Introduction to fish anesthesiology

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The ideal anesthesia

• Reversible and controlled loss of consciousness
• “No” mortality
• Safe for the patient and for the operator
• Undisturbed physiology/vital functions
• Minimal homeostatic changes
• Optimal conditions for surgery
• Relief of pain, stress and discomfort
• Easily administered

Why use anesthesia?

• Legal requirements
• Ethical reasons
• Handling
  • Reduce stress and damage
• Surgical procedures
  • Blood sampling
  • Marking
• Killing of fish
  • Endpoint in experiments
  • Animal welfare reasons
Definitions

- **Anesthesia**
  - Condition of controlled, reversible loss of consciousness.
  - Reduced sensory perception and motoric response.

- **Analgesia**
  - Temporary absence or reduction of pain

- **Sedation:** commonly used term in veterinary medicine
  - "Light anesthesia"
  - Convenient for small noninvasive/not painful procedures like handling, weighing, simple marking, imaging
  - For surgery sedation in combination with local anesthetics

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Important terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Induction time</strong></td>
<td>The number of minutes to reach a certain anesthesia level</td>
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<tr>
<td>Lethal Concentration (LC50)</td>
<td>The concentration that cause 50% mortality within a given time</td>
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<tr>
<td>Effective concentration (EC 50)</td>
<td>The concentration that cause anesthesia effect in 50% of the fish within a given time</td>
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<td>Exposure time</td>
<td>The total time when the fish is in contact with the anesthesia solution</td>
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<td>Wake up time</td>
<td>The time it takes before the fish regain full mobility</td>
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<td>Safety margin</td>
<td>LC50/EC50 for the specific anesthesia solution</td>
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Absorption of anesthesia over gills

- Anesthesia substance mainly absorbed through the gills
  - Gill surface related to body surface
  - Concentration of anesthetic drug

- Environment and acclimatization
  - Water temperature, O₂ saturation, pH
  - Same conditions in anesthesia tank as fish is acclimatized to

Anesthesia procedures

- Challenges in fish anesthesia
  - Many fish anesthetised at the same time demands good planning of procedures and monitoring the process
  - If neglected fish can die
  - Risk for overdosing some fish, and no effect on other fish
Pre-anesthetic preparation
“Planning is half the job”

- Crucial for satisfying anesthesia
- Minimize anesthesia complications
- Smooth running of research protocol

- Includes preparation of both fish, drugs, facilities, personnel
- Peaceful induction - be calm and quiet
- Check all equipment using a check list before you start

Pre-anesthetic preparation
Anesthetic equipment, drugs and personnel

- Make a simple pre-use checklist
- Sufficient anesthetic drugs for whole period + unexpected additional requirements
- Check expiry dates and storing conditions for all drugs
- Check water quality
  - (pH, O2, temperature)
- Check post-operative recovery facility
  - (recovery tank)
- Check that all personnel are familiar with research protocol, equipment and techniques including awakening time post anesthesia
Pre-anesthetic preparation
Environment and acclimatization

- Water temperature
- \(O_2\) saturation
- pH
  - Same conditions in anaesthesia tank as fish is acclimatized to

- Fasting 48-72 h before anaesthesia

Challenges in fish anesthesia

- High stocking densities and intensive handling during harvesting and transport are common to aquaculture, and often result in fish being exposed to high ammonia and low dissolved oxygen levels
- Often many fish anesthetized at the same time demands good planning of procedures and monitoring the process
- If neglected fish can die
- Risk of overdosing some fish, and no effect on other fish
- Monitor also induction and recovery tank
- Recovery within a few minutes
Water quality

- Change anesthesia solution
  - When effect decrease
  - O2 is decreasing
  - Water become turbid
  - Large scale: Every second hour or after 20 000 fish

Common adverse affects of anesthesia

- Respiration
  - Lack of O₂
- Circulation
- Metabolism

- Care has to be taken to avoid adverse effect or death caused by anesthesia !!!
Adverse effects of anesthesia

- Overdosage
  - Poor rinsing after anaesthesia
- Mechanic trauma of fish during handling
  - Keep fish skin humid, avoid dry skin
- Avoid direct sunlight (indoor, use a tent)
  - Sun heats water and reduce oxygen
  - Some anesthesia drugs are degraded by sunlight

Post anesthetic care

- Must be considered as a
  - Natural and essential extension of good anesthetic technique
- Failure to attend the animals needs’ during this critical period delay recovery from anesthesia
- Poor postoperative care will exacerbate and prolong the metabolic disturbances caused by surgery and if seriously neglected, the animal will die
Long term anesthesia

- Maintain anesthesia
- Support $O_2$
- Avoid dehydration and dry up of skin
- Monitoring
  - Water quality ($O_2$, pH, turbidity)
  - Respiration
  - ECG
  - Blood gas

Safe anaesthesia procedures

- Planning important for safe anesthesia!
- Dedicated personnel with dedicated tasks during anesthesia
- Monitor induction and recovery tank
  - Recovery within a few minutes
- Change anesthesia solution
  - When effect decrease
  - $O_2$ is decreasing
  - Water become turbid
  - Large scale: Every second hour or after 20 000 fish
After anesthesia

- Monitor the fish until it is completely recovered and have maintained normal swimming behavior after anesthesia

- Consider
  - Supply Analgesia (painful procedures)
  - Antibiotics (invasive procedures)

Distribution of anesthetics

- Bath anesthesia

- Mainly absorption of substance through the gills
  - Gill surface related to body surface
  - Concentration of anesthetic drug

- Injections
  - Intraperitoneal
  - Local infiltration
Use of neuromuscular blockers

- Agents that block neuromuscular transmission are used to abolish muscle tone during anesthesia in man and animals.
- Special care is necessary when such pharmacological compounds are used systemically because they specifically block neuromuscular transmission causing paralysis, yet have no significant central effects and will not therefore induce analgesia, unconsciousness or even sedation.
- Commonly used in human medicine
- If administered to a conscious animal they would not prevent it feeling pain and the animal would be in a helpless state of paralysis.
- Anesthetic protocol has to be well documented

Anesthesia in fish larvae

- Some larvae tolerate large concentrations of anesthesia
- If no gills – uptake is reduced
  - Uptake trough the skin
Anesthesia – effect

- Stressful induction
- Poor recovery from anesthesia
- Inadequate analgesia
- Poor post anesthetic care
- Anesthesia drug side effects

Reminder

- Blood sampling from heart is only allowed in anesthetised animals who will be killed after the procedure
Control questions

1. Why is anesthesia necessary in fish?

2. What is adequate anesthesia for handling and marking of fish?

3. What is adequate anesthesia for surgery?

4. What are important factors to consider before, during and after anesthesia?

5. Make a plan for preparation before anesthesia of 200,000 fish for vaccination
   1. Which factors are important to consider?
   2. Make a flow chart for the whole procedure including responsible persons