combined with a benodiazepine:
  - surgical anaesthesia
  - Good analgesia
  - good muscle relaxation
  - Mild / moderate respiratory depression
- Reversal of fentanyl component:
  - Full reversal with naloxone, analgesia also reversed
  - Maintain analgesia partial reversal with μ agonist / antagonist (e.g. buprenorphine or butorphanol)

Benzodiazepines
- Midazolam - IV, IM, SC, IP
- Diazepam - IV
- Minimal cardiovascular and respiratory depression
- Alone produce light sedation but in some species (hamsters) will cause excitation
- Usually used in combination (opioids, hypnorm, ketamine and α₂-agonists)
- Reversal agent: Flumazenil (expensive)

Ketamine and α₂-agonists
- Ketamine and α₂-agonist combinations are commonly used in small mammals
  - Administration IV, IM, IP and SC
  - Significant cardiovascular depression can occur
  - Moderate respiratory depression, (administer O₂ during anaesthesia)
  - Analgesia
- If anaesthesia is insufficient it is preferable to use a low concentration of an inhalant anaesthetic or a local anaesthetic technique
- Medetomidine can be reversed by the specific α₂-antagonist atipamezole
  - Administration IM, IP, SC, IV
**Analgesia**
- Pain is difficult to detect in these species (prey animals do not show weakness to predators)
- Pain can cause:
  - Inappetence
  - Immobility
  - Poor wound healing
- Many agents have been shown to be safe in laboratory animals, there is no justification for withholding analgesia

**Local Anaesthesia**
- EMLA cream to anaesthetise site for intravenous catheterisation
  - clip area, apply cream, apply dressing and leave for 45 minutes before catheterisation
- Use local anaesthesia in combination with other anaesthetic techniques
  - Calculate dose carefully (dilute if necessary)
- Consider long acting LA (bupivicaine) to provide analgesia into the post operative period

**Opioids**
- Commonly used opioids
  - Buprenorphine (SC, IM, IV 6-12hours)
  - Pethidine (IM, SC 2-4hours)
  - Butorphanol (SC, IM, IV 2-4hours)
- Pre-operative buprenorphine in rabbits enables a reduction in inhalant anaesthetic concentrations (↓0.25-0.5%)

**NSAIDs**
- Commonly used NSAIDs
  - Carprofen (SC, IV ?24 hours)
  - Meloxicam (SC, oral ?24 hours)
  - Ketoprofen (IM ?12-24hours)
- Provision of analgesia for 24-48 hours is usually sufficient for most surgical procedures
- Many rabbits find meloxicam liquid palatable and it can be used for chronic painful conditions in this species
Recovery

Hypothermia in Recovery
- Temperature of recovery area
  - 35-36°C patient still unconscious
  - 32°C patient first recovers consciousness
  - Once the animal has resumed normal activity reduce temperature to:
    - 26-28°C rats and mice
    - 23-24°C guinea pigs and rabbits
- Provide oxygen in recovery if the animal is shivering

Recovery
- Place patient in familiar surroundings (own cage) as soon as possible
  - Avoid saw dust → damages eyes
  - Consider vet bed (insulating and absorbs moisture)
  - Do not provide water bowl until fully conscious → drowning excessive wetting and hypothermia
- The patient should be encouraged to eat within 1-2 hours postoperatively
  - Offer animals normal diet
- If in appetent consider syringe feeding and SC or IP fluid therapy
- Do not send home until fully recovered
Specific species information

Rats and Mice
- Volatile anaesthetic techniques are often preferred
- Injectable anaesthetic techniques: strain, family and sex specific differences occur
- Intramuscular injection often causes pain and muscle damage due to the small muscle mass available (consider IP administration)
- In rats and mice the preferred technique is to use an induction chamber followed by maintenance by mask with a volatile anaesthetic agent,
  - Isoflurane 2-3% for induction and 1.5-2% for maintenance of anaesthesia
  - Sevoflurane 6-8% for induction and 3-3.5% for maintenance of anaesthesia

(The use of injectable anaesthetic agents and combinations in mice and rats can result in unpredictable results due to large, breed, strain, and sex differences)

Analgesia in rats and mice

<table>
<thead>
<tr>
<th>Species</th>
<th>Drug</th>
<th>Dosage</th>
<th>Administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat</td>
<td>Buprenorphine</td>
<td>0.01-0.05mg/kg</td>
<td>SC 8-12 hourly</td>
</tr>
<tr>
<td>Mouse</td>
<td>Buprenorphine</td>
<td>0.05-0.1mg/kg</td>
<td>SC 12 hourly</td>
</tr>
<tr>
<td>Rat</td>
<td>Butorphanol</td>
<td>2.0 mg/kg</td>
<td>SC 3-4 hourly</td>
</tr>
<tr>
<td>Mouse</td>
<td>Butorphanol</td>
<td>1 - 5 mg/kg</td>
<td>SC 3-4 hourly</td>
</tr>
<tr>
<td>Rat</td>
<td>Carprofen</td>
<td>4 mg/kg</td>
<td>SC 8-12 hourly</td>
</tr>
<tr>
<td>Mouse</td>
<td>Carprofen</td>
<td>4 mg/kg</td>
<td>SC 8-12 hourly</td>
</tr>
<tr>
<td>Rat</td>
<td>Meloxicam</td>
<td>0.2 mg/kg</td>
<td>SC ?</td>
</tr>
<tr>
<td>Mouse</td>
<td>Meloxicam</td>
<td>0.2 mg/kg</td>
<td>SC ?</td>
</tr>
</tbody>
</table>

Gerbils
- Restraint grasp loose skin at the back of the neck
- The tail base can be held but the tail is fragile and degloving injuries of the tail are common after incorrect handling
- Administer injections IP or SC (back of neck)
- Opiates alone can cause excitement
- Volatile agents are usually preferred for induction and maintenance of anaesthesia (see rats and mice)
- For sedation
  - Light sedation: diazepam or midazolam 5-7 mg/kg SC or IP
  - Light to moderate sedation: medetomidine 0.1-0.2mg/kg SC or IP

Analgesia in gerbils

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<td>0.05 mg/kg</td>
<td>SC 8 hourly</td>
</tr>
<tr>
<td>Butorphanol</td>
<td>1-5 mg/kg</td>
<td>SC 2-4 hourly</td>
</tr>
<tr>
<td>Carprofen</td>
<td>4 mg/kg</td>
<td>SC 8-12 hourly</td>
</tr>
<tr>
<td>Meloxicam</td>
<td>0.2 mg/kg</td>
<td>SC ?</td>
</tr>
</tbody>
</table>
Guinea Pigs
- Pre existing diseases
  - Chronic bronchopneumonia
  - Chronic renal disease
- May retain food material at the back of the pharynx, this can usually be prevented by removing food 1 hour before anaesthesia
- Some authors recommend premedication with atropine (0.5mg/kg IM) prior to inhalation anaesthesia to reduce salivation and bronchial secretions
  - The use of sevoflurane in this species has been linked to serious respiratory complications, isoflurane is the inhalant of choice
- Sedation
  - Diazepam or midazolam 2.5-5 mg/kg IM
  - Medetomidine 0.15mg/kg SC/IM
- Induction of anaesthesia is often carried out by mask, or in an induction chamber with 3-4% isoflurane and maintained by mask 1.5-2% isoflurane.
- Injectable anaesthesia: Dose of 8 ml/kg IP of a mixture containing 1 part hypnorm + 2 parts water for injection and 1 part midazolam (5mg/ml). This combination produces surgical anaesthesia with good muscle relaxation and only moderate respiratory depression for 45-60 minutes, full recovery can take up to 3 hours.

Analgesia in guinea pigs

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosage</th>
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</tr>
<tr>
<td>Butorphanol</td>
<td>0.4 mg/kg</td>
<td>SC</td>
</tr>
<tr>
<td>Carprofen</td>
<td>4 mg/kg</td>
<td>SC</td>
</tr>
<tr>
<td>Meloxicam</td>
<td>0.2 mg/kg</td>
<td>SC</td>
</tr>
</tbody>
</table>

Hamsters
- Opiates and benzodiazepines given alone produce excitement
- Filled cheek pouches make respiration more difficult, and respiratory obstruction during anaesthesia more likely
- Sedation: medetomidine 0.2-0.3 mg/kg SC
- Volatile agents are usually preferred for induction and maintenance of anaesthesia (see rats and mice)

Analgesia in hamsters

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<td>0.01-0.05 mg/kg</td>
<td>SC</td>
</tr>
<tr>
<td>Butorphanol</td>
<td>1 mg/kg</td>
<td>SC</td>
</tr>
<tr>
<td>Carprofen</td>
<td>4 mg/kg</td>
<td>SC</td>
</tr>
<tr>
<td>Meloxicam</td>
<td>0.1- 0.5 mg/kg</td>
<td>SC/IP</td>
</tr>
</tbody>
</table>
Rabbits

- Careful handling (risk of damaging spinal cord)
- Atropine may be ineffective in many strains of rabbit due to atropinase, glycopyrrolate 0.01mg/kg can be used as an anticholinergic.
- Sedation
  - Medetomidine 0.25-0.5mg/kg SC/IM
  - Hypnorm 0.2-0.5 ml/kg IM
- Facemask inductions without prior premedication can lead to violent struggling, catecholamine release and apnoea and should be avoided.
- Injectable anaesthetic combinations
  - Hypnorm 0.3 ml/kg IM + midazolam 2 mg/kg IM produces 30-40 minutes of surgical anaesthesia, the combination can be partially reversed by the administration of buprenorphine or butorphanol.
  - Ketamine 15mg/ml SC + medetomidine 0.25mg/ml SC. This combination produces approximately 30 minutes of anaesthesia this inclusion of butorphanol increases anaesthetic time to approximately 80 minutes. These combinations can be reversed with atipamezole 1mg/kg.
- Tracheal intubation is possible with uncuffed tubes, always allow the rabbit to breathe 100% oxygen for 3-4 minutes before attempting intubation and never force a tube into the trachea as this can cause haemorrhage and oedema.
  - Laryngoscope or otoscope can be used
  - Blind technique listening for breath sounds
  - Spray larynx with local anaesthetic prior to intubation

Analgesia in rabbits

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<td>SC 8 hourly</td>
</tr>
<tr>
<td>Butorphanol</td>
<td>0.1-0.5 mg/kg</td>
<td>SC 4 hourly</td>
</tr>
<tr>
<td>Carprofen</td>
<td>4-5 mg/kg</td>
<td>SC once daily</td>
</tr>
<tr>
<td>Meloxicam</td>
<td>0.2 mg/kg</td>
<td>SC/ orally once daily</td>
</tr>
</tbody>
</table>

Further reading
BSAVA Manual of Exotic Pets
BSAVA Manual of Small Animal Anaesthesia and Analgesia
Laboratory Animal Anaesthesia 2nd Edition P. Flecknell