



Humane Slaughter Update

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Outline

A brief history

Recent research

On the horizon

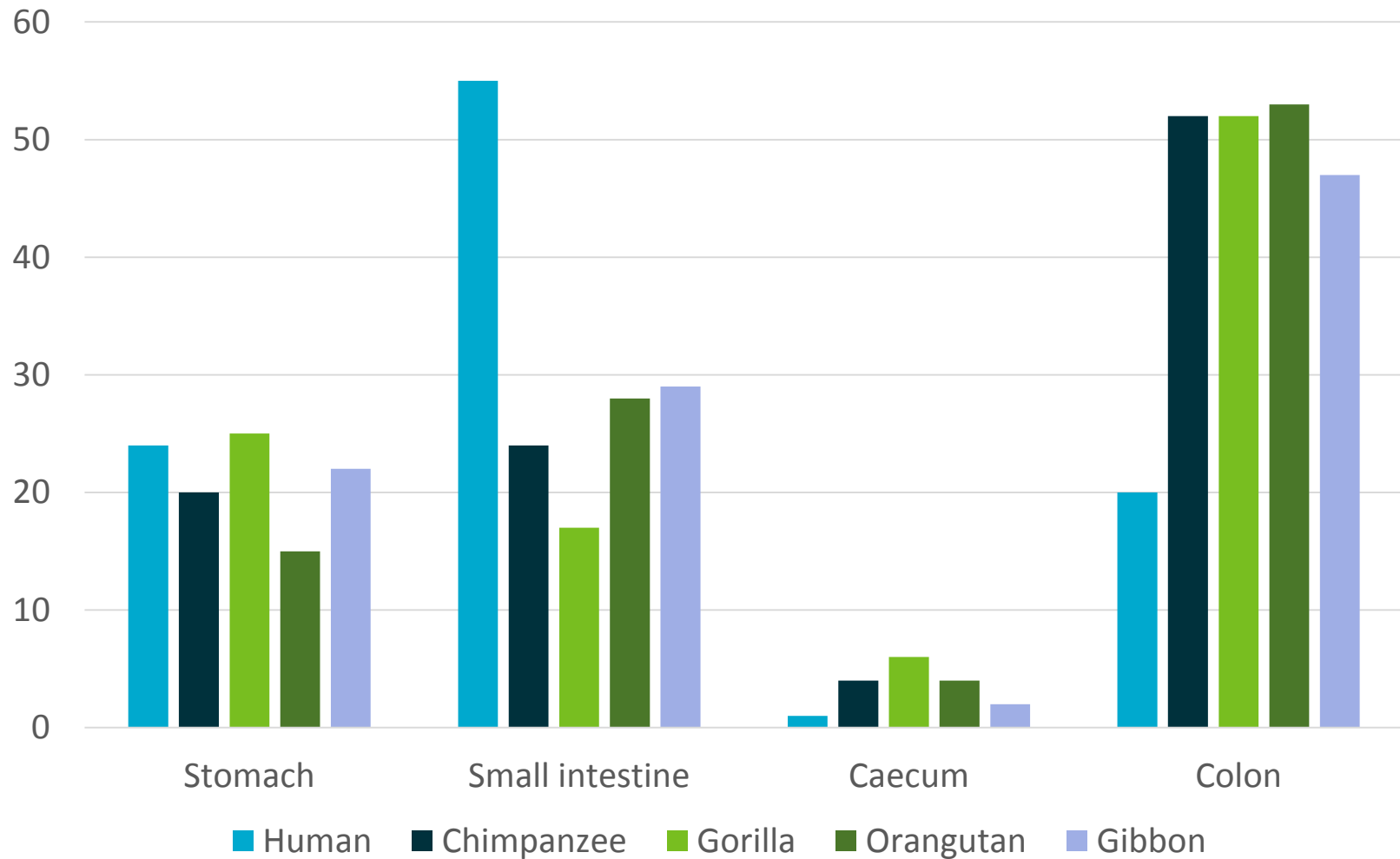
Early man

- Humans emerged over 200,000 years ago
 - Hunter-gathering
- Farming emerged around 10,000 years ago
 - Closer relationship with animals



- Good reasons for humane slaughter
 - Fast
 - Safe
- Tools?
 - Clubs, spears, arrows
 - Mechanical methods

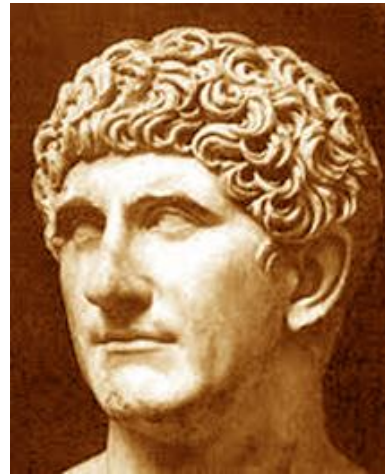
Relative gut volume (%)



Source: Milton (1999) Nutrition 15(6): 488-498

The Romans

- E.g. Marcus Antonius
 - 83 BCE – 30 BCE
 - Commander of armies for Julius Caesar
- Roman generals would sacrifice bulls as an offering to the war gods
 - Using a hammer or axe



Source: Britannica.com

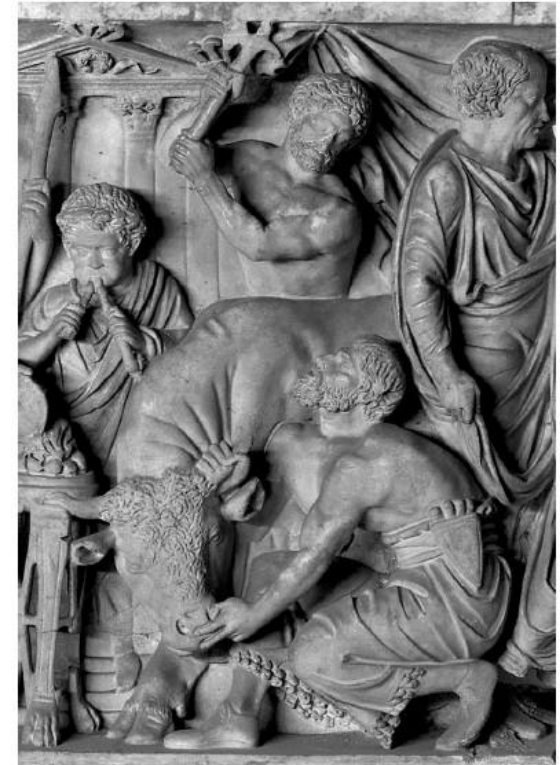


FIG. 5. Relief from sarcophagus in Museo del Palazzo Ducale, Mantua, of sacrifice scene showing *papa* with upraised axe prior to striking at animal's neck. (Photo: Scala/Ministero per i Beni e le Attività culturali/Art Resource, NY)

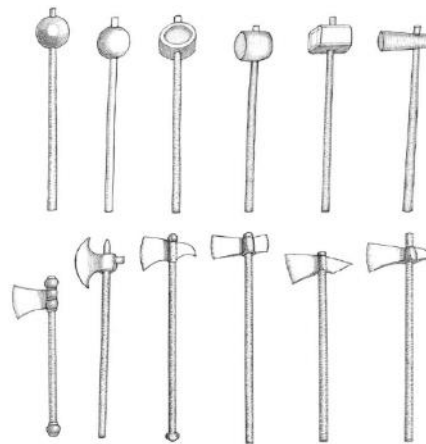
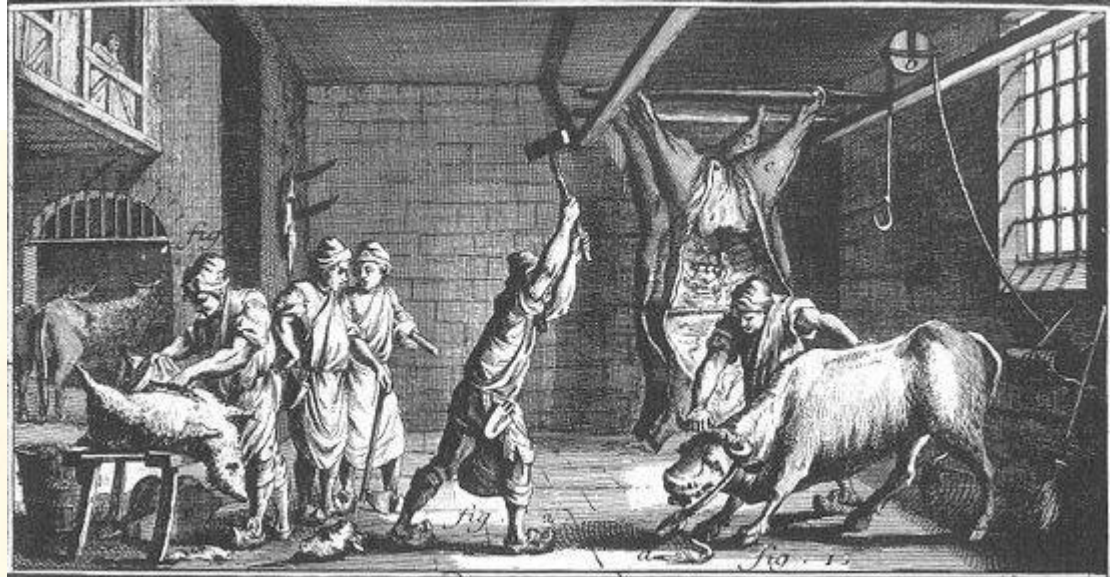
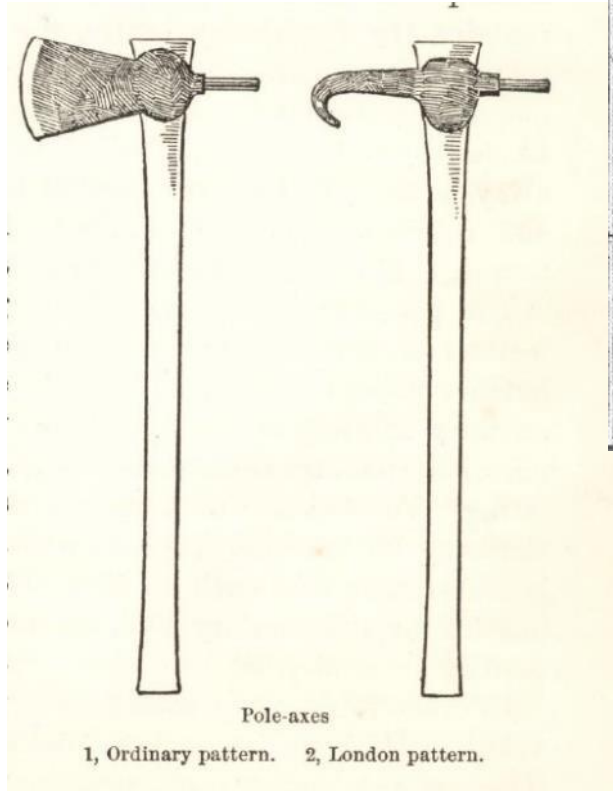


FIG. 2. Representative selection of different types of hammers (top row) and axes (bottom row) appearing in bronze sacrificial scenes in Roman art. (Drawing by Alicia Aldrete)

Source: Aldrete 2014, Journal of Roman Studies

Before 1900s

- The Poleaxe



Source: Diderots Encyclopaedia of 18th Century Butchers' Tools: www.livinghistory.co.uk

Source: Food Inspection (McEwen, 1922)

1920s

- Development of the captive bolt pistol



Source: Food Inspection (McEwen, 1922)



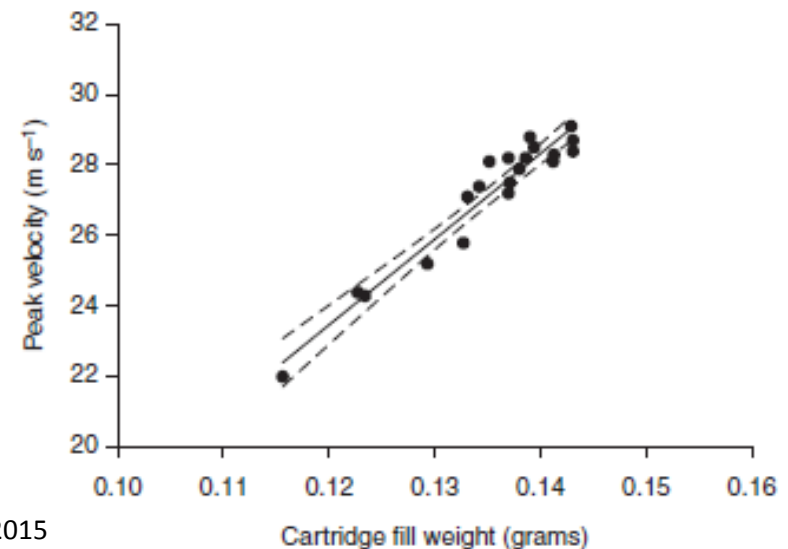
- Velocity 50 m/s
- Extension 1.2-1.5 msec
- Penetrating
- Non-penetrating (mushroom head)

More recent mechanical stun developments

- Refining of stun methods
 - Improved captive bolt instruments
 - More efficient cartridge-driven instruments
 - Compressed-air driven captive bolt instruments
- Factors affecting performance
 - Bench testing of 6 captive bolt pistols (Gibson et al. 2015)
 - Cash special (.22) reached 88.8°C after 2hr firing at 4 shots/minute
 - Extended periods of repeat firing reduces performance



Source: www.jarvisanz.com.au



Source: Gibson et al. 2015

More recent mechanical stun developments

- Comparison of penetrative, percussive and non-stun
 - Sub-comparison of thoracic v neck sticking

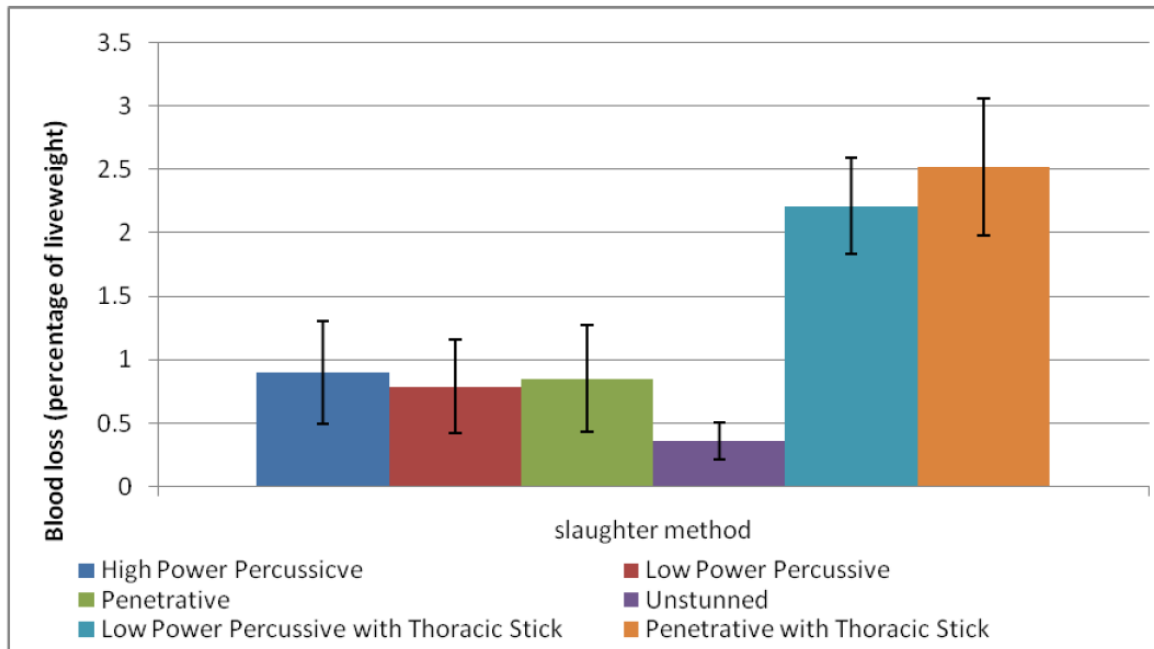


Figure 2: Blood weight collected at sticking (as a percentage of liveweight).

Source: Zulkifli et al. 2014

Non-Penetrating Mechanical Stun

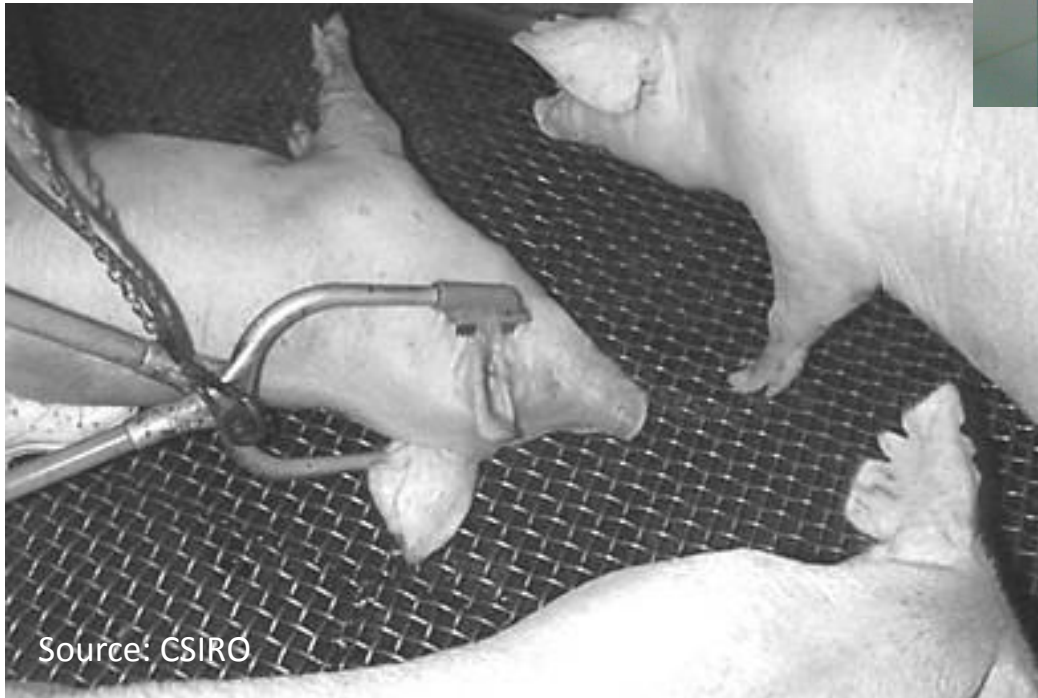
- EU – only permitted for animals under 10kg
 - In-plant surveys showing efficacy rates as low as 64%
 - But Australian plants target 95-98%
 - Why the difference?
- New developments
 - Can it be used in Buffalo?



1920s to 1930s

- Emergence of electrical stunning
 - *Grand mal* epileptiform fit

Source: MLA



Source: CSIRO

| Species | Minimum current |
|-----------------|-----------------|
| Pigs | 1.3 A |
| Sheep and goats | 1.0 A |
| Lambs and kids | 0.6 A |
| Calves | 1.0 A |
| Cattle | 1.2 A |

More recent electrical stun developments

- Refining of stun methods
 - Improved electrical stun methods
 - High frequency current
 - Different current waveforms
- Appropriate currents for light lambs (<16 kg)
 - 0.3, 0.5 and 0.7 A induce effective stunning similar to 1.0 A in lambs and kid goats (Llonch et al. 2015)
 - Aim – reduction in blood splash

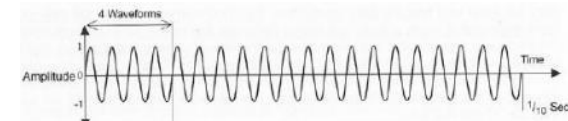


Figure 3a Example of standard 200Hz frequency

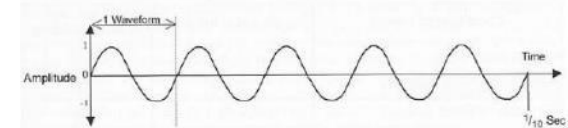
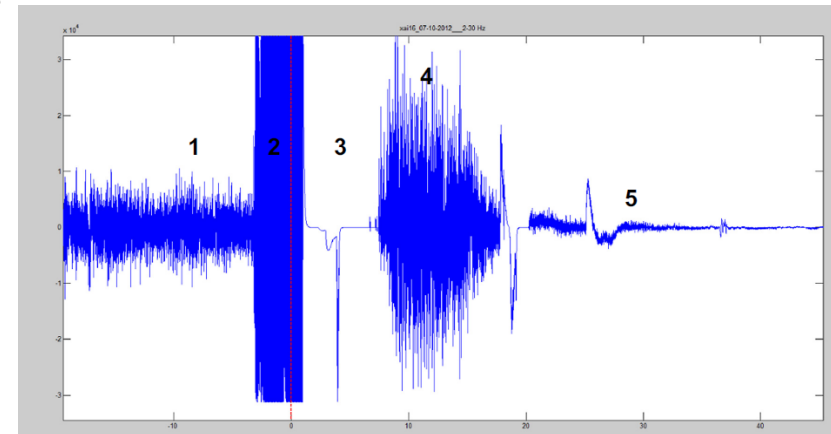


Figure 3b Example of standard 50Hz frequency

Source: Humane Slaughter Association



Source: Llonch et al. 2015

1930s

- Emergence of gas killing
 - Pigs and Poultry
 - CO₂
 - N₂/CO₂ mix
 - Argon



Source: CSIRO

The gas controversy

- Is it humane?
 - Reports of aversive reactions to CO₂
 - Gasping, escape attempts
 - 37 sec till collapse
 - But other studies find no such responses.
 - Why?
 - Rate of increase in CO₂ concentration?
 - Genetics?
 - Something else?

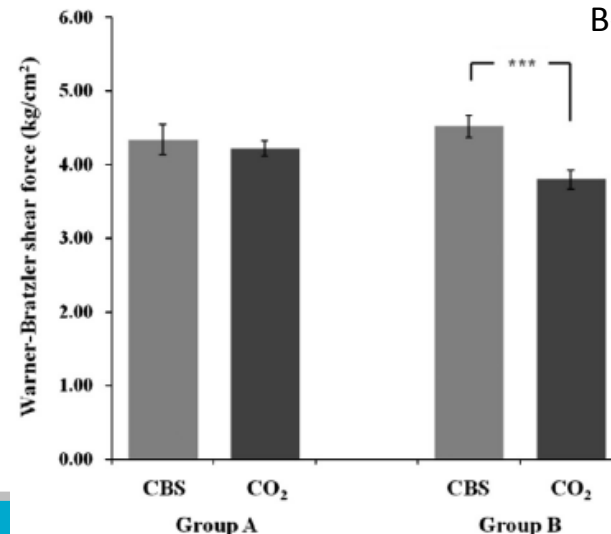
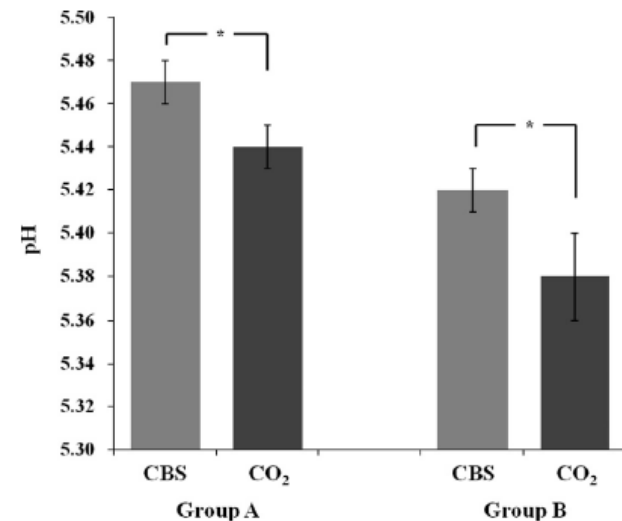


Source: CSIRO

More recent gas killing developments

- Refining of stun methods
 - Improved gas killing methods
 - Gas mixtures
 - Gas immersion parameters
- CO₂ stunning of cattle
 - 70% CO₂ for 140 sec
 - Cattle 620-790 kg (A –lighter, B heavier)
 - Compared against captive bolt
 - CO₂ – lower pH, lighter colour,

Source: Kim et al. 2013



Gas killing of sheep and goats

- Sheep (lambs)
 - Bornez et al. 2009
 - 80 or 90% CO₂ for 60s gave 100% of animals unconscious
 - No blood splash
 - No difference in pHu or colour compared with electrical stun
 - More tender than electrical stunned at 7 days
- Goats
 - Millman *et al.* 2015
 - Goat kids tolerated 20-30% CO₂ (n=12)
 - Loss of posture occurred between 87 and 271 s of exposure

The Future

On the Horizon

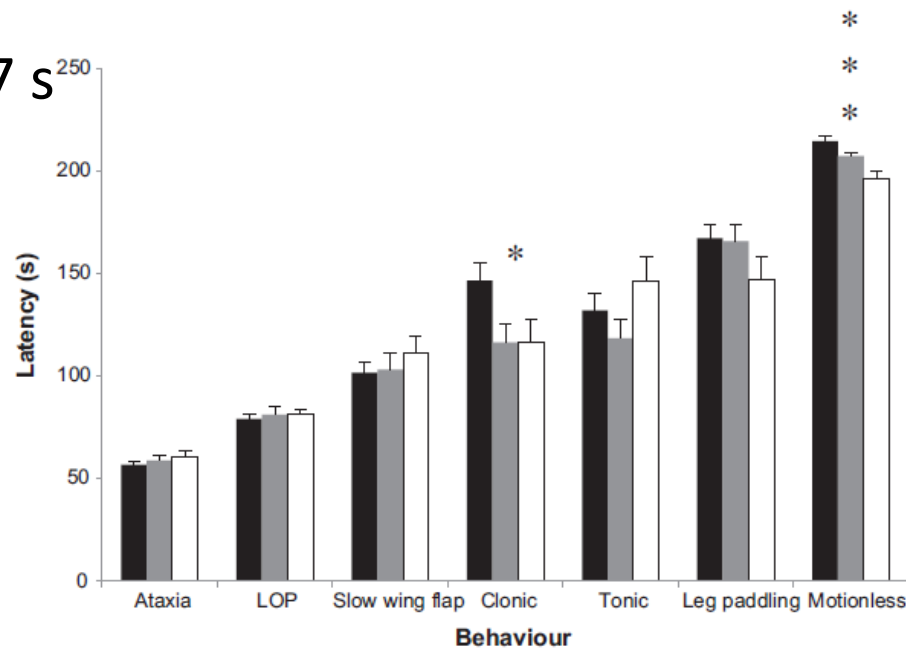
- LAPS
 - Low Atmospheric Pressure Stunning
 - Poultry
 - Kill method
- SPUC
 - Single Pulse Ultra-High Current
 - Hoping to eliminate blood splash issues
 - 5000 V; 70 A; 50 ms
 - Successes in cattle
- TOMS
 - Transcranial Oscillating Magnetic field Stunning
 - Similar to transcranial magnetic therapy (TMS)
 - Successes in broiler chickens
- DTS: Diathermic Syncope TM
 - Recent research in cattle

SPUC, TOMS and DTS are potentially reversible

LAPS

- Aircraft pilot suggested replication of altitude hypoxia
 - O₂ concentration is reduced at altitude
 - Leads to dizziness and fainting
- Controlled decompression over 280 s
 - 80.6 kPa less than atmospheric air
- Open bill breathing seen at 44-57 s
- Loss of posture at 63-97 s
- Convulsions 53-147 s later
- Motionlessness at 178-222 s
- Commercial pilot plant

Source: Mackie *et al.* 2016





Source: TechnoCatch LLC (www.chickencatcher.com)



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LAPS

- Successful in broiler slaughter
- What about other species?
 - Pigs?
 - Bobby Calves?
- What about on-farm disposal
 - Unwanted piglets
 - Poultry
 - Disease outbreaks?

SPUC

- Pulsed ultrahigh current (5000 V, 70A)
- 38 cattle successfully stunned
- Unconsciousness lasted up to 4 min
- Elimination of clonic phase

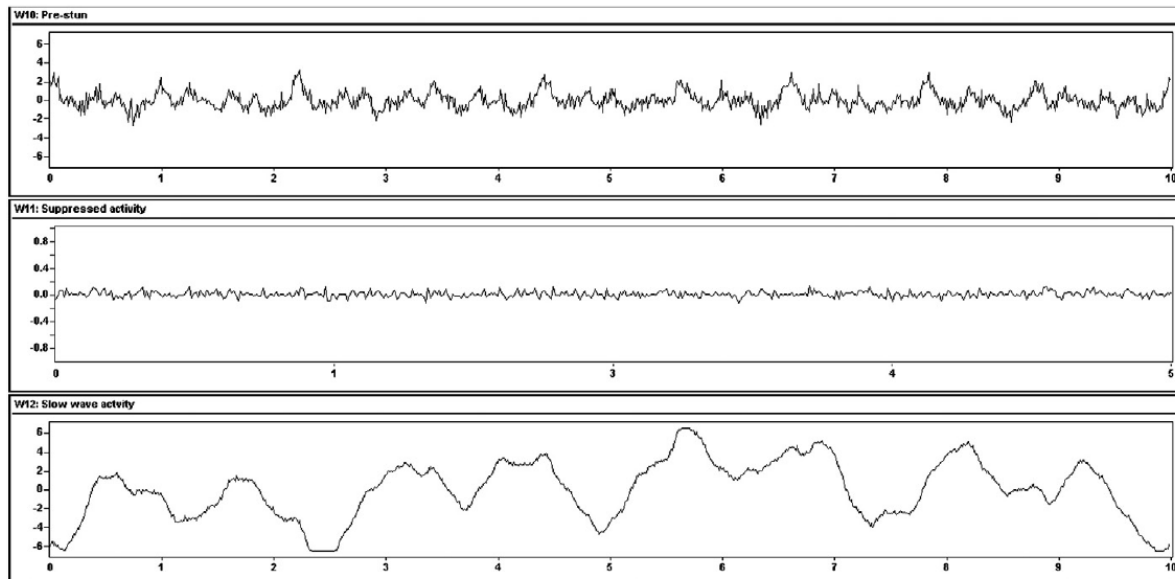


Fig. 1. An example of the electrical recording before and following a UHC2 stun, with the Y axis representing voltage (mV) and the X axis time in seconds.

Source: Robins *et al.* 2014



Source: CSIRO

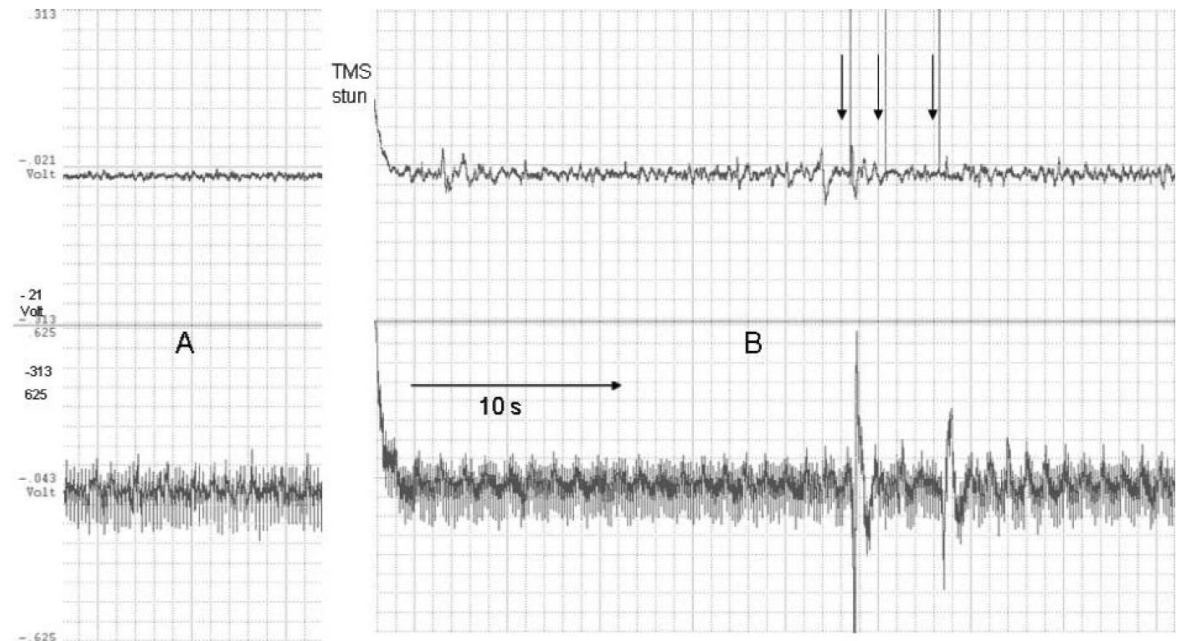


SPUC

- No ongoing research in Australia
- But interest from the UK
 - Humane Slaughter Association funding – PhD student
- Can the animal recover?

TOMS

- Broilers unconscious for 15-20 s post application (n=25)
- Loss of muscle tone
- Loss of behavioural responsiveness



Source: Lamboij *et al.* 2011

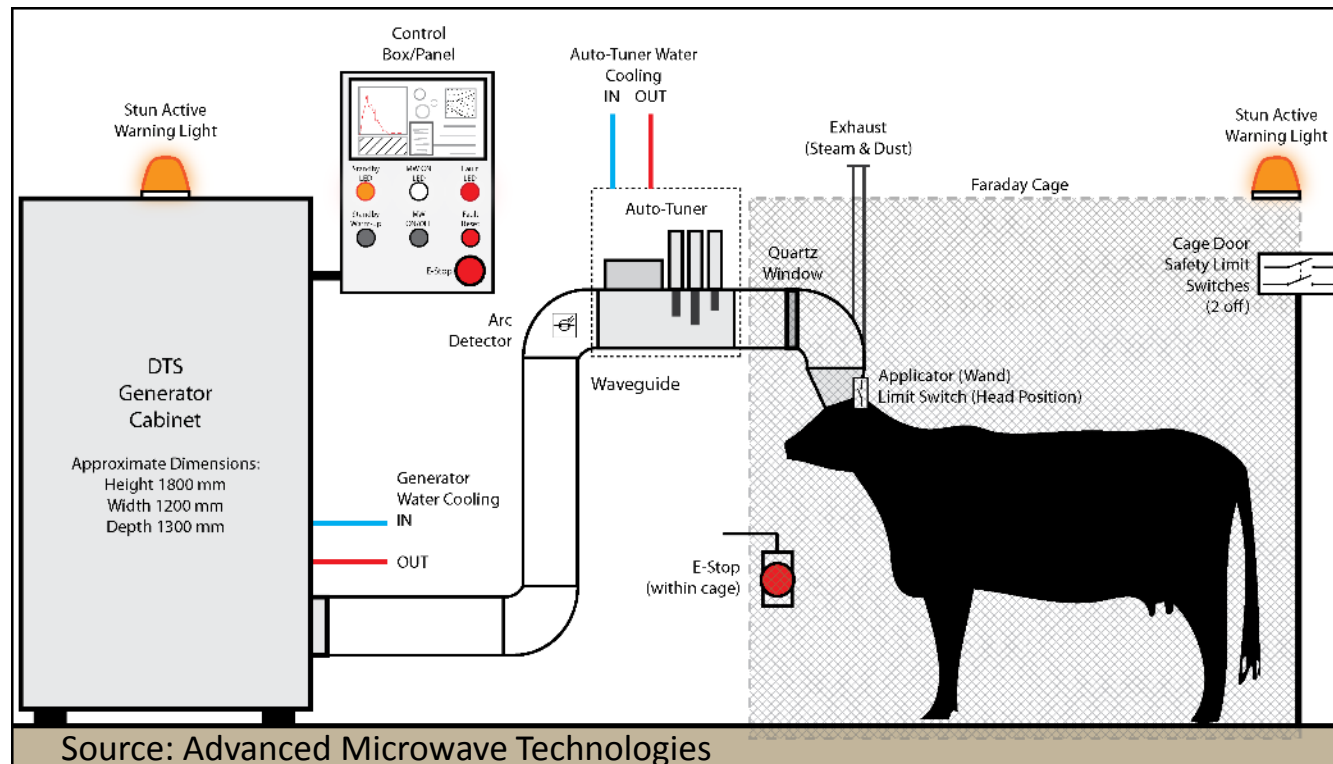
EEG (upper) and ECG (lower) (A) before and (B) after TMS stunning using a double coil with a power of 51% (↓ administration of a comb pinch).

TOMS

- Some work has been done with rabbits - successful
- A few attempts on sheep – inconsistent
- Can it be upscaled to other species?
- Can the animal recover?

DTS: Diathermic Syncope[®]

- Electromagnetic energy (922 MHz)
 - Focused into the brain
 - Volumetric heating
- Induced Hyperthermia
 - Above 43° C
 - Below 50° C



Outcomes of pilot study 2014-15

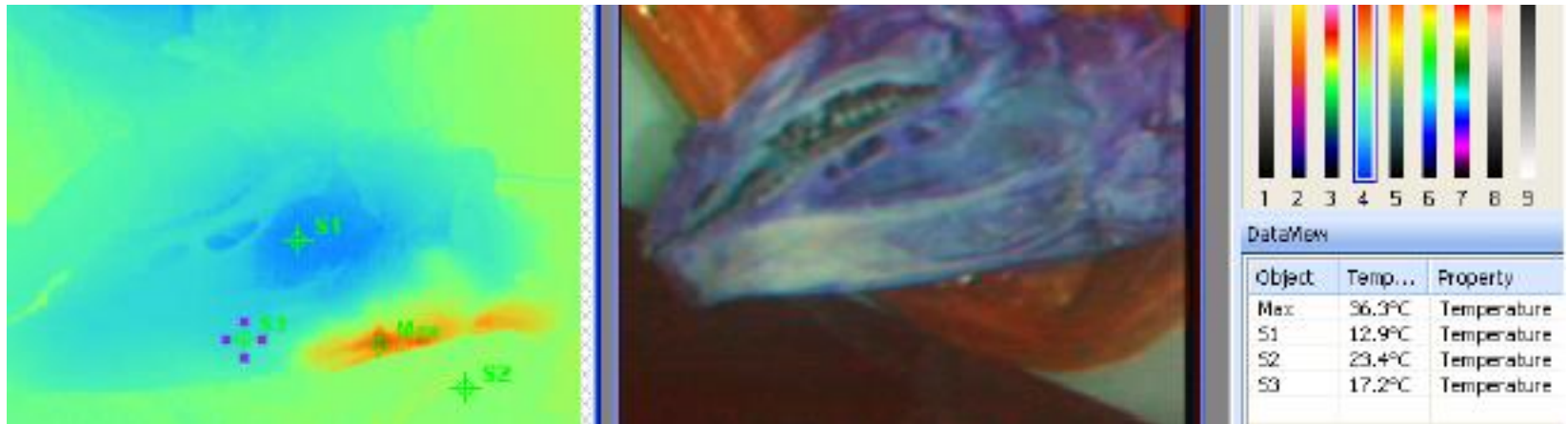
- DTS induced insensibility:
 - EEG suppression for 3-4 minutes.
- DTS animals remained unresponsive to stimuli:
 - No evidence of the eye beginning to focus and follow movement for 3-4 minutes post energy application;
- DTS animals maintained rhythmic breathing and a strong heart beat throughout the period of insensibility;
- Two animals showed evidence of return to consciousness, including the righting reflex, after around 4 minutes



Source: CSIRO

Ongoing work

- Development of new applicator wand
 - Reduce skin heating
 - Improve energy transfer
 - More focused heating



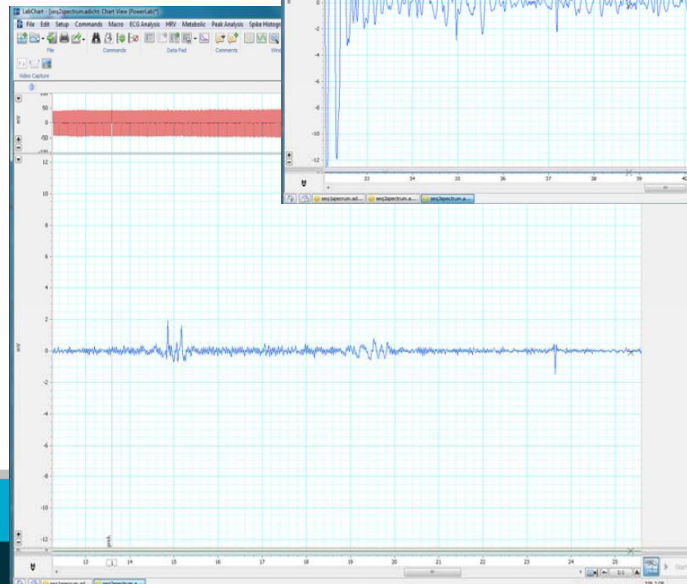
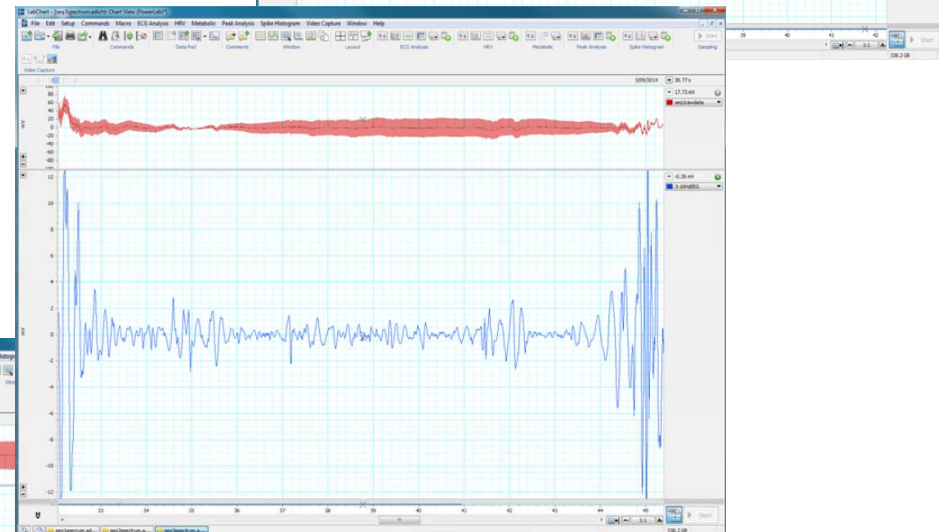
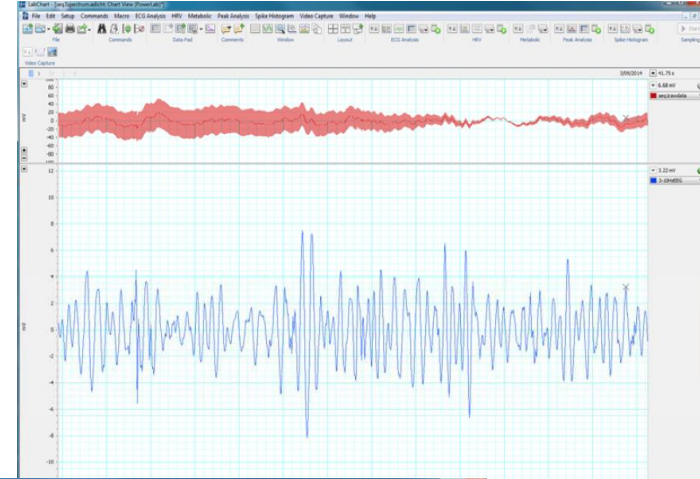
Source: Advanced Microwave Technologies

DTS

- Upcoming research study
 - DTS
 - Captive Bolt
 - Percussive (mushroom) stun
- Pre-commercial validation – 300 animals
 - Varying weight, gender
 - Target: 98% insensible on first application

A challenge

- How to assess unconsciousness?
 - Behavioural indicators
 - Loss of reflex = unconscious
 - Return of reflex??
 - EEG
 - Epilepsy = unconscious
 - Flat line = unconscious
 - Transitional state???



Images source: CSIRO

Thank you

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