Carbon Dioxide Stunning of Poultry and Swine: Animal Welfare Implications

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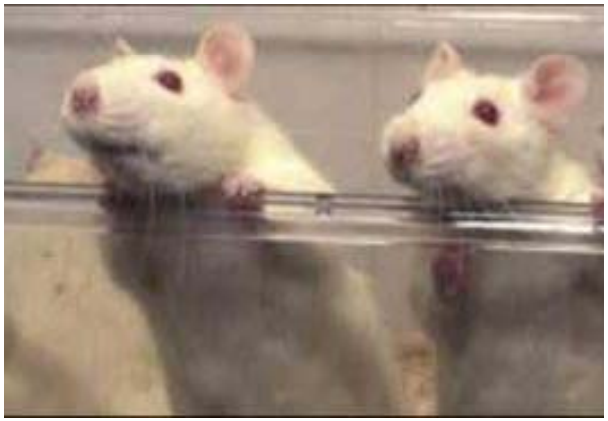
Today's talk

- 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

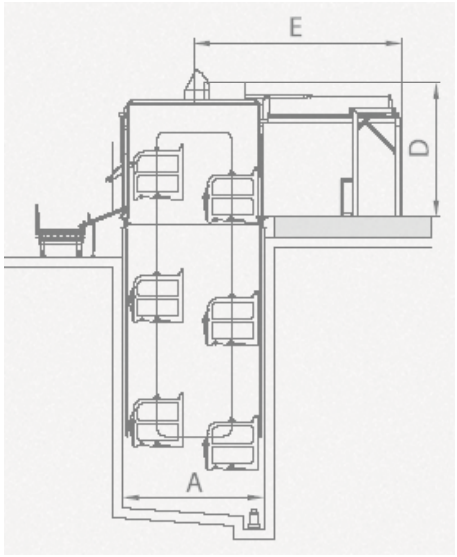


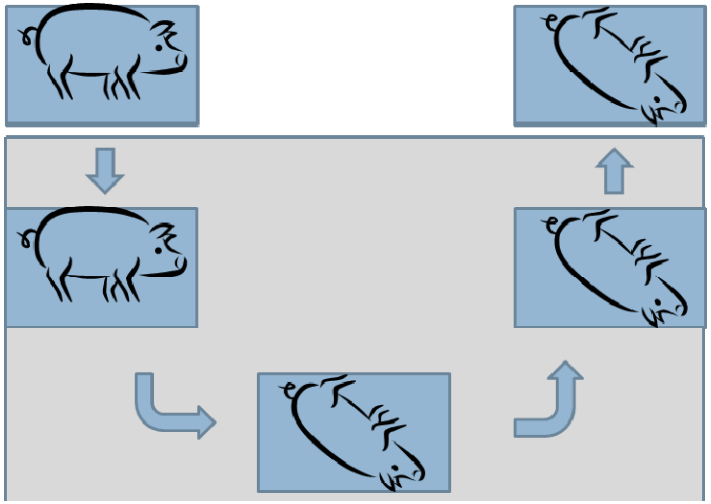
CO_2 stunning

- 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



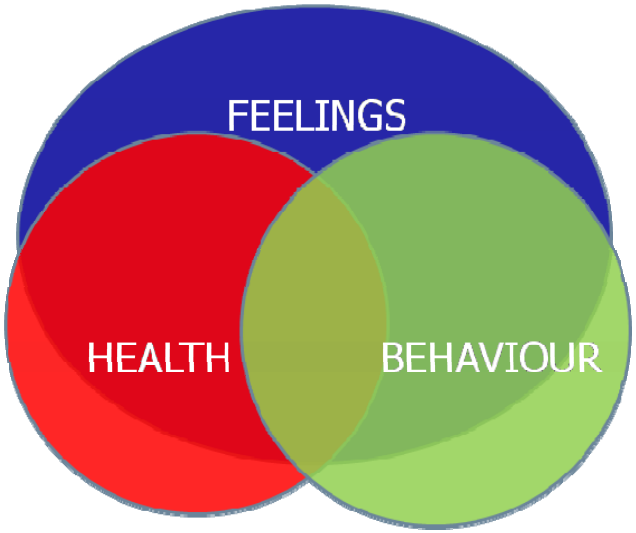


Butina CO_2
anesthetizing plant

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

Advantages

- Reduced handling
- Reduced isolation stress
- Reduced chance of error?
- Other non-welfare benefits

Disadvantages?

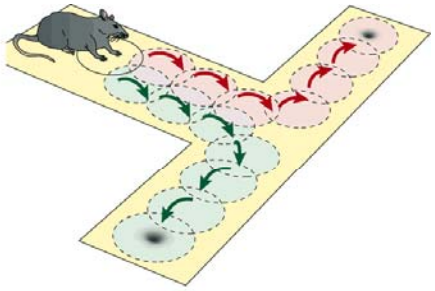
- Relatively slow
- Pain?
  - CO_2 converted to acid
- Dyspnea?
  - Unpleasant sensation of breathlessness
  - Respiratory stimulant
- Convulsions?

How can we assess animal welfare?

- Extrapolate from human experiences

- Physiological responses

- Animal behaviour



Nature Reviews | Neuroscience

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 CO_2?

- Humans
  - Self-report starting at ~8%
  - Severe at ~15%

- Animals
  - No models for dyspnea
  - Compare behavioural response with key concentrations

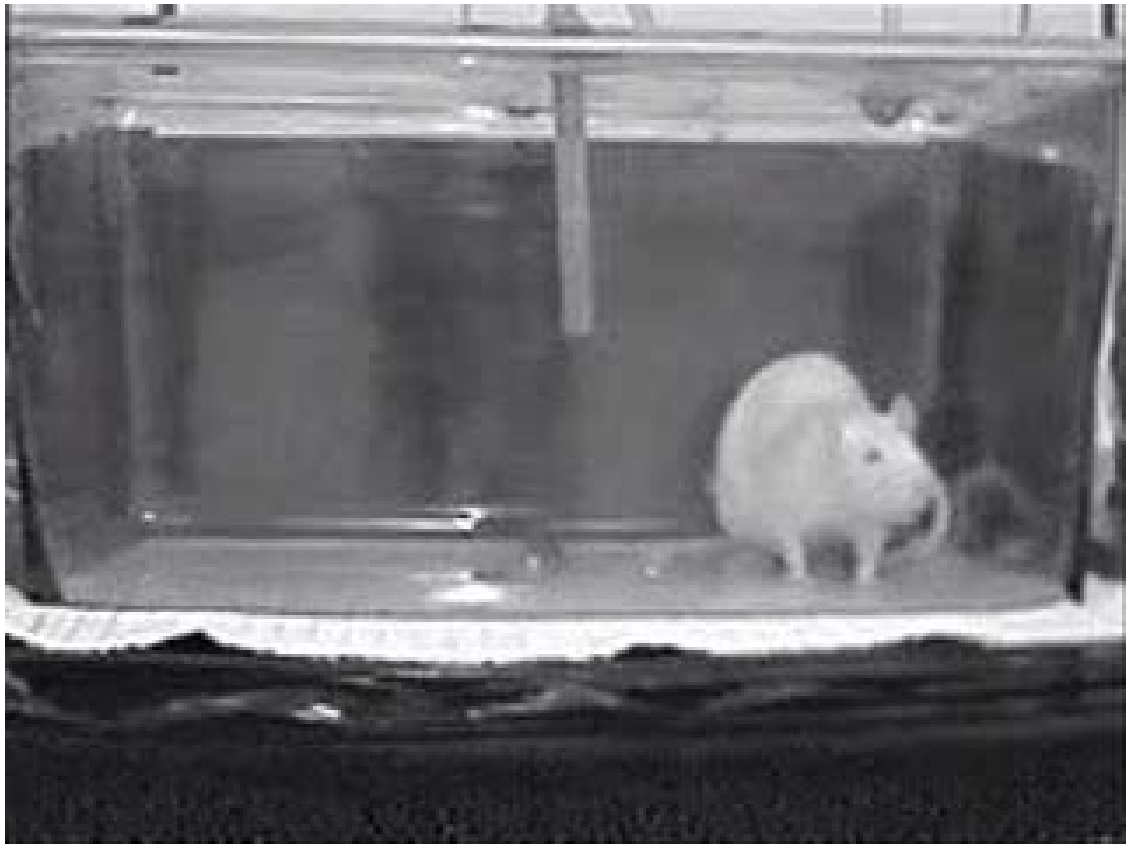
What about inert gases?

- No potential for pain
- Potential for dyspnea?
  - human responses suggests 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

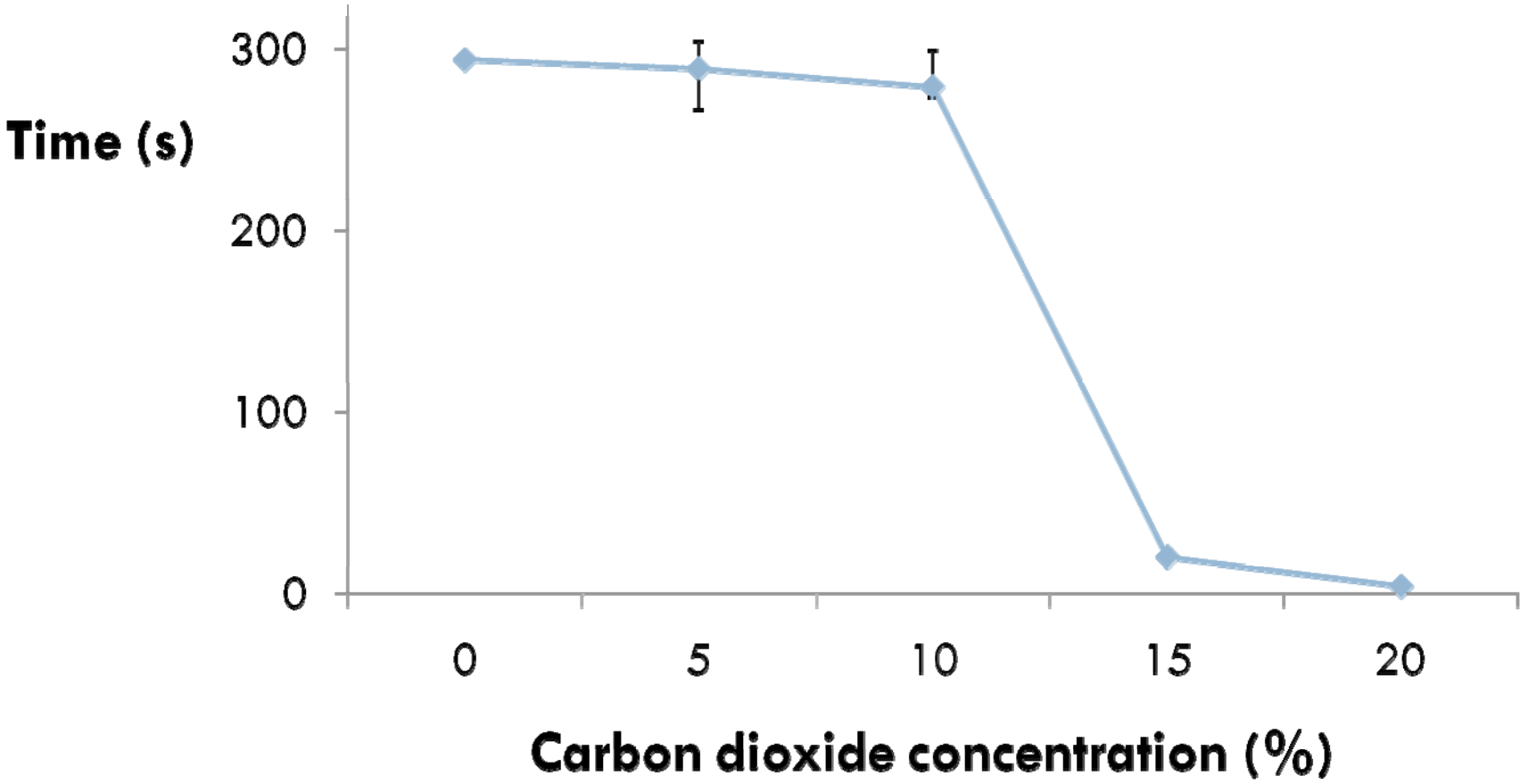


Niel & Weary, 2006

Rat aversion to CO_2

Niel & Weary, 2007

Aversion to static CO_2



Niel & Weary, 2007

Pigs - CO_2

- 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% CO_2

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 – CO_2

- 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% CO_2
  - 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
  - CO_2 and mixtures may be more consistent than inert gases

Cost-benefit analysis - Pigs

Electrical/Captive Bolt Stunning	CO_2/Mixture Stunning
Immediate	Delayed effect
Not inherently painful/distressing	Potential for pain/dyspnea
Errors possible - During/After	Errors possible - After
Single-file	Group Stunning

Cost-benefit analysis - Poultry

Electrical Stunning	CO_2/Mixture Stunning
Immediate	Delayed effect
Shackling and stunning painful/distressing	Potential for pain/dyspnea – but behaviour suggests not severe!
Errors possible - During/After	Errors possible - After

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 CO_2?

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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