Stress in Macropods

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Stress in Macropods

- Pathophysiology not well understood and a paucity of knowledge in the literature. The term ‘stress myopathy’ is nebulous and inaccurate.
- Trigger for a stress syndrome is stress caused by fear or anxiety.
- Risk of death is increased by intense physical exertion.
- Obvious triggers include macropod caught in a fence or chased by a motor vehicle or dogs, or a joey separated from its mother. Presentation after severe stress varies.
- Three stress syndromes will be discussed.
- Some triggers are more subtle eg change in carer, relocation to release site or certain noises.
- Personality of the animal also plays a role in whether a stress syndrome develops.
- Animals with anxiety traits are more likely to develop a stress syndrome.

Important concepts

There are a number of concepts which are important in understanding the development and treatment of stress syndromes.

- Sympathetic nervous system & the hormones adrenalin and cortisol
- Aerobic & anaerobic metabolism & metabolic acidosis.
- Exertional rhabdomyolysis
- Polyvagal theory

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Fear factor

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

Sympathetic - fight or flight

Parasympathetic ventral vagal – rest and digest

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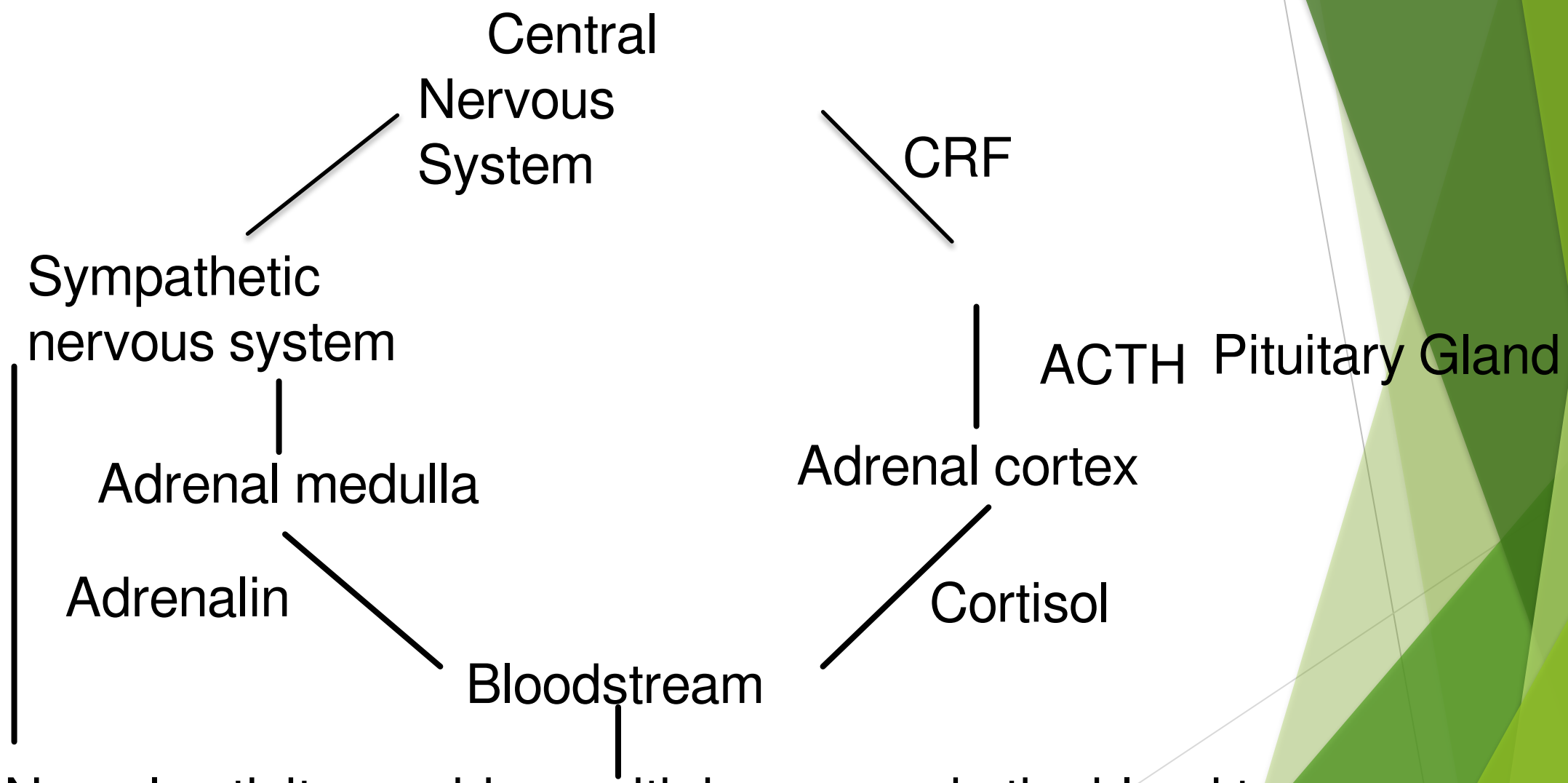
Fight or Flight Response



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 ventral vagal branch acts like a brake and dampens the stress response.

Cortisol Results

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	
Ginni	Fence hanger, ischemic toe, dislocated hip.	588	
Shannon	Fire victim, alone in a burnt area. Burnt hind feet, unable to hop	362	33 (after 6 weeks)
Cherry Blossom	Attacked by 2 large dogs	242	59 (after 17 days)

Cortisol case studies

Big Al

Swallow

Lily

Cherry Blossom

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)

Produces a total of 34 molecules of ATP, the body's 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)

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

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Exertional rhabdomyolysis

- Prolonged, strenuous muscle activity in hot conditions can cause exertional rhabdomyolysis especially if associated with dehydration.

- The breakdown of the muscle tissue releases the muscle protein myoglobin, enzymes: creatine kinase (CK, AST/ALT and potassium into the blood.

- The myoglobin results in dark brown or what is known as ‘Coca Cola’ urine and can result in kidney damage and consequent renal failure

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Stress Syndrome 1

- Severity and outcomes variable
- Fear or anxiety plus prolonged 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)
- Kidney damage caused by myoglobin
- Acute renal failure if severely dehydrated
- Pulmonary oedema

Stress Syndrome 1 - Weroona

Weroona was hanging by one leg in a fence on a warm day in the sun. On arrival at Possumwood she was severely dehydrated, hyperthermic (39.5c), tachycardic, tachypnoeic.

She was cooled with wet towels and a fan and IV fluid (NS) were given. She was also given IV sodium bicarbonate to treat lactic acidosis.

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

She died within six hours of coming into care.

Swallow

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.

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.

Stress Syndrome 1- Majura

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 recovered well with treatment and has been released

Treatment of stress syndrome 1

- 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 rescue. Initially 3% by weight SC NS. Fluids can be given IV if necessary. Offer water or 1% glucose orally.

Fluid therapy is important to treat dehydration and prevent acute kidney failure and prevent kidney damage caused by myoglobin and consequent chronic renal failure.

Emu – fence hanger survivor

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Treatment of stress syndrome 1 (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 IM – maximum 5 mg/ kg. Haloperidol is an anxiolytic and according to human patients has less side effects than Diazepam. Helps to switch animals from the sympathetic 'fight or flight' state to the ventral vagal 'rest and digest' state.

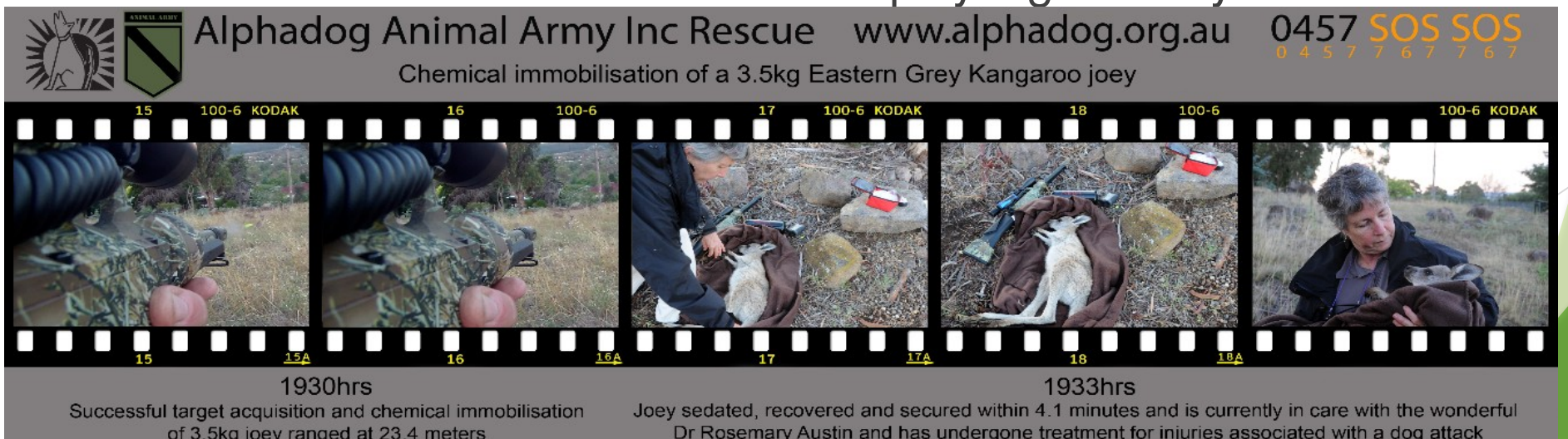
Macca, fence hanger

Stress Syndrome 2 - Iggy

- Less common
- Previous stress syndrome1
- Ongoing fight or flight state (PTSD)
- Rapid progression to death after a subsequent stress

trigger (even if 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 went into a trance-like state – recumbent, muscle fasciculation, respiratory arrest and death within one hour.? The shutdown state of the polyvagal theory.



Stress Syndrome 3

- We have observed that some macropods at rescue are already in what could be in a ‘shut down’ dorsal vagal state. These animals are under- responsive, are or are becoming hypothermic, bradycardic and bradypnoeic. They progress to respiratory arrest and death. We are questioning whether a medication like adrenalin could switch them from the parasympathetic ‘shut down’ to the sympathetic ‘fight or flight’ state and then to the ‘rest and digest’ state.

Name	CK	Cort	Temp	HR	RR	BP
Toto (10kg)	13009	257	32.4	60	14	102/42

State switching