Stress Myopathy

Rosemary & Rudi

Stress Myopathy

- **Pathophysiology not well understood**
- **Major trigger – stress caused by fear or anxiety.**
- **Risk enhanced by physical exertion.**
- **Obvious causes – macropod caught in a fence or chased by a motor vehicle or dogs will definitely have stress myopathy. Severity and presentation varies.**
- **Some causes more subtle eg change in carer, relocation to release site or certain noises.**
- **Personality of the animal also plays a role in whether stress myopathy develops.**

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Important concepts

Two concepts are important in understanding the development of stress myopathy:

- Sympathetic nervous system & the hormones adrenalin and cortisol
- Aerobic & anaerobic metabolism

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Fear factor

Fear & anxiety trigger the sympathetic nervous system & synthesis & release of hormones such as adrenalin and cortisol

Sympathetic - fight or flight

Parasympathetic – rest and digest

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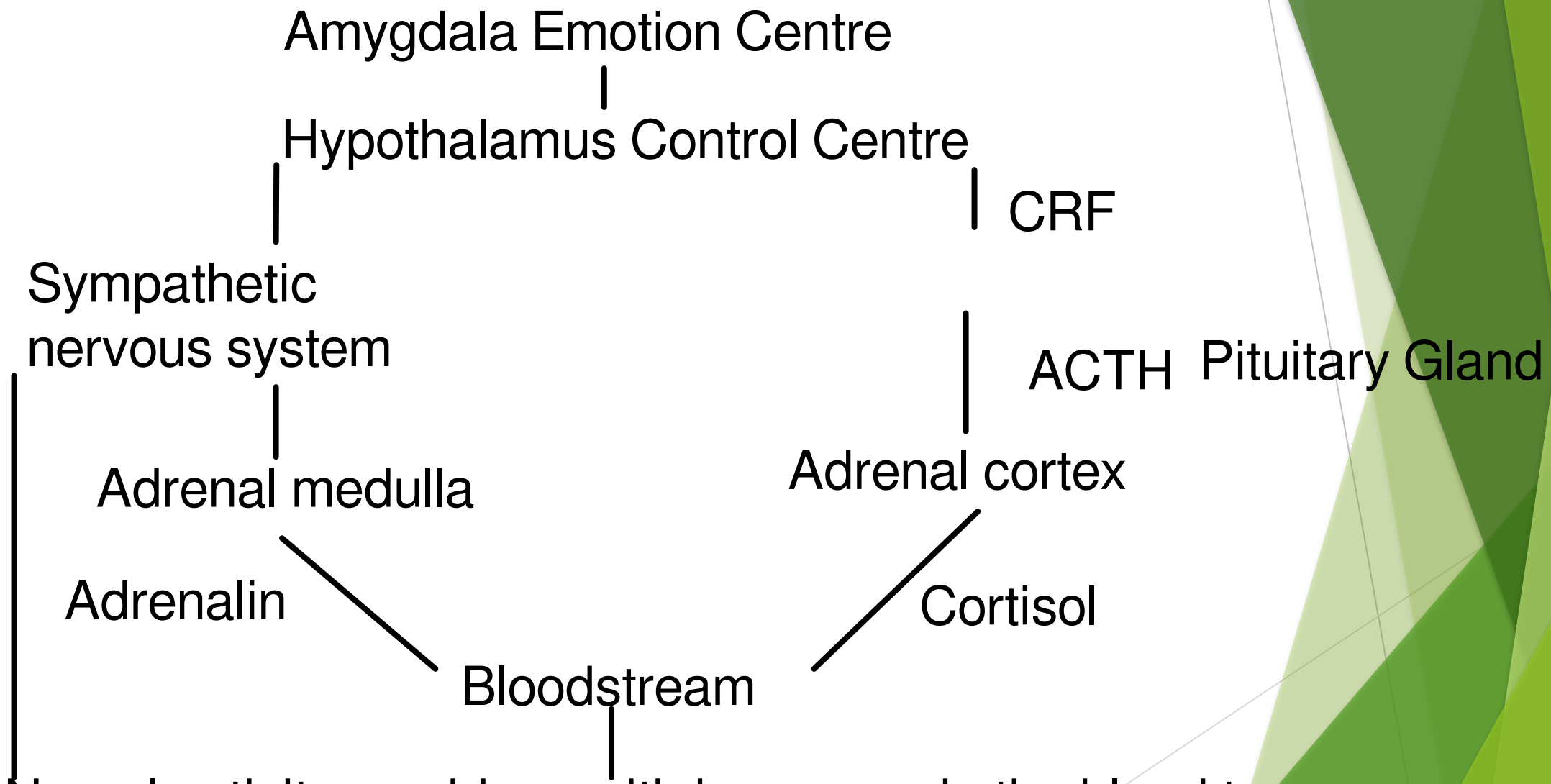
Fight or Flight Response



Neural activity combines with hormones in the blood to constitute the fight or flight response

Sympathetic nervous system: Effects

- Stimulates release of adrenalin
- Stimulates glucose release from liver
- Diverts blood away from GIT, kidneys and skin
- Enhances blood flow to skeletal muscles (1200%) & lungs
- Dilates bronchioles (airways) of lungs allowing better oxygen exchange
- Increases heart rate and contractility of heart cells
- Dilates cardiac blood vessels
- Dilates pupils
- Posturing in macropods

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The Adrenalin Rush

Adrenalin contributes to the fight or flight response by:

- increasing blood flow to the muscles
- increasing output of the heart
- pupil dilation
- increasing blood glucose

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Cortisol Contribution

- Increasing blood pressure
- Increasing blood glucose
- Heightened attention
- Decreasing sensitivity to pain

- As an analogy with respect to the fight or flight response adrenalin puts the foot on the accelerator. As the initial adrenalin surge subsides, cortisol keeps the accelerator on. When the threat passes, the parasympathetic nervous system acts like a brake and dampens the stress response.

Cortisol readings
(*Possumwood research)
Normal = <50nmol/L

Name	History	Cortisol initial (nmol/ L)*	Cortisol follow up
Swallow	Dog attack, severe injuries	531	56 (after 3 weeks)
Cherry	spinal injury, fox attack, joey taken & pouch torn	522	62 (after 4 weeks)
Big Al	Attacked by 3 dogs	431	
Carrie	Fence hanger, dog attack	525	
Arrow	70kg male with arrow penetrating eyelid	24	
Lily	Normal	31	
Josh	Fence hanger	196	

Cortisol case studies

Big Al

Lily

Swallow

Carrie

Aerobic metabolism

Glucose

↓ Glycolysis – in cell cytoplasm

ATP (energy source) + Pyruvate + H^+ (acid)

O_2 → ↓ Krebs cycle
Electron transport chain –in cell mitochondria

CO_2 (exhaled during respiration) + H_2O + ATP (energy source)

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Anaerobic metabolism

Glucose

↓

Glycolysis – in cell cytoplasm

ATP (energy source) + Pyruvate + H^+ (acid) → Lactate

OR

Creatine kinase (CK)

Creatine phosphate → Creatine + energy – in muscle cells

Phosphate + ADP → ATP (energy source)

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Useful reference: http://www.teachpe.com/physiology/energy_systems.php

Stress myopathy - consequences

Fear or anxiety plus strenuous muscle activity cause sympathetic stimulation + Adrenalin + Anaerobic metabolism which have the following consequences

- Tissue ischemia due to reduced tissue perfusion
- Lactic acidosis
- Muscular ATP (energy source) depletion
- Muscle cell damage & consequent release of myoglobin & potassium
- Compartment syndrome due to muscle swelling
- Acid stimulation of nerve endings in muscles causing muscle pain
- Rapid respiratory rate due to metabolic acidosis
- Cardiac rhythm disturbance due to hyperkalemia (high potassium)
- Hyperthermia (temp > 37 deg C)
- Myoglobinuric nephrosis
- Acute renal failure if severely dehydrated
- Pulmonary oedema

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Stress Myopathy Syndromes#1*

Hyper acute

- Infrequent
- Genetic predisposition?
- Rapid respiratory & heart rate, hyperthermia, recumbency
- Metabolic acidosis, hyperkalemia, ventricular fibrillation
- Death within 6 hours of coming into care

Weroona. Fence hanger, Autumn day, had tachypnoea, tachycardia, temp 39.5. Died several hours after rescue. Given IV NS & sodium bicarbonate infusion, cooled with wet towels

* Syndromes based on Possumwood observations over 16 years and with reference to Breed, D. et al, *Conservation Physiology*, 7, 2019

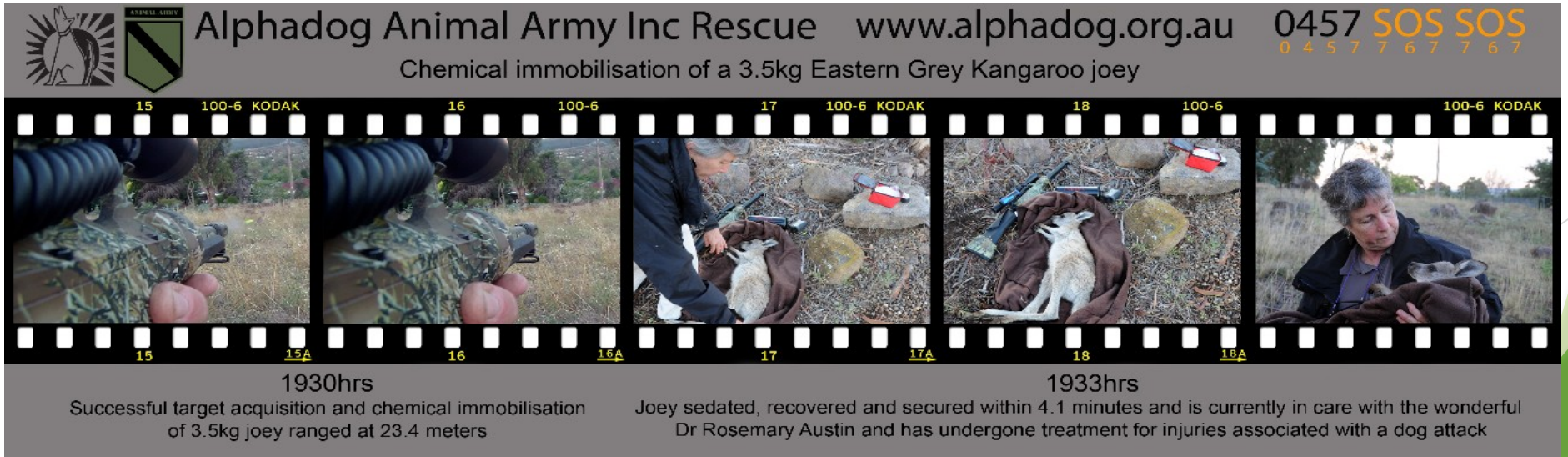
Stress Myopathy Syndromes#2*

Per Acute

- Rare
- Previous stress & myopathy
- Rapid progression to death after a subsequent

event (even mild).

Iggy. Mother euthanased, alone for three days, harassed by dogs and then darted and brought into care at 3.5kg. Always hypervigilant, thought to have PTSD. After a minor stressor, Iggy developed shivering, dilated pupils, recumbency, muscle fasciculations.



Respiratory arrest & death within one hour.

Stress Myopathy Syndromes#3*

Acute

- Most common
- Severity & survival variable
- Tachypnoea (rapid respiratory rate). One cause which can be fatal if not treated with sodium bicarbonate sterile infusion is lactic acidosis.

$$H^+ + HCO_3^- \longleftrightarrow CO_2 + H_2O$$

- Tachycardia
- Brown ‘Coca Cola’ urine
- Stiff limbs
- Pain - appears uncomfortable eg stretching hind legs
- Muscle fasciculation
- Elevated CK

What you might observe (signs of stress myopathy)

- Hyperthermia (> 37 Deg C)
- Tachypnoea (rapid respiratory rate)
- Tachycardia (rapid heart rate)
- Brown (Coca Cola) urine
- Stiff limbs
- Pain – macropod appears uncomfortable (eg stretching hind legs)
- Muscle fasciculation
- Elevated CK (if able to do a blood test in the acute situation the CK would be significantly elevated.

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Test	21/ 03/ 2019	16/ 04/ 2019	Normals*
Cortisol (nmol/ L)	531	56	<50**
Potassium (mmol/ L)	5.7	4.6	2.2 – 8.2
Urea (mmol/ L)	18.8	6.9	4.3 – 17.1
Creatinine (umol/ L)	120	55	44 – 168
AST (U/ L)	3343	96	30 – 281
Creatine Kinase (U/ L)	82900	1829	203 – 6868

* Vetnostics data.
**Possumwood research.

Swallow

Female Red Neck wallaby attacked by two dogs. Arm severe lacerations and fractures, bites to legs and neck. Small pinkie in pouch died

Test**		Normals*
Cortisol (nmol/ L)	525	<50**
Potassium (mmol/ L)	6.5	<6.6
Urea (mmol/ L)	13.1	3.9 – 16.4
Creatinine (umol/ L)	120	88 - 256
AST (U/ L)	5121	8 - 325
Creatine Kinase (U/ L)	356540	172 - 6020

* Vetnostics data.
** Possumwood research

Carrie

Fence hanger & attacked by dog while caught. Deep puncture wound to neck. Mother close by & probably saved her from the dog attack.

Test		Normals*
Cortisol (nmol/ L)	170	<50**
Potassium (mmol/ L)	12.3*	< 6.6
Urea (mmol/ L)	8.2	3.9 – 16.4
Creatinine (umol/ L)	115	82 - 256
AST (U/ L)	3650	8 - 325
Creatine Kinase (U/ L)	216230	172 - 6020

* Vetnostics data. ** Possumwood research.

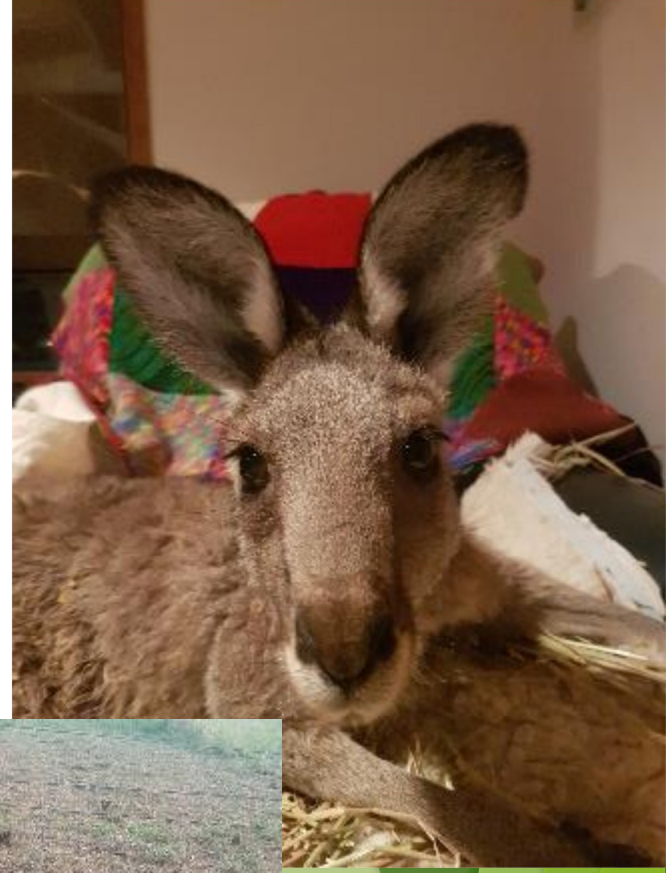
Rovere

Found collapsed in a garden. Hypothermic, likely chased by dogs.

Test		Normals*
Cortisol (nmol/ L)	-	<50**
Potassium (mmol/ L)	5.2	< 6.6
Urea (mmol/ L)	13.3	3.9 – 16.4
Creatinine (umol/ L)	110	82 - 256
AST (U/ L)	2625	8 - 325
Creatine Kinase (U/ L)	137870	172 - 6020

* Vetnostics data.
** Possumwood research.

Majura

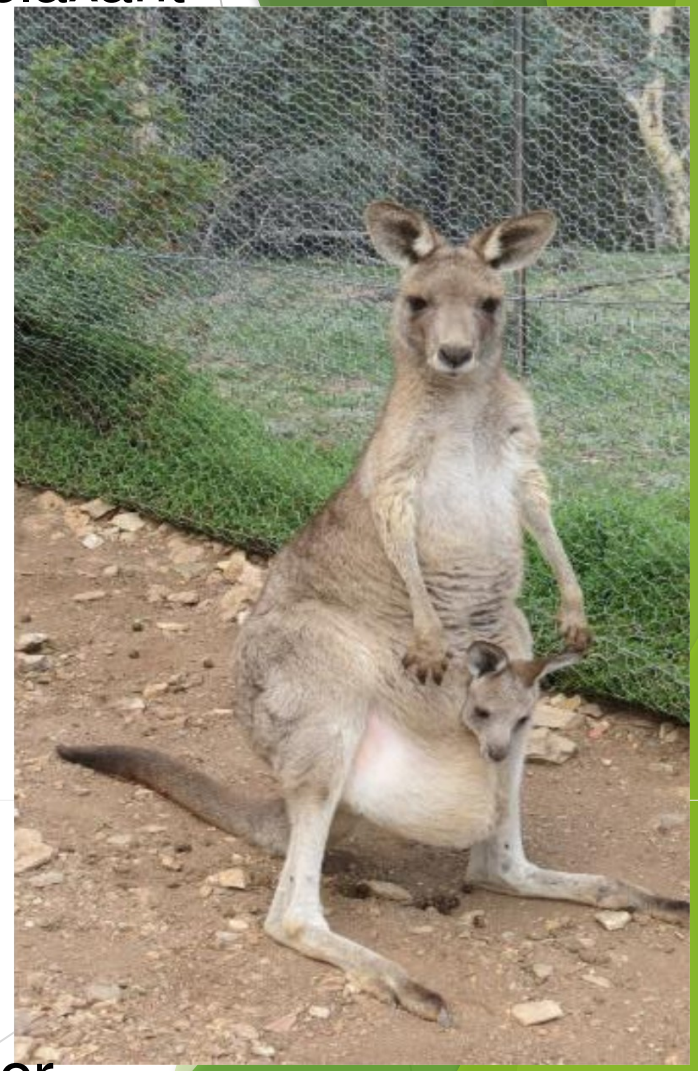


Macca

Test		Normal
Cortisol (nmol/ L)	118	<50

Treatment of stress myopathy

- Diazepam (0.25 – 0.5mg/ kg SC or IM) – anxiolytic & muscle relaxant
- Check temperature (tympanic thermometer - ear)
- If hyperthermia (> 37) - cool animal (eg wet towels & fan). Cool IV fluids most effective but not normally necessary
- If hypothermia (< 35) – warm animal (eg electric throw rug) around trunk
- It is very important to provide fluid therapy ASAP after Incident. Initially 3% by weight SC NS. Fluids can be given IV if necessary. Offer water or 1% glucose orally.



Emu – fence hanger survivor

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Treatment of stress myopathy (Cont)

- If still tachypnoeic after Diazepam & cooling give sodium bicarbonate intravenous infusion 8.4% – 1ml/kg SC, dose will likely need to be repeated
- Analgesia – Tramadol 1mg/kg IM twice daily or Panadol 10mg/ kg twice daily
- Vitamin E/Selenium – 1mg/ ml selenium & 50mg/ ml Vit E (0.05ml/ kg IM) once daily for 3 days
- Optional – Haloperidol decanoate 50mg/ml (6mg/ kg), Dexamethasone, Frusemide (Lasix) sometimes used
- Dantrolene Sodium (1ml/ kg IV) is mentioned in some texts as a skeletal muscle relaxant but is expensive

Macca, fence hanger