Carbon Dioxide Stunning of Poultry and Swine: Animal Welfare Implications

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Today’s talk

- Intro to carbon dioxide (CO$_2$)
- Potential welfare benefits and concerns
- A look at the data...
- Cost/benefit analysis
- Final thoughts
Contexts of CO$_2$ use
**CO$_2$ stunning**

- **Procedure:**
  - CO$_2$ alone, or mixed with inert gases
  - Single or multiple stage systems

- **Effects:**
  - CO$_2$ depresses central nervous system, causes anesthesia (>20-30%) and death
  - Inert gases reduce oxygen levels (< 2%), cause death
Gas Stunning Systems

Butina CO₂ anesthetizing plant

Linco MaxiLoad CAS system
Animal Welfare

- Continuum ranging from poor to good

- Acute response to stunning - sum of all procedures in terms of pain and distress
Principles of humane stunning

- Important factors to consider:
  - How quickly does loss of consciousness occur?
  - Does the procedure cause pain or distress?
  - Are all animals stunned?
  - Is the duration of insensibility sufficient?
CO$_2$ Stunning – the welfare debate

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages?</th>
</tr>
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<tbody>
<tr>
<td>Reduced handling</td>
<td>Relatively slow</td>
</tr>
<tr>
<td>Reduced isolation stress</td>
<td>Pain?</td>
</tr>
<tr>
<td>Reduced chance of error?</td>
<td>CO$_2$ converted to acid</td>
</tr>
<tr>
<td>Other non-welfare benefits</td>
<td>Dyspnea?</td>
</tr>
<tr>
<td></td>
<td>Unpleasant sensation of breathlessness</td>
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<td></td>
<td>Respiratory stimulant</td>
</tr>
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<td></td>
<td>Convulsions?</td>
</tr>
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</table>
How can we assess animal welfare?

- Extrapolate from human experiences
- Physiological responses
- Animal behaviour
Is pain likely with CO$_2$?

- **Humans**
  - Pain reported at 30 – 50%
  - Nociceptor threshold ~ 45%

- **Animals**
  - Rats – nociceptor threshold ~ 40-50%, signs of respiratory irritation at > 50%
  - Chickens – nociceptor threshold ~40-50%
  - Pigs – no data
Is dyspnea likely with $\text{CO}_2$?

- **Humans**
  - Self-report starting at $\sim 8\%$
  - Severe at $\sim 15\%$

- **Animals**
  - No models for dyspnea
  - Compare behavioural response with key concentrations
What about inert gases?

- No potential for pain

- Potential for dyspnea?
  - Human responses suggest low oxygen levels not detectable

- Convulsions — are animals conscious?
Behavioural indicators of distress

- General activity changes
  - overall excitation

- Pain or dyspnea specific behaviours
  - pain at mucous membranes, sensation of breathlessness

- Avoidance behaviours
  - experience is negative
Rat behavioural response to CO$_2$

Niel & Weary, 2006
Rat aversion to CO$_2$

Niel & Weary, 2007
Aversion to static CO$_2$

Niel & Weary, 2007
Pigs - CO₂

- **Behavioural response** (e.g., Rodriguez et al., 2008; Raj et al., 1997):
  - Head movements, sneezing, gasping, muscle excitation, vocalization prior to complete loss of consciousness

- **Preference testing** (e.g. Velarde et al., 2007; Raj & Gregory, 1995):
  - Increased reluctance to enter dip-lift system with repeated exposure
  - Avoid exposure to 90% CO₂
Pig response to 90% CO2

Courtesy of ABM Raj, University of Bristol
Pigs – inert gases

- Behavioural response:
  - Insufficient information available

- Preference testing:
  - No avoidance of argon during approach-avoidance (Raj & Gregory, 1995)
Pig response to argon

Courtesy of ABM Raj, University of Bristol
Poultry – CO₂

- **Behavioural responses** (e.g., Raj, 1996; McKeegan et al., 2006, 2007):
  - Often gasping, head-shaking
  - Wing-flapping varies between studies

- **Approach-avoidance tests** (e.g., Raj, 1996; Webster & Fletcher, 2004):
  - Most birds will enter < 60% CO₂
  - True for broilers, turkeys
  - Sometimes signs of distress
Poultry – inert gases

- **Behavioural responses** *(e.g., Raj, 1996; McKeegan et al., 2006, 2007)*:
  - Often gasping, head-shaking, wing-flapping
  - Generally before complete loss of consciousness

- **Approach-avoidance tests** *(e.g., Raj, 1996; Webster & Fletcher, 2004)*:
  - Most birds will enter > 90% argon, nitrogen
  - True for broilers, turkeys
How reliable is gas stunning?

- Are all animals properly stunned?
- Do animals remain unconscious for a sufficient duration?
Which exposure method is best?

- Disagreement on best practice in terms of animal welfare
  - Inert gases elicit lower levels of aversion, but associated with higher level of convulsions
  - \( \text{CO}_2 \) and mixtures may be more consistent than inert gases
# Cost-benefit analysis - Pigs

<table>
<thead>
<tr>
<th>Electrical/Captive Bolt Stunning</th>
<th>CO$_2$/Mixture Stunning</th>
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<tbody>
<tr>
<td>Immediate</td>
<td>Delayed effect</td>
</tr>
<tr>
<td>Not inherently painful/distressing</td>
<td>Potential for pain/dyspnea</td>
</tr>
<tr>
<td>Errors possible</td>
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</tr>
<tr>
<td>- During/After</td>
<td>- After</td>
</tr>
<tr>
<td>Single-file</td>
<td>Group Stunning</td>
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## Cost-benefit analysis - Poultry

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<th>CO₂/Mixture Stunning</th>
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<tr>
<td>Immediate</td>
<td>Delayed effect</td>
</tr>
<tr>
<td>Shackling and stunning painful/distressing</td>
<td>Potential for pain/dyspnea – but behaviour suggests not severe!</td>
</tr>
<tr>
<td>Errors possible</td>
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Cost-benefit analysis - Summary

- **Pigs**
  - Benefit is minimal, outweighed by potential costs
  - Inert gases promising, more research needed

- **Poultry**
  - Obvious benefit to delayed shackling, elimination of electrical stunning
    - Does it outweigh issues with CO₂?
Final thoughts...

- Welfare concerns associated with gas stunning

- For poultry welfare benefits may outweigh costs, but not for pigs

- Any change in processing methods must be carefully considered
Thank you! Questions?

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