COLLEGE OF VETERINARY MEDICINE

Heat Stress in the Horse

Brittnee Sayler, DVM

Outline

- Heat stress definition and importance
- Types of thermoregulation in horses
- Neuroendocrine responses to heat stress
- What happens as heat stress develops
- How is heat stress identified
- Methods for mitigating severe heat stress
- How to prevent heat stress
- Heat stress-related illnesses
- Case

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Heat Stress

- There is no clear definition of heat stress in horses
  - Little data available regarding heat stress in horses
- inability of the horse to maintain body temperature within a temperature range
- Healthy adult horses
  - 37.5 - 38.5 °C
  - 99.5-101.5 °F
  - When in their thermoneutral zone
    - 5 - 25 °C
    - 41-77 °F

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Heat Stress

- Accumulation of body heat exceeds dissipation and horses can suffer from heat stress
- Heat stress is a serious welfare issue under hot and humid conditions during
  - Thoroughbred and Standardbred racing
  - Endurance events
  - Olympic competition
  - Leisure riding
  - Transportation
  - Inappropriate housing and management

https://www.smartpakequine.com/learn-health/horse-heat-stress-stroke

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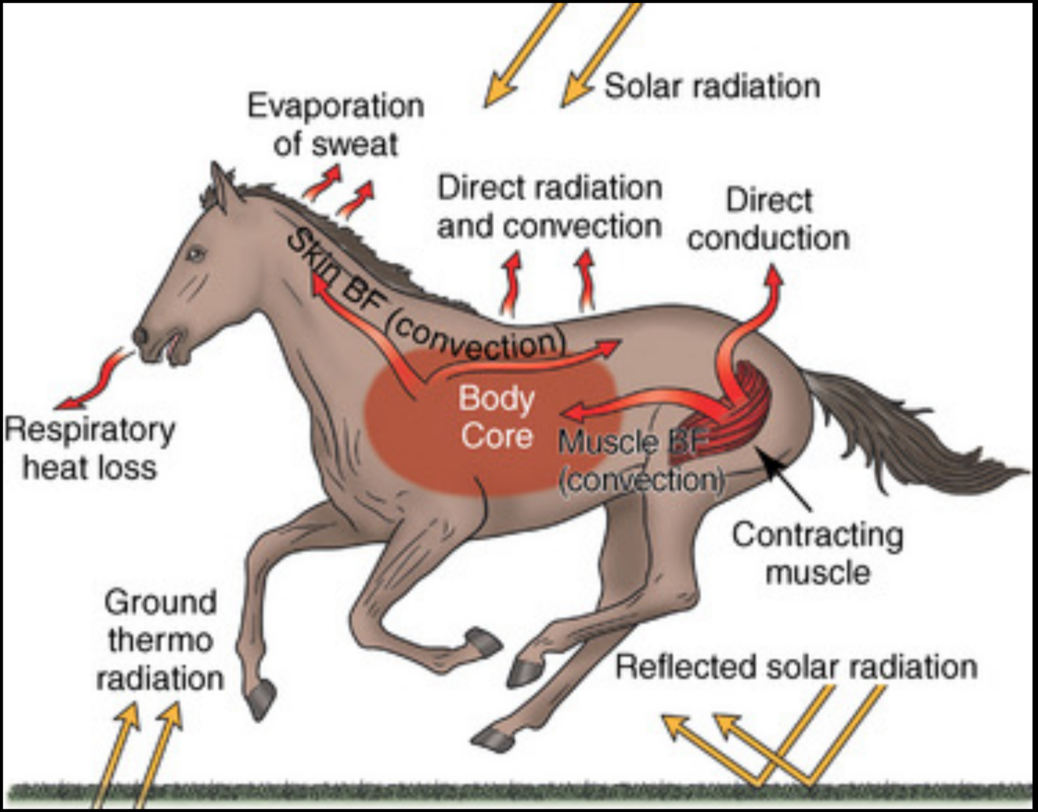
Thermoregulation

- Process that allows your body to maintain core internal temperature
- Mechanisms help return your body to homeostasis
- Core body temperature
  - Tightly regulated parameters of physiology
- Body temperature fluctuates due to circadian and seasonal rhythms
  - Minimum → early morning during the winter season
  - Maximum → late afternoon during summer
- Balance between heat production and heat dissipation



https://veteriankey.com/thermoregulation/

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Thermoregulation

- Negative feed back to minimize changes from preset, values
- Hypothalamus was destroyed →animals were unable to adequately regulate body temperature
- Normal thermoregulation → signals from nearly every tissue type
- Processing of thermoregulatory information → three phases:
  - Afferent thermal sensing
  - Central regulation
  - Efferent responses

Physiology of Thermoregulation

Andrea Kurz* M.D.
Professor and Vice Chair
Department of Outcomes Research, The Cleveland Clinic, 9500 Euclid Avenue, P77 Cleveland, Ohio 44195, USA

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Physical Heat Transfer

- Comparatively lower body surface-to-mass ratio
  - 1:90–100 m2/kg
- Further reduces their ability for heat dissipation
- Increases the use of energy required
- Body temperature is maintained in the narrow range

https://training.arioneo.com/en/blog-thermoregulation-in-horses-how-does-he-regulate-his-body-heat/

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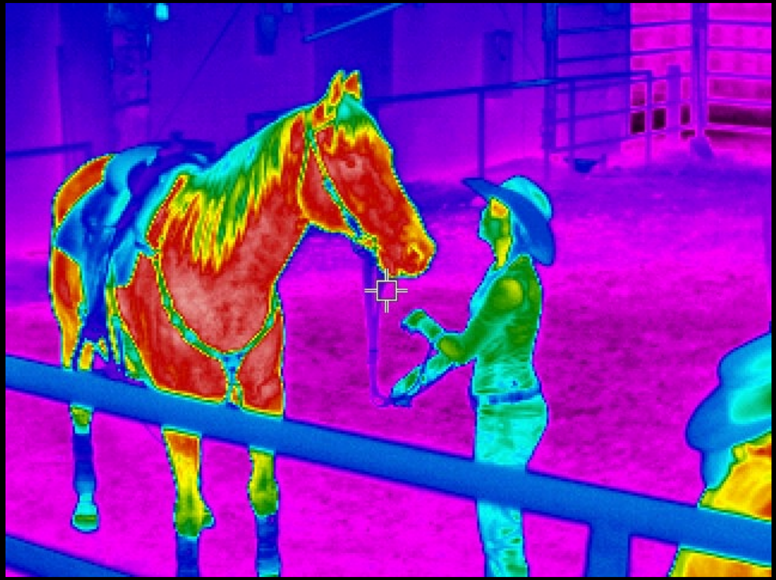
Heat Transfer in Horses

- Thermal Radiation
- Convection
- Conduction
- Evaporation

https://breedingnews.com/heat-stress-in-horses-a-literature-review/

Thermal Radiation

- Heat exchange occurs between the animal's skin and surrounding environment
  - Electromagnetic waves without direct physical contact
- Heat gain via radiation becomes greater than the heat dissipation under sunlight
  - Depends on thermal radiation added to ambient temperature
- Under hot and humid conditions
  - heat dissipation is limited



https://activerain.com/blogsview/2260970/farmington--utah-equine-thermal-imaging-at-the-legacy-event-center

Do zebra stripes influence thermoregulation?

Alison Cobb & Stephen Cobb

To cite this article: Alison Cobb & Stephen Cobb (2019) Do zebra stripes influence thermoregulation?, Journal of Natural History, 53:13-14, 863-879, DOI: 10.1080/00222933.2019.1607600

To link to this article: https://doi.org/10.1080/00222933.2019.1607600

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Thermal Radiation

- Color of hair coat in horses impacts body temperature
- Black and white stripes of the Zebra coat had different temperatures
  - Solar radiation absorbance
    - Black coat twice as much as white coat
  - Temperature of the black stripes of the Zebra was higher than the white stripes

https://www.worldofwarmth.com/zebras/

Do zebra stripes influence thermoregulation?

Alison Cobb & Stephen Cobb

To cite this article: Alison Cobb & Stephen Cobb (2019) Do zebra stripes influence thermoregulation?, Journal of Natural History, 53:13-14, 863-879, DOI: 10.1080/00222933.2019.1607600

To link to this article: https://doi.org/10.1080/00222933.2019.1607600

Convection

- Movement of a gas or liquid
- Depends on the temperature gradient between the body surface and surrounding gas or liquid
- Viscosity determines how rapidly the warmed gas or liquid is replaced by the cool gas or liquid
- Body heat is transferred from the surface into the cooler surrounding air
  - The body heat can be dissipated more quickly to the replaced cool air
- Faster gas movement can increase the heat exchange

https://www.nor-val.com/equipment.asp?action=category&category=89&key=070%2D0290

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Convection

- Long hair has poor body heat dissipation
  - The hair traps the warmed air
- Increased blood flow can help heat dissipation
- Increased respiratory rate results in heated air being replaced by cooler air
  - High respiratory rate can dissipate 25% of the metabolic heat production

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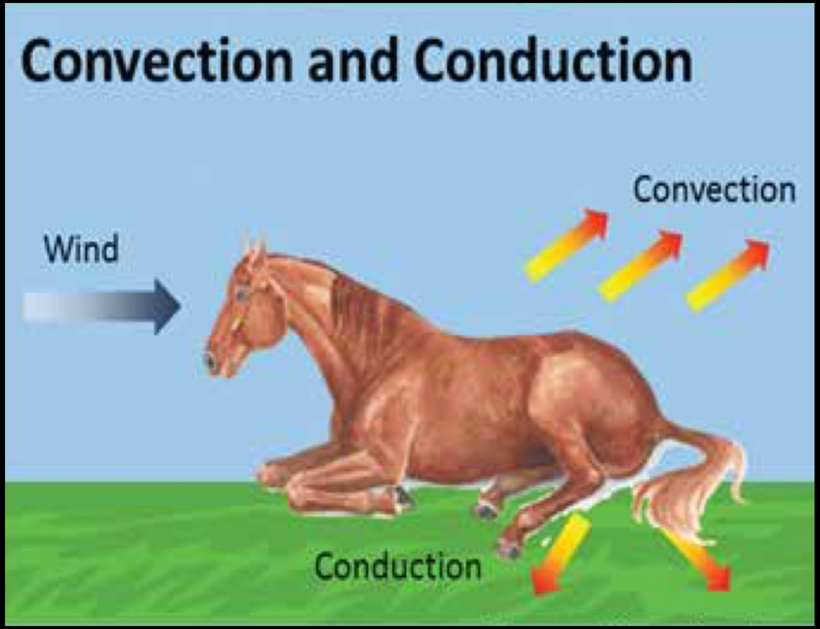
Conduction

- Heat transfer through molecular interactions
- Heat is exchanged between surfaces when the surfaces have different temperatures
- Emit body heat to the surrounding air when the air temperature is lower than body temperature
- Reverse when the air temperature is higher than that of body temperature
- Body heat from the surface of the horse to cooler surrounding air heats up the air
  - Heated air can be replaced by wind
  - Enhancing the conductive heat dissipation to the surrounding air



https://www.equineguelph.ca/pdf/tools/thermoregulator/Thermoregulator-Hot_FINAL_LINKS.pdf

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Conduction

- Skin thickness, hair formation, length and density affects conductive heat transfer
- Depends on relative humidity of the air
  - Water has a high heat conductivity
- Most effective method to cool down the body temperature
  - When water that is cooler is applied to the body
- Prolonged dehydration can lead to dysfunction of the central nervous system and heat stroke
  - Horse may die due to a malfunction of thermoregulation

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Evaporation

- Only Equidae, Bovidae, and primate species have sweat glands that allow them to use the evaporation of sweat as the primary form of thermoregulation
- Humans and horses use sweat evaporation as a primary thermoregulation method
- Approximately 70% of heat loss during exercise is via evaporation when humidity is low
- The sweat of horses is hypertonic and contains abundant Na+, K+, Cl−, and latherin
    - Latherin: enhances evaporation

https://www.horsejournals.com/horse-care/seasonal-care/summer/your-horse-heat-stress-and-hydration

Thermoregulation: Base Mechanisms and Hyperthermia

Alan J. Guthrie BVSc, MMedVet, PhD, Raymond J. Lund BSc(Eng), MSc

Man and Animals in Hot Environments (Topics in Environmental Physiology and Medicine)

by D.L. Ingram (Author), L.E. Mount (Author)

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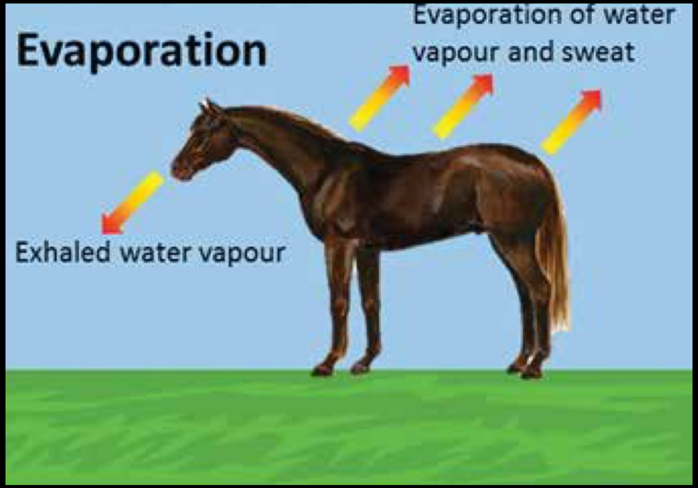
Evaporation

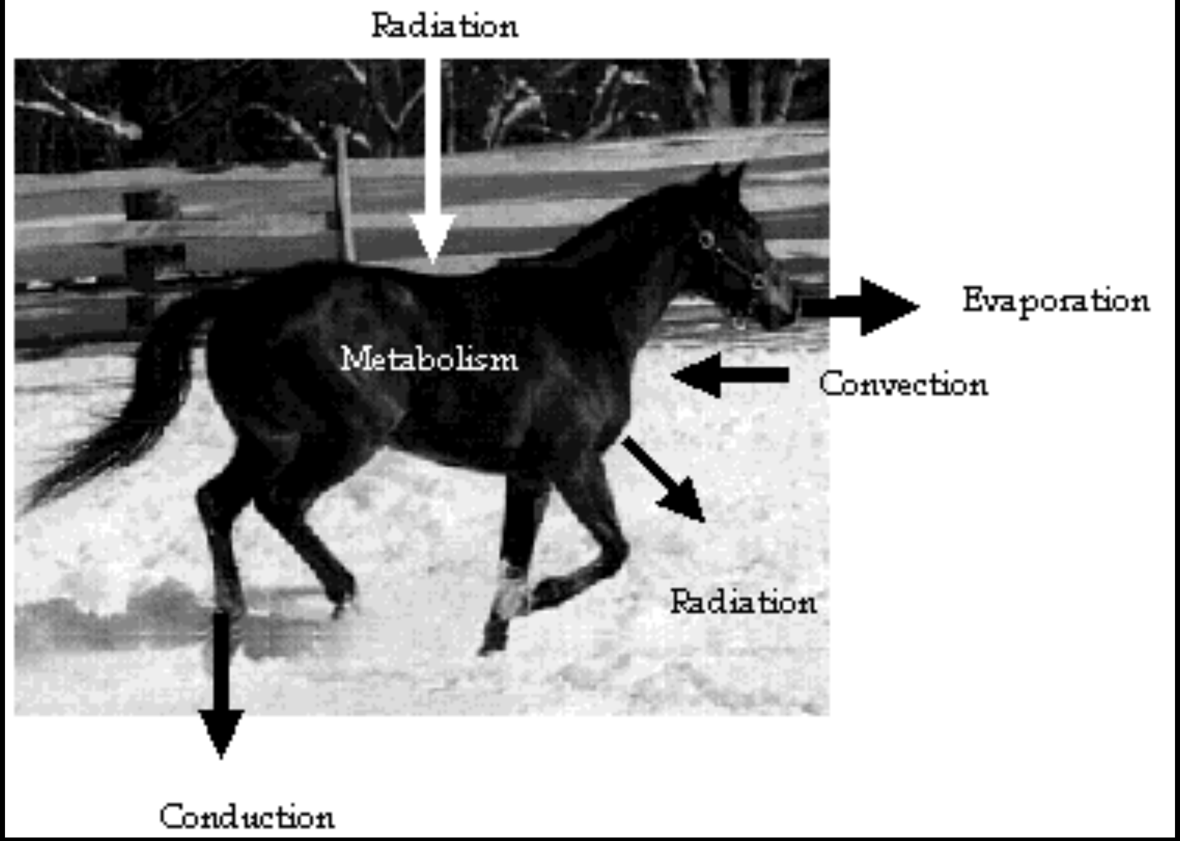
- Occurs via the respiratory tract of horses
  - Expelled air is always of body temperature with a humidity of 100%
  - Breathing frequency and volume of air intake → increase tenfold and up to 18-fold during strenuous exercise
  - Enhances evaporative cooling via the respiratory tract
- Cold circumstances respiration rate decreases
- Heat dissipation through evaporation relies significantly on relative humidity
  - Evaporation is increased when humidity is lower



https://www.equineguelph.ca/pdf/tools/thermoregulator/Thermoregulator-Hot_FINAL_LINKS.pdf

Overview of Heat Transfer

- Horses can dissipate body heat produced by Increasing
  - conduction
  - Convective
  - Evaporation
  - Increasing heart rate
  - Redistributing blood flow
  - Increased Respiratory rate
  - Sweating



https://www2.nau.edu/~gaud/course/GCeco/enbal.htm

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Overview of Heat Transfer

- Horses have only a few options to dissipate body heat due to limited or reversed heat transfer
  - Convection
  - Conduction
  - Radiation
  - Evaporative heat transfer
- Continuous sweating increases the use of body water and electrolytes which can lead to dehydration

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Neuroendocrine Response

- Attempts to return body temperature to its normal range
- Changes are detected by the nerve endings of temperature-sensitive neurons in
  - Epidermis, Blood vessels, Brain, Different body systems (abdominal viscera and spinal cord)
- 20 to 40% detect heat and 5 to 10% detect cold
- Signals detected by the thermoreceptors are transferred to
  - Thalamus
  - Primary somatosensory cortex in the brain
- Mediate the perception of heat to the lateral parabrachial nucleus

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Neuroendocrine Response

Heat stress in horses: a literature review

Hyungsuk Kang[1] · Rebeka R. Zsoldos[1] · Albert Sole-Guitart[2] · Edward Narayan[1] · A. Judith Cawdell-Smith[1] · John B. Gaughan[1]

Received: 2 February 2022 / Revised: 21 March 2023 / Accepted: 28 March 2023 / Published online: 15 April 2023

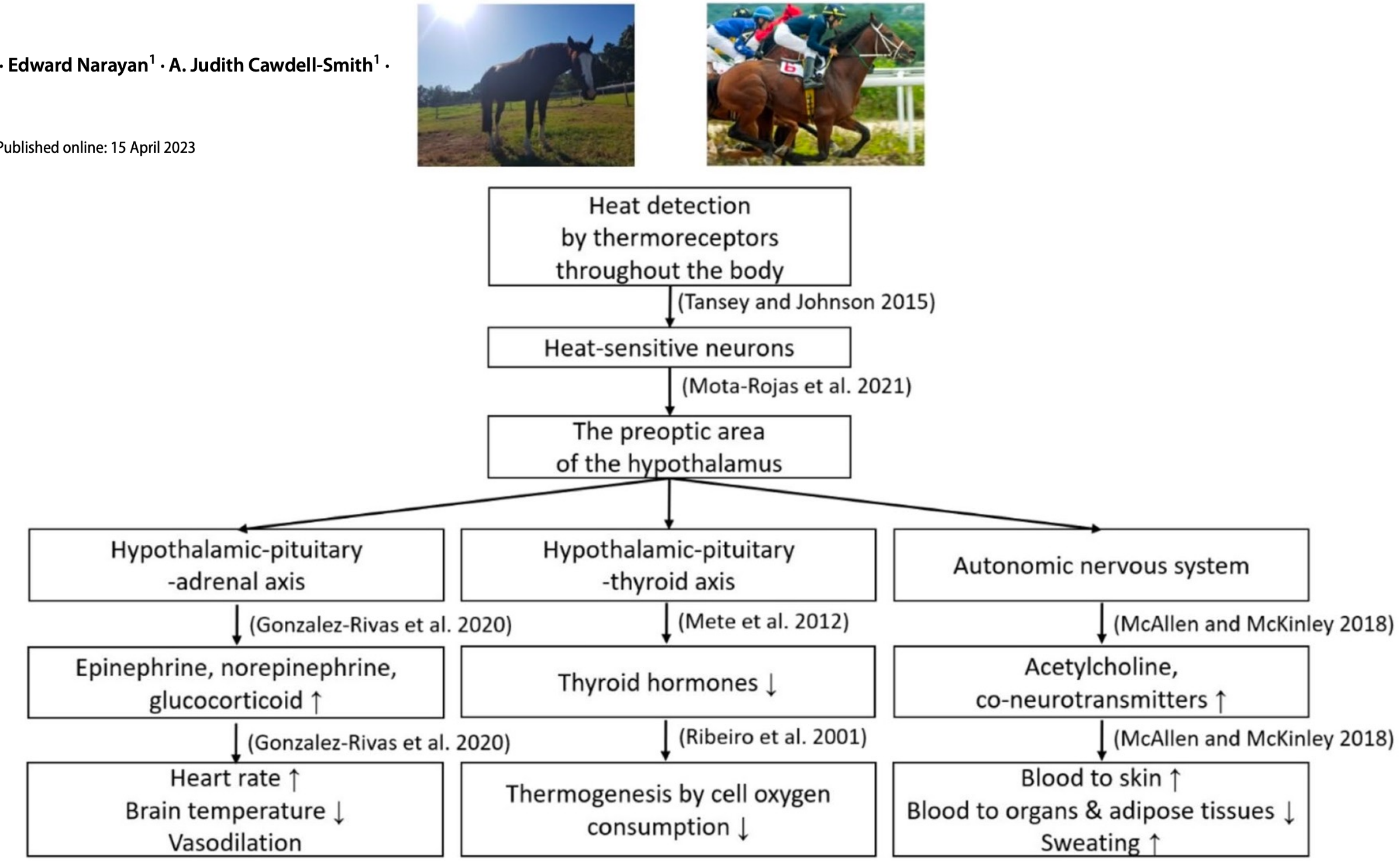

Fig. 2 Neuroendocrine and physiological responses to heat stress. Arrows in the boxes — '↑', increasing; '↓', decreasing. The images were adapted from Hyungsuk Kang and open source 'Adobe stock images'

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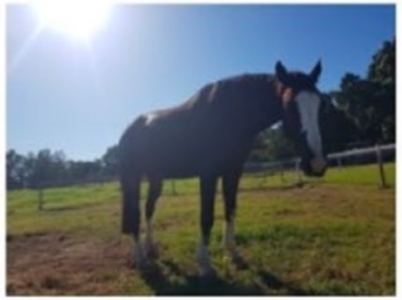
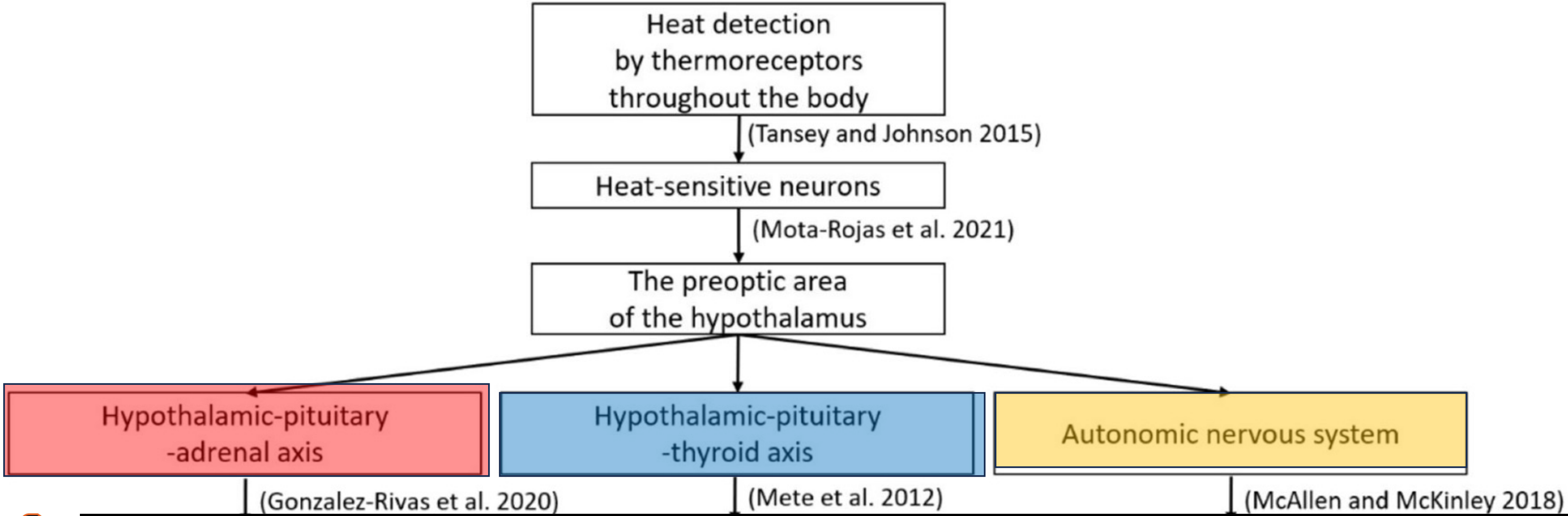
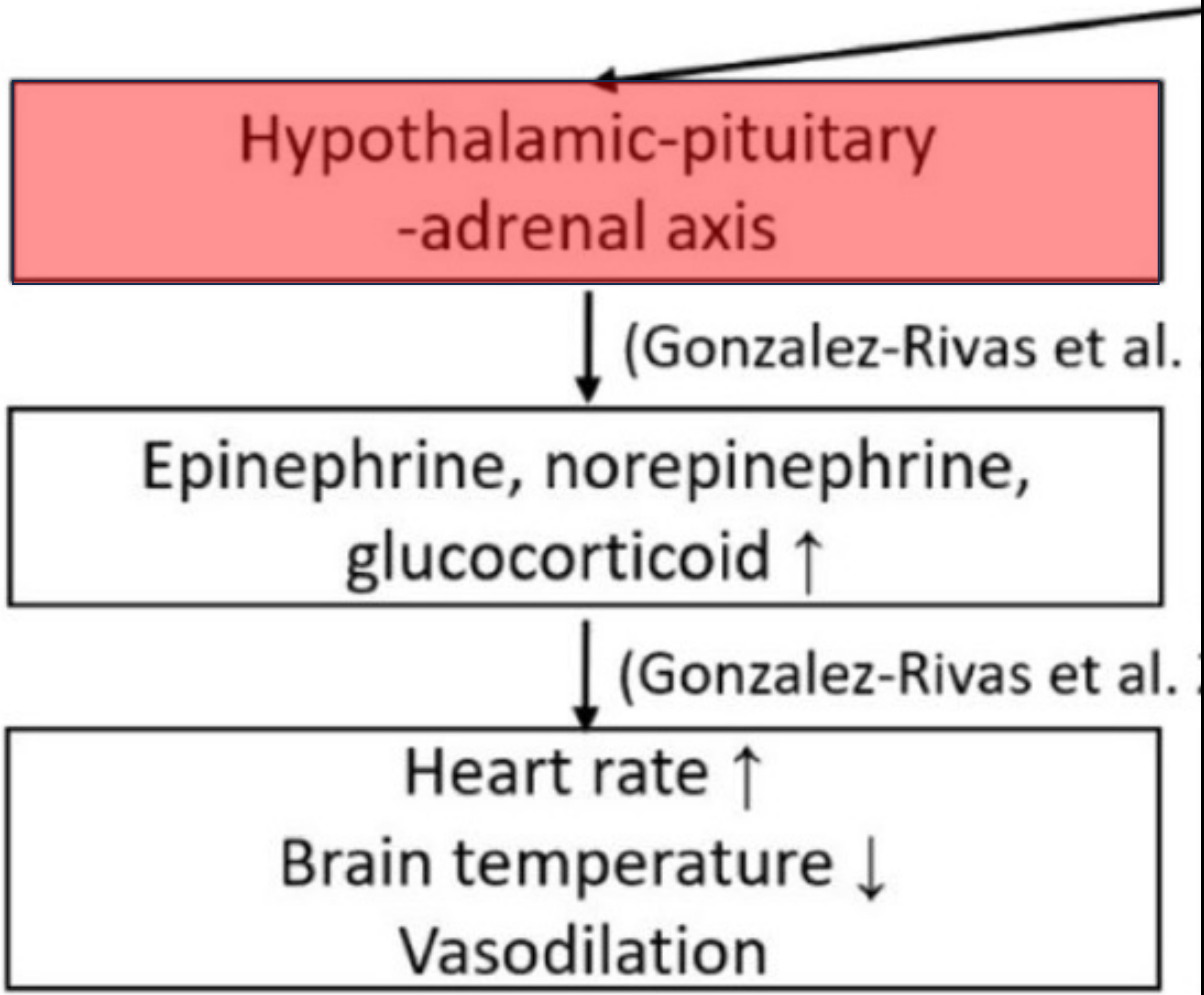
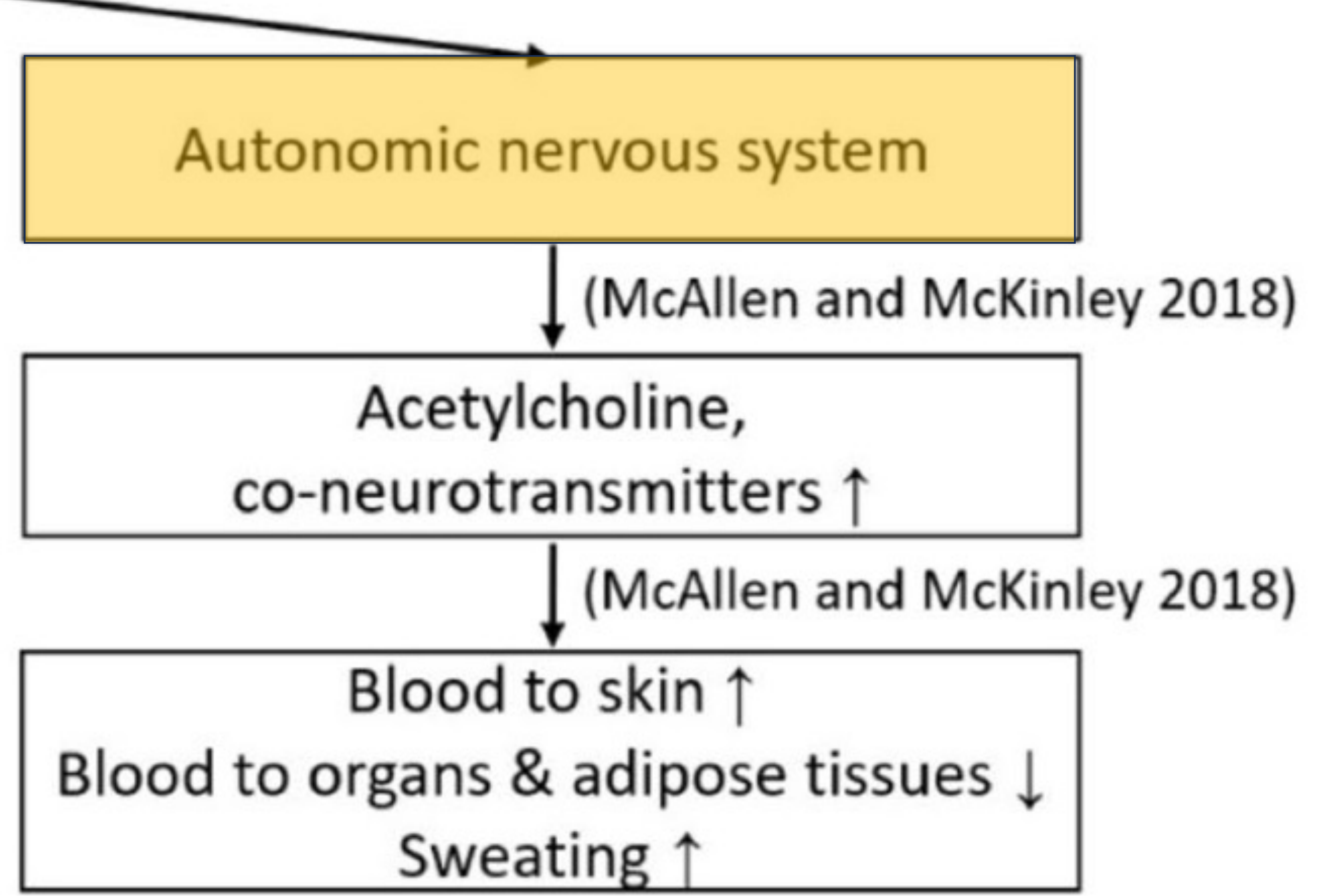
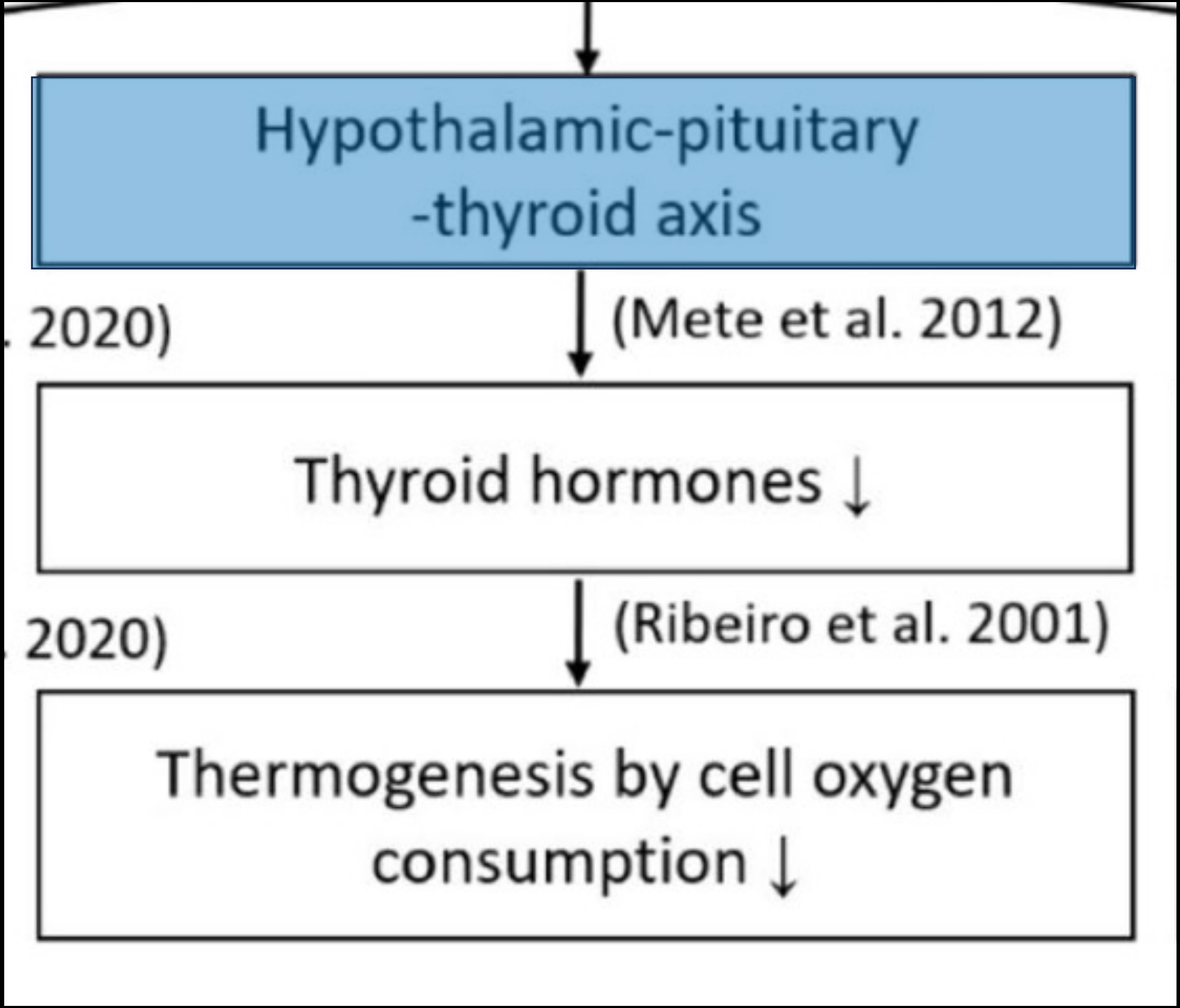



Heat detection
by thermoreceptors
throughout the body
(Tansey and Johnson 2015)
Heat-sensitive neurons
(Mota-Rojas et al. 2021)
The preoptic area
of the hypothalamus
Hypothalamic-pituitary
-adrenal axis
Hypothalamic-pituitary
-thyroid axis
Autonomic nervous system
(Gonzalez-Rivas et al. 2020)
(Mete et al. 2012)
(McAllen and McKinley 2018)



Hypothalamic-pituitary
-adrenal axis
(Gonzalez-Rivas et al.
Epinephrine, norepinephrine,
glucocorticoid ↑
(Gonzalez-Rivas et al.
Heart rate ↑
Brain temperature ↓
Vasodilation


Autonomic nervous system
(McAllen and McKinley 2018)
Acetylcholine,
co-neurotransmitters ↑
(McAllen and McKinley 2018)
Blood to skin ↑
Blood to organs & adipose tissues ↓
Sweating ↑


Hypothalamic-pituitary
-thyroid axis
. 2020)
(Mete et al. 2012)
Thyroid hormones ↓
. 2020)
(Ribeiro et al. 2001)
Thermogenesis by cell oxygen
consumption ↓

What happens as heat stress develops

- No additional energy to maintain body temperature
- Balance can be disrupted in some circumstances
- During strenuous exercise → 80% of the energy consumed by the muscles is released as metabolic heat
- Metabolic processes of muscular contraction can be divided into two types
  - Aerobic
  - Anaerobic
- Higher-intensity exercise requires more rapid energy consumption in the skeletal muscles

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What happens as heat stress develops

- Hot and humid climatic conditions may exacerbate heat accumulation
- Body temperature can significantly increase as ambient temperature increases
- Humidity influences body temperature
  - Water has high conductivity
- The respiration rate of some species increases in an attempt to maximize heat dissipation through evaporation
  - Dogs, sheep, humans and cattle
- Horses increase in respiratory rate during periods of heat load

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What happens as heat stress develops

- Various physical factors can change as an adaptation
  - Normal body temperature range
  - Fat deposition
  - Coat thickness
  - Hair density
- Sensitivity and population of the receptors can be changed

https://www.horsenation.com/2022/06/19/when-is-it-too-hot-to-ride-your-horse-presented-by-kentucky-performance-products/

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What happens as heat stress develops

- Adaptation to heat stress changes the sensitivity of the onset of sweating
- Repeated exercise initiates the onset of sweating
- Adaptation to the prolonged heat stress
  - Changes in morphological traits
  - Behavior
  - Metabolism
  - Productivity

https://equimed.com/health-centers/fitness-and-conditioning/articles/equine-energy-thermo-regulation-and-electrolyte-balance

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Heat stress

Heat stroke is a life-threatening illness

- Clinical Signs:
  - Depression
  - Weakness
  - Refusal to work
  - Decreased appetite
  - Tachypnea
  - Tachycardia
- Elevated rectal temperature (41 to 43 °C)
- Lethargy
- Poor sweating response (hot and dry skin)
- Slow capillary refill response (muddy mucous membranes)

Risk factors in equine transport-related health problems: A survey of the Australian equine industry

B Padalino [1 2 3], S L Raidal [3], E Hall [1], P Knight [4], P Celi [5 6], L Jeffcott [1], G Muscatello [1]

Affiliations + expand

PMID: 27564584 DOI: 10.1111/evj.12631

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Heat stress

- Can change mental status (confusion, or coma)
- Damage
  - Brain, Liver, Kidneys, Muscles
- Heat stroke in horses → rectal temperature exceeds 105.8 °F
  - Over-exercising during hot and humid conditions
  - Being confined in a space where the ventilation system is inadequate
  - Being moved to a hot and humid climate

Risk factors in equine transport-related health problems: A survey of the Australian equine industry

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Affiliations + expand

PMID: 27564584 DOI: 10.1111/evj.12631

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Case

- 14-year-old American Quarter Horse mare, presented for diarrhea and suspected dehydration
- The evening of 4 days before presentation she was put in the barn without water for roughly 36 hours
- Outside temperature at that time was around 105ºF
- When the owners noticed, Let them out and they ran to the pond, he then began hand watering her every 3 hours
- 3 day before presentation the mare developed diarrhea
- 2 days before presentation the rDVM gave her dexamethasone, thiamine, and Bo-se (Selenium, Vitamin E)
- The day of arrival she didn't have an appetite and was sore on her right front foot

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Physical Exam

- On presentation, she was quiet, alert and painful
- T: 102.9F, HR: 64 bpm, RR: 36bpm
- Gut sounds were absent in all four quadrants
- Bounding digital pulses in all four limbs
- Her mucous membranes were pale pink, tacky with a toxic line
- The remainder of her physical examination was unremarkable
- Weighed approximately 1,150 lbs. with a body condition score of 5/9.

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Blood Work Day 1

Date	Day 1
Creatinine (1-2 mg/dl)	5.5
Calcium (10.8-13.5 mg/dL)	9.8
Sodium (132 -146 mg/dL)	123
Potassium 2.4-4.7 mEq/L)	2.2
Chloride (95-110 mEq/L)	89
CPK (45-360 IU/L)	1632
AST (148-360 IU/L)	1211
Fibrinogen (76-230 mg/dL)	285
WBC (5.1-12.5 x10^3/UL)	4.4
Lymphocytes (1500-5500 /uL	352

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Medication – Day 1

- Acetaminophen 500mg
  - 21 tablets by mouth every 12 hours
- Lidocaine:
  - 160ml/hr CRI
- Pentoxifylline 400mg
  - 13 tablets by mouth every 12 hours
- Plasmalyte
  - 2L/hr
    - Calcium Gluconate 23% 50 - 100mL
    - Potassium Chloride 40Meq
- Ice boot all 4 feet
- Polymyxin B Sulfate 500,000 Units/Vials
  - 5 Vials once

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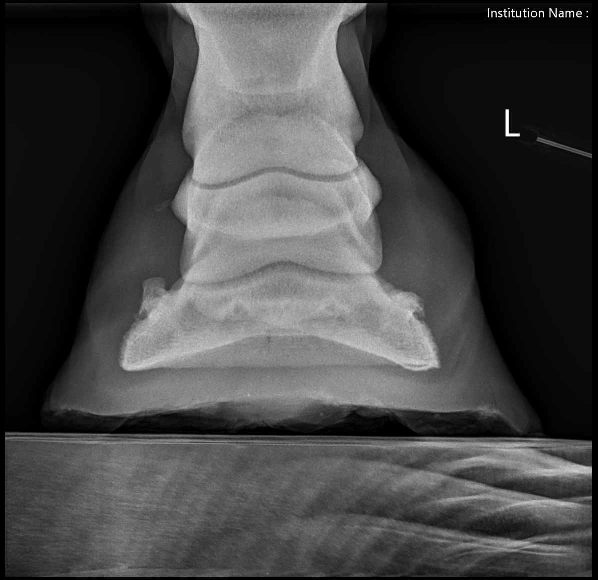
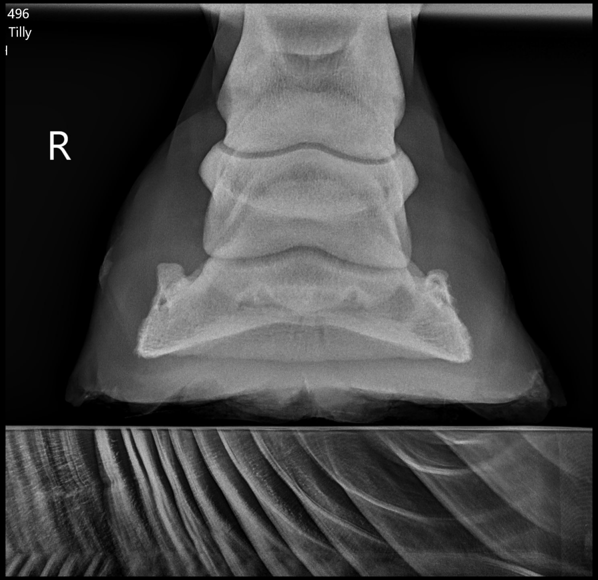
Front Foot Radiographs – Day 2

- No rotation at this time, however
- Her soles are very thin
- Mild sinking in both front feet
  - Left > Right.





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Diarrhea Panel

- Clostridium perfringens, Salmonella
  - Positive
- Clostridium difficile A&B, Equine Coronavirus, Lawsonia intracellularis, Neorickettsia risticii
  - Negative

TEST RESULT(S) AND INTERPRETATION(S)

Report Date: 8/1/2023 EDS Test #: 2023-19417

Adult GI PCR Panel

Test	Result	Interpretation
Clostridium difficile A&B toxins:	**Negative**	C. difficile A&B toxins were not detected.
Clostridium perfringens:	**31.7 CT Positive**	C. perfringens was detected.
C. perfringens A toxin:	**32.14 CT Positive**	C. perfringens A toxin was detected.
C. perfringens B toxin:	**Negative**	C. perfringens B toxin was not detected.
C. perfringens E toxin:	**Negative**	C. perfringens E toxin was not detected.
C. perfringens NetF toxin:	**Negative**	C. perfringens NetF toxin was not detected.
Equine Coronavirus:	**Negative**	Equine Coronavirus RNA was not detected.
Lawsonia intracellularis:	**Negative**	Lawsonia intracellularis was not detected.
Neorickettsia risticii (PHF):	**Negative**	N. risticii (PHF) was not detected.
Salmonella spp.:	**25.89 CT Positive**	Salmonella was detected.

Final Report 8/2/23

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Problem List

- Endotoxemia
- Myositis/Rhabdomyolysis?
- Acute Renal Damage
- Laminitis
- Refusal to eat
- Salmonella
- Lymphopenia

Date	Day 1	Day 2	Day 3	Day 4	Day 5
Creatinine (1-2 mg/dl)	5.5	4.4	4.1	3.9	3
SDMA (<12 uG/dL)		24.5	23		
Calcium (10.8-13.5 mg/dL)	9.8	11.1	10.9		10.7
Sodium (132 -146 mg/dL)	123	130	134		133
Potassium 2.4-4.7 mEq/L)	2.2	2.2	3.4		2.2
Chloride (95-110 mEq/L)	89	98			107
CPK (45-360 IU/L)	1632	1773			925
AST (148-360 IU/L)	1211	1023			909
Fibrinogen (76-230 mg/dL)	285				
WBC (5.1-12.5 x10^3/UL)	4.4				10.5
Lymphocytes (1500-5500 /uL	352				840
Neutrophils (2700-7000/uL)					9135

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Medication In Hospital – Day 5

- Acetaminophen 500mg (7/31/23 - 8/9/23)
  - 21 tablets by mouth every 12 hours
- Plasmalyte
  - 2L/hr (7/31/23 - 8/9/23)
    - Calcium Gluconate 23% 50 - 100mL
    - Potassium Chloride 40Meq
- Lidocaine:
  - 160ml/hr CRI (7/31/23 - 8/5/23)
- Pentoxifylline 400mg (7/31/23 - 8/8/23)
  - 13 tablets by mouth every 12 hours
- Metronidazole 500mg (8/1/23 - 8/4/23)
  - 15 tablets by mouth every 8 hours
- Sucralfate 1g (8/3/23 - 8/12/23)
  - 10 tablets by mouth every 12 hours
- Well Gel 3 lbs. (8/4/23 - 8/9/23)
  - 1-3 lb. of powder 2-3 times a day

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Identifying Heat Stress

- Heat stress in horses include
  - Rapid shallow breathing
  - Flared nostrils
  - Unpredictable behavior and gait
  - Very high body temperature
  - High respiratory rate
  - High heart rate
  - Profuse sweating

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Identifying Heat Stress

- Measuring body temperature can provide a quick and easy method to detect heat stress in horses
- Defining heat stress or hyperthermia in horses
  - Variations in regard to how the critical core temperature was assessed
- Continuous body temperature measurement

Thermoregulation: Base Mechanisms and Hyperthermia

Alan J. Guthrie BVSc, MMedVet, PhD, Raymond J. Lund BSc(Eng), MSc

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Identifying Heat Stress

- Several methods can be used for continuous measurement of body temperature
  - Rectum Temperatures
  - Infrared thermography
  - Gastrointestinal thermal sensing pill
  - Central-venous catheter
  - Thermal sensing microchips

Heat stress in horses: a literature review

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Rectal temp

- Easiest measurements for body temperature
- Most commonly used method
- Highly correlated with deep core body
- Not ideal for
  - Early stages of fever
  - Exercise
  - Immediate post-exercise
- Tolerate of the procedure and risk
- Depth of the thermometer

https://www.deephollowranch.com/normal-horse-temp/

Physiological responses of horses to a treadmill simulated speed and endurance test in high heat and humidity before and after humid heat acclimation

D J Marlin [1], C M Scott, R C Schroter, R C Harris, P A Harris, C A Roberts, P C Mills

Patterns of Rectal Temperature and Shipping Fever Incidence in Horses Transported Over Long-Distances

Yousuke Maeda [1], Masa-Aki Oikawa [2]

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Eye temp

- Infrared thermography:
  - Passive, non-invasive, and rapid method
- Positive correlations
  - Eye temperature and heat stress
- Fever and stress-induced hyperthermia
- Little data to support

Thermographic Eye Temperature as an Index to Body Temperature in Ponies

Shylo R. Johnson MS [a], Sangeeta Rao BVSc, MVSc, PhD [b], Stephen B. Hussey DVM [b], Paul S. Morley DVM, PhD, DACVIM [b], Josie L. Traub-Dargatz DVM, MS, DACVIM [b]

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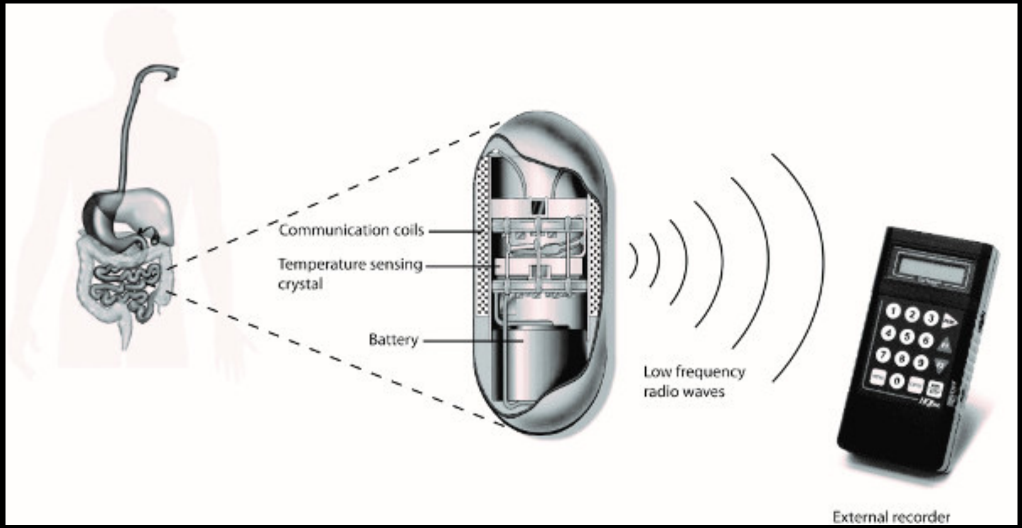
Gastrointestinal pill

- Continuously and non- invasively
- Nasogastric intubation
- Approximately 12 days before being expelled through feces
- Transit time differs on
  - Age, diet, gender, or physical status
  - May be terminated within 5 days
- Correlated well with rectal temperature
- 3 hours after being administered
- Ingested up to 6 hours prior to use
- Expensive and can only be used once



https://www.jove.com/t/53258/using-an-ingestible-telemetric-temperature-pill-to-assess

Evaluation of a telemetric gastrointestinal pill for continuous monitoring of gastrointestinal temperature in horses at rest and during exercise

Elisabeth-Lidwien J M M Verdegaal, Catherine Delesalle, Charles G B Caraguel, Louise E Folwell, Todd J McWhorter, Gordon S Howarth, Samantha H Franklin

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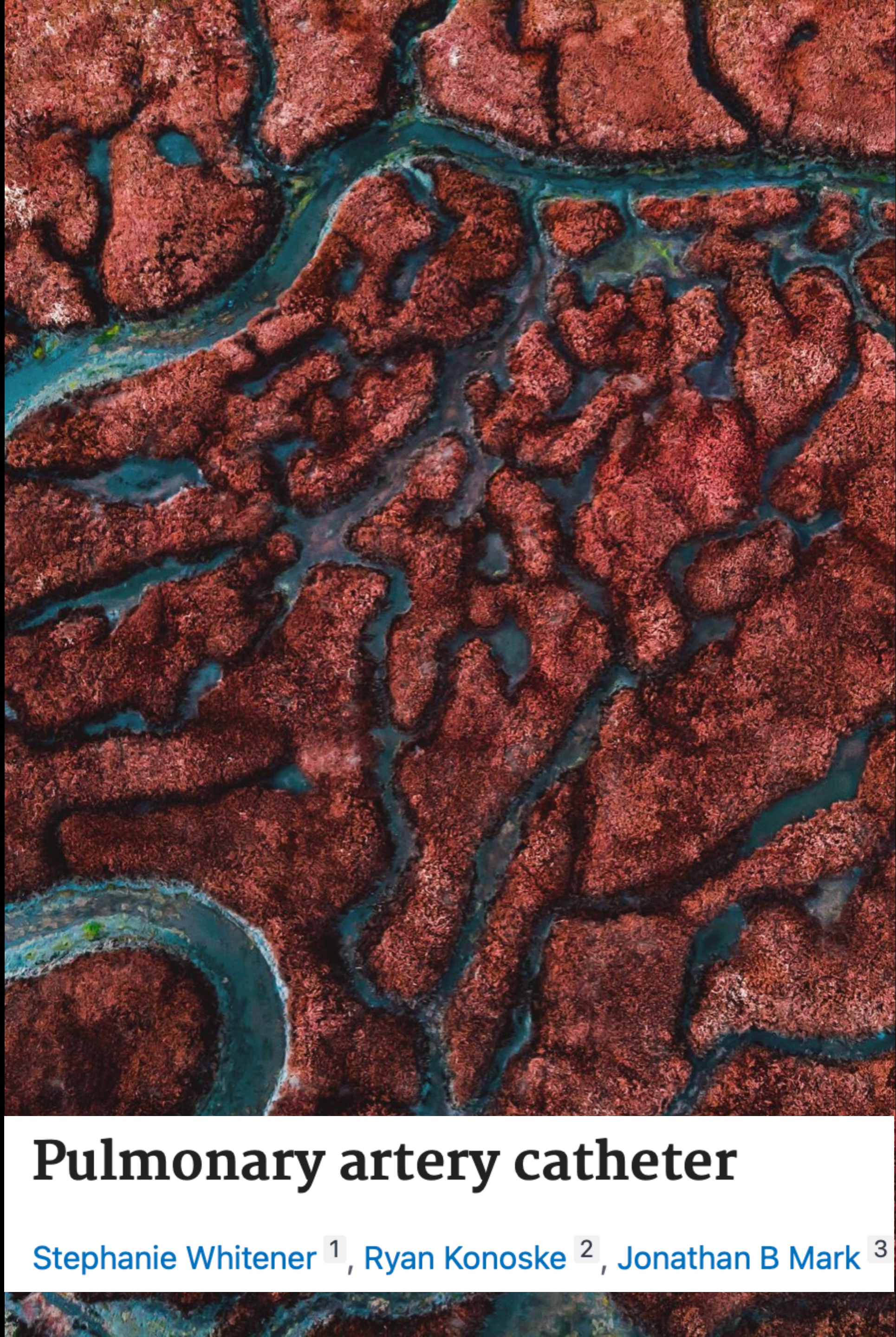
Blood Temperature

- Central venous temperature
  - → most accurate site for measuring core body temperature
- Significant correlation with brain temperature
- Widely used in humans
- Not practical in horses → invasive procedure
- Is difficult to keep in place



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Muscle temperatures

- Requires invasive procedures initially
- Allows non-invasive measurement
- Significant positive correlations with core body temperature
- Varies according to the muscle

The Use of Percutaneous Thermal Sensing Microchips for Body Temperature Measurements in Horses Prior to, during and after Treadmill Exercise

Hyungsuk Kang [1], Rebeka R Zsoldos [1], Solomon M Woldeyohannes [2], John B Gaughan [1], Albert Sole Guitart [2]

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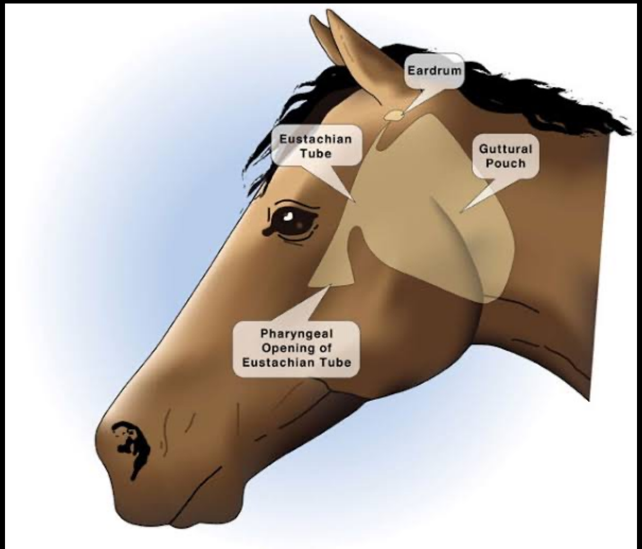
Brain Cooling

- Guttural pouches and cavernous sinuses
- Two guttural pouches located in the caudal area of the head
  - Largest pouches of any mammal
- Blood flows through the internal carotid arteries
  - Even under 100% humidity the blood flowing to the brain is cooled down



https://www.drprofessionals.in/2022/08/why-horse-have-guttural-pouch.html

A preliminary study on the role of the equine guttural pouches in selective brain cooling

K E Baptiste [1]

Affiliations + expand

PMID: 9564267 DOI: 10.1016/s1090-0233(98)80009-9

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Brain Cooling

- No brain cooling by the guttural pouches
- Initiation of sweating or cessation of exercise
- Sweat produced by horses on their head
  - Reduce brain temperature by approximately 0.4 °C
  - Via evaporation extrapolated
- Respiratory dynamics
  - Decrease the temperature of blood flowing to the brain
  - Water evaporation from the nasal mucosa and upper respiratory tract

https://www.foxvalleyequine.com/heat-stress/

Guttural pouches, brain temperature and exercise in horses

Graham Mitchell,[1,3,*] Andrea Fuller,[1] Shane K Maloney,[1,2] Nicola Rump,[1] and Duncan Mitchell[1]

Author information ▸ Article notes ▸ Copyright and License information PMC Disclaimer

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Methods of cooling – Air Movement

- Using a fan for cooling → more effective than ice-cooling
- Fans can help convection heat transfer between skin and air
- Fanning (ventilation)
- Not as efficient as cold water cooling under hot and humid climate conditions

https://www.canarm.com/agriculture/equinecentral/equine-mechanical-ventilation

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Methods of cooling – Cool Water

- Easiest and most popular method to cool down a hyperthermic horse
- Increase conductive heat dissipation
- Used as a gold standard for heat stroke treatment

https://premierperformance.uk/blog/cooling-your-horse/

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Methods of cooling – Cool Water

- Cooled with cold water (43 °F) coupled with scraping the water
  - Core body temperature dropped 4.1 °C in 11 min
  - Rectal temperature and muscle temperature dropped 1.1 °C and 2 °C
- Using cold water → scraping after pouring cold water, or continuously pouring tap water
- Applying cold water itself has a greater cooling down effect on its own
  - Than when it is followed by scraping the poured water

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A Comparison of Five Cooling Methods in Hot and Humid Environments in Thoroughbred Horses

Yuji Takahashi [1], Hajime Ohmura [2], Kazutaka Mukai [1], Tomoki Shiose [3], Toshiyuki Takahashi [1]

Post exercise changes in compartmental body temperature accompanying intermittent cold water cooling in the hyperthermic horse

D J Marlin [1], C M Scott, C A Roberts, I Casas, G Holah, R C Schroter

Methods of cooling - Combination

- Air movement and water application
  - Help overheated horses
- Combining the two cool-down strategies
  - Cool-down effect may be maximized
- Methods such as:
  - Misting fan
  - Hosing cold water
  - Exposing horses to a fan
- Cooling rate will increase further with a larger quantity of water and a stronger velocity of the fan

https://www.countrysidevets.com/post/anhidrosis

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Methods of cooling - Shade

- Providing shade
  - Spent more time in shady areas during peak solar radiation
- Spend more time near the drinking water
- Horses without shade had a higher
  - Respiratory rate
  - Rectal temperature
  - Sweating rate
  - Skin temperature

https://stablemanagement.com/barns-grounds/natural-shade-for-horses/

Preference of domestic horses for shade in a hot, sunny environment

K E Holcomb [1], C B Tucker, C L Stull

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Prevent Heat stress

- It would be better if the horses were not heat-stressed
- Accurate measures of climate conditions
- Precautions should be put in place to assist in the cooling of horses
  - Ice
  - Water
  - Adequate ventilation with fans
- When the climatic conditions are extreme
  - Sporting events can be modified, postponed, or canceled

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Heat stress related illness - Anhidrosis

- Anhidrosis is a reduction or lack of sweat
- Normally seen in exercising athletic horses or stabled horses
- Prolonged exposure to hot and humid conditions
- Present with
  - Exercise intolerance
  - Hyperthermia
  - Reduced appetite and water intake
  - Higher rectal temperatures
  - High respiratory rate
  - Depression

https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.thehorsesadvocate.com%2Fno-sweat%2F&psig=AOvVaw2jg47bAW1AyuHXr8AAcEyl&ust=1695060364616000&source=images&cd=vfe&opi=89978449&ved=0CBIQ3YkBahcKEwjInPClnrKBAxUAAAAAHQAAAAAQBg

Heat stress related illness - Anhidrosis

- The clinical signs generally develop gradually → rapid onset
- The symptoms can be corrected by:
  - Anti-pyretic agent
  - Electrolyte supplementation
  - Clipping body hair
  - Moving the horse into an air-conditioned stall

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Heat stress related illness - EHI

- Exercise-induced heat stress
  - Exertional heat illness (EHI)
    - Sporting horses do high-intensity exercise during a 3-day event
    - Endurance racing
    - Thoroughbred racing
- In most cases, EHI occurs suddenly
- Rapid detection of early-stage EHI → exercise followed by aggressive interventions is essential

https://thehorse.com/1121532/researchers-identify-key-factors-for-heat-stress-in-racehorses/

Heat stress in horses: a literature review

Hyungsuk Kang[1] · Rebeka R. Zsoldos[1] · Albert Sole-Guitart[2] · Edward Narayan[1] · A. Judith Cawdell-Smith[1] · John B. Gaughan[1]

Received: 2 February 2022 / Revised: 21 March 2023 / Accepted: 28 March 2023 / Published online: 15 April 2023

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Overview

- Heat stress is a serious welfare issue for horses as it can cause severe illness and death
- Horses can dissipate accumulated body heat by physical reactions
- When the heat load is prolonged or exceeds the heat stress tolerance:
  - Abnormal organ function
  - Impaired immune system
  - Heat stroke may occur
- Heat-stressed horses can be cooled down by pouring cool water over the horse either:
  - Alone or combined with air ventilation

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Overview

- Currently no accurate information regarding the most effective cool-down method
- Accurate body temperature measurement of horses
- Measure accurate body temperature:
  - Quickly, safely, and non-invasively
- Lack of any standardized method or validated interpretation of heat stress in horses

Day 10 – She started eating again

Day 12 – Stopped IV fluids

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Date	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12
Creatinine (1-2 mg/dl)	5.5	4.4	4.1	3.9	3	2.9	2.1		2	1.6	1.7	1.7
SDMA (<12 uG/dL)		24.5	23					11.9				
Calcium (10.8-13.5 mg/dL)	9.8	11.1	10.9		10.7							
Sodium (132 -146 mg/dL)	123	130	134		133	134	132					
Potassium 2.4-4.7 mEq/L)	2.2	2.2	3.4		2.2							
Chloride (95-110 mEq/L)	89	98			107	104	102					
CPK (45-360 IU/L)	1632	1773			925							
AST (148-360 IU/L)	1211	1023			909							
Fibrinogen(76-230 mg/dL)	285				194			278				
WBC (5.1-12.5 x10^3/UL)	4.4				10.5							
Lymph (1500-5500 /uL	352				840							
Neut (2700-7000/uL)					9135							
Total Protein 5.6-8 g/dL)	6.8	5.8	5.6		6			5.2				

Day 13 – Went Home

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Date	Day 12	Day 18	Day 26	Day 47
Creatinine (1-2 mg/dl)	1.7	2.2	2.2	2.2
Calcium (10.8-13.5 mg/dL)		11.4		11.5
Sodium (132 -146 mg/dL)		135		136
Potassium 2.4-4.7 mEq/L)		3.4		3.4
Chloride (95-110 mEq/L)		98		100
Total Protein 5.6-8 g/dL)		6.8		6.6

Recheck Appointments

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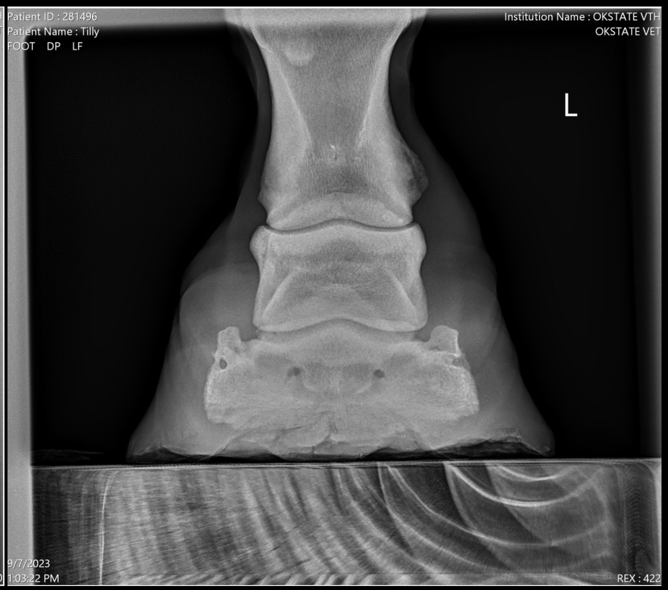
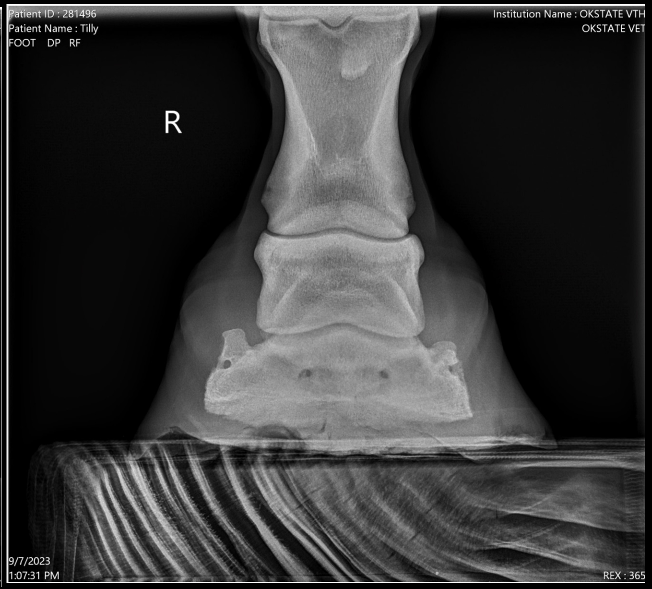
Front Foot Radiographs – Day 47

- Markedly thin soles on the left and right front, rotation more on the left than the right





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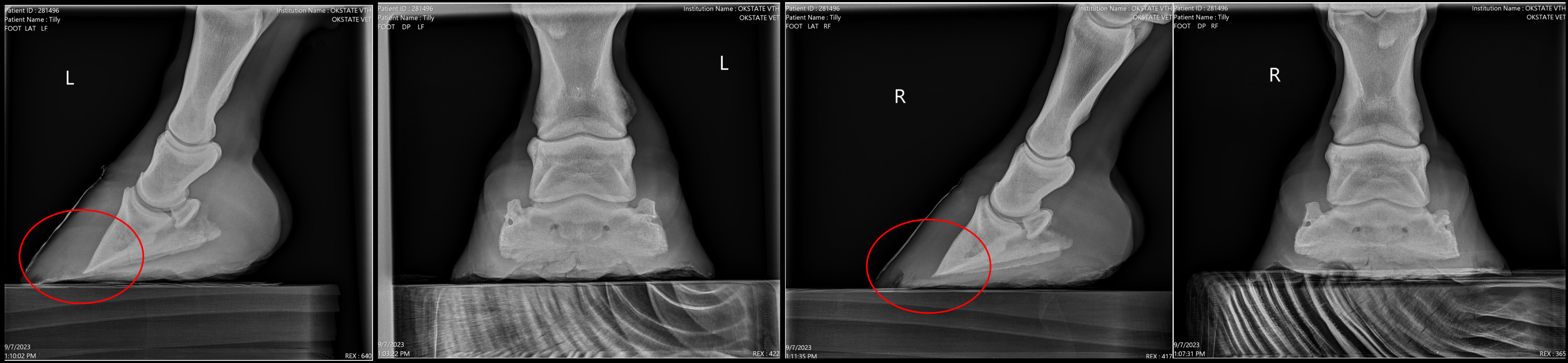
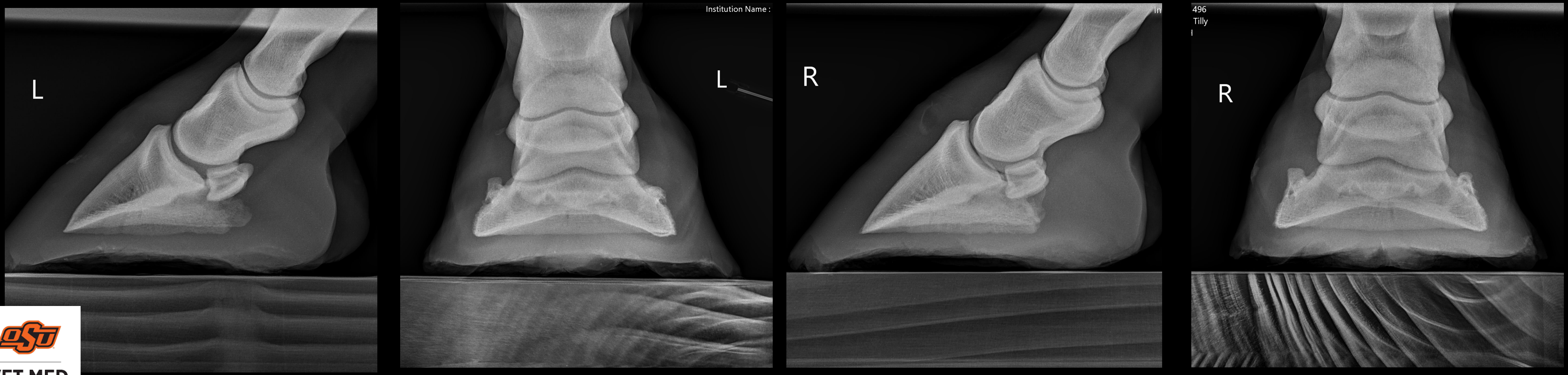
Day 47



Front Feet Comparison



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Day 2

Clogs Placed

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Thank You!

Any Questions

https://www.vecteezy.com/free-photos/horse-wallpaper?page=3

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Dr. Sayler – Equine

- This QR Code will take you to a feedback form for this session.
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