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**ORIGINAL RESEARCH**

***Biology***

**Frydman et al. Coagulation Biomarkers in Healthy Chinese-Origin Rhesus Macaques (*Macaca mulatta*), pp. 252-259**

Primary Species: Macaques (Macaca spp.)

SUMMARY: Rhesus macaques are commonly used for the study of human biology and disease. The ability to measure coagulation biomarkers is necessary. In this study, it is described the development of a bead-based ELISA assay to determine the normal ranges of 4 coagulation biomarkers in a population of healthy rhesus macaques: D-dimer, antithrombin III, protein C, and soluble p-selectin (sCD62P).

A population of 28 healthy Chinese-origin rhesus macaques was used in this trial. The animals were sedated and blood was collected from the femoral vein. A magnetic bead-based sandwich ELISA format was used to obtain quantitative outputs for coagulation biomarkers. Sequence homology between the human and rhesus macaque coagulation biomarker targets was confirmed and then the antibodies they used in this study were likely able to accurately detect rhesus macaque targets, despite being originally raised against human antigens.

The range established in the current study for antithrombin III is 124.2 to 133.4 µg/mL, it is somewhat higher than the previously reported range. Regarding D-dimer, the established range in this study is 110.3 to 161.3 ng/mL, in this case lower than the previously reported normal range. To the author knowledge, the study marks the first time that sCD62P and protein C concentration ranges have been reported for rhesus macaques. The ranges of sCD62P and protein C (0.12 to 0.14 ng/106 platelets and 3.18 to 3.62 µg/mL, respectively) in rhesus macaques are similar to reported human reference ranges.

The many advantages to using a bead-based ELISA format for these assays include high sensitivity, quantitative readouts, and the potential for multiplexing which accommodates the measurement of multiple coagulation biomarkers from just microliters of plasma.

QUESTIONS

1. Which of these statements is false:

a. Acquired coagulopathies is an important cause of morbidity and mortality of various disorders.

b. Rhesus macaque is a very commonly used model in biomedicine despite its low genetic homology to humans.

c. Infectious agents including SIV, Ebola, dengue, malaria, hantavirus, plague, and rickettsial diseases, are associated with bleeding and clotting complications.

2.   Which are the advantages/disadvantages of in vitro coagulation assays, such as prothrombin time and activated partial thromboplastin time?

3.  Which are the advantages/disadvantages of coagulation biomarkers?

4.  Which are the 4 main arms of the hemostatic system?

ANSWERS

1. B is false. Rhesus macaques have 92.7% of genetic homology.

2. They are easy to use and interpret, but they fail to reflect in vivo processes and do not capture the true risk of bleeding and clotting.

3. They reflect accurately the risk of hemostatic complications, but their measurement is frequently limited to specialty clinical coagulation laboratories, logistically and financially hindering their use. Additionally, there is a lack of species-specific reagents.

4. Coagulation, anticoagulation, fibrinolysis, and platelet activation.

***Husbandry***

**Washington and Payton. Ammonia Levels and Urine-Spot Characteristics as Cage-Change Indicators for High-Density Individually Ventilated Mouse Cages, pp. 260-267**

Domain 4: Animal Care

Primary Species: Mouse (Mus musculus)

SUMMARY: These authors sought to find a performance-based approach to changing individually ventilated mouse cages, rather than at specified time points (e.g. every two weeks).  Specifically, they evaluated the use of urine spotting in the cage as an indicator of ammonia levels.  To test this, they evaluated a wide range of mouse strains and ages, housed five adults per cage, in two separate rooms in a barrier facility.  Colorimetric ammonia indicators were suspended in the cage for 2 hours at various time points up to 16 days after cage change (14 time points, 12-28 cages per time point).  Urine spot characteristics were evaluated in terms of diameter, color, edge characteristic, and location.  Significant results include:

* Ammonia levels reached cage-change criterion (25ppm) at 10 days for males and 16 days for females
* Urine spot scores were strongly associated with ammonia level
* There was a strong correlation between ammonia levels and urine spot size, color, and edge characteristic
* The facility switched to this performance-based approach to cage changing and decreased the number of mouse cages from 50% weekly to 33% weekly

QUESTIONS

1. What is the exposure limit of ammonia for mice?

a. 10 ppm

b.  25 ppm

c.   50 ppm

d.  There is no published exposure limit for rodents

2. In humans, the maximal exposure limit for ammonia is \_\_\_\_\_\_ and the limit for exposure averaged over an 8 hour work day is \_\_\_\_\_\_\_.

3. True or False: This study found that males produce higher levels of ammonia than females.

ANSWERS

1. d

2. 50 ppm; 25 ppm

3. True

**Carbone et al. Feasibility of Using Rice Hulls as Bedding for Laboratory Mice, pp. 268-276**

Domain: 4. Animal Care – K1. Species-specific husbandry

Primary Species: Mouse (*Mus musculus*)

SUMMARY: Researchers from UC Davis examined the effectiveness of rice hull in comparison with ¼” corncob, pine shavings, and reclaimed wood pulp (RWP) looking at a variety of variables and how they relate to mouse husbandry.  Some of the things the examined were in each bedding situation were: health of mice (n=60) housed in the different bedding (daily health checks), breeding (put breeding pairs together), bedding absorbance (tested by taking a set volume of bedding and applying 1/5th volume of saline), surface moisture (tested by adding small volumes of liquid to different spots of bedding in a cage and measure the remaining liquid on the surface at a later time),  ammonia monitoring (done in specially designed cages that sample air), and the effect on cytochrome levels (histological examination).

In general, the researchers found that rice hulls were less absorbent than was corncob bedding. Rice hulls also seemed to be more hydrophobic than the other bedding types resulting in pooling of liquids.  Ammonia levels were negligible when cages contained 5 young adult female mice. The expression of Cytochrome p450 enzyme Cyp1a2 was 1.7 times higher in the livers of mice housed on rice hulls than on pine shavings, but other differences were not statistically significant. In the end, the authors conclude that the relatively poor moisture control is a major disadvantage.

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QUESTIONS

1. In the current study, rice hull bedding was evaluated with regard to \_\_\_\_\_\_?

a. Absorbency

b. Daily health checks

c. Cytochrome induction

d. All of the above

e. Only A and C

2. Rice bull bedding was less absorbent than:

a. ¼” Corncob

b. Pine shavings

c. Reclaimed wood pulp (RWP)

d. All of the above

e. Only A and C

3. True/False. One of the major advantages of utilizing unprocessed rice hull bedding is that the per-cage bedding cost was lower than of corncob and RWP.

ANSWERS

1. d. All of the above

2. e. Only a and c, they did not test the absorbency of pine shavings

3. True (2 cents compared to 12 cents and 21 cents)

**Elfenbein et al. Effect of Indoor Compared with Outdoor Location during Gestation on the Incidence of Diarrhea in Indoor-Reared Rhesus Macaques (*Macaca mulatta*), pp. 277-290**

Domain: 3 Research

Primary Species: Macaques (Macaca spp.)

SUMMARY: An indicator of overall non-human colony health is the number of animals with diarrhea in the population at a given time. This study looked at personality, a trait or motive with genetic components as well as prenatal stressors that played a role in nonpathogenic diarrhea.

Results: Indoor gestation has a more deleterious consequence than indoor postnatal environment locations. Animals gestated outdoors had significantly lower diarrhea risk than those that gestated indoors. Animals with a nervous temperament based on the personality scale had significantly greater risk of diarrhea. These animals were more likely nursery-reared than mother-reared.  Female animals with the MAOA genotype influenced diarrhea, but this trend was not seen in male macaques.  On the other hand, the presence of the short allele of the serotonin transporter (5HTT) had a protective effect for female macaques.

QUESTIONS

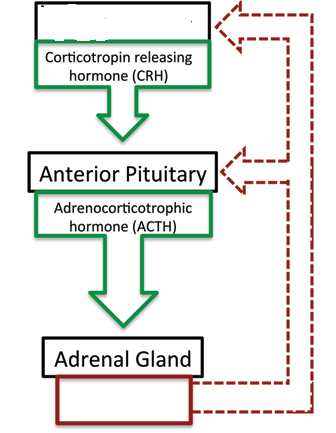
1. Fill in the missing gland and hormone in the hypothalamic-pituitary-adrenal (HPA) axis

2. True or False: Indoor gestation of the dam decreased the likelihood of diarrhea in offspring.

ANSWERS

1.

2. F; Outdoor…



**Wafer et al. Effects of Environmental Enrichment on the Fertility and Fecundity of Zebrafish (*Danio rerio*), pp. 291-294**

Domain 4: Animal Care

Secondary Species: Zebrafish (Danio rerio)

SUMMARY: Zebrafish (Danio rerio) are popular research models in the fields of developmental biology, neurophysiology and biomedicine. Previously, few studies have characterized larval growth in conjunction with enrichment conditions.  This study objective was to quantify reproductive success based on enrichment conditions consisting of plastic grass, plastic leaves and no enrichment.

*Methods/Materials*

18 pairs of wildtype zebrafish at 90 days post fertilization (*dpf*) were chosen randomly from a line that had been maintained in the facility for over 6 years. Fish were housing in self-cleaning recirculating racks on a 12:12 light cycle at 27 degrees C water temperature, pH 7.2-7.4, conductivity between 600-700 uS/CM, alkalinity at 120 mg/L as CaCO3, nitrite undetectable and nitrate at 0-40 mg/L. 5% daily water change was performed by reverse osmosis.

*Effect of Enrichment on Egg Production: Spawning and Egg Counting*

Each breeder pair was initially housed together for 1 week in a 2.8L barren tank and then moved to individual 1.5L tank for spawning. Each 1.5l tank contained one of 3 conditions: plastic grass, plastic leaves or no enrichment (n=6 breeding pairs per condition). The mating pair was placed together for 3 hours in the 1.5L breeding tank and then upon spawning, the pair was placed back into the 2.8L-holding tank and ova in the 1.5L tank counted. Each pair was exposed to each environmental condition weekly and repeated the cycle 2 more times.

Collected ova was transferred to E3 media culture dishes and incubated for 6 days at 28.5C and resulting fry counted.

*Effect of Enrichment on Survivability of Zebrafish Fry*

The same 18 pairs were placed together in a single barren breeder tank to generate embryos.  Embryos were collected and placed into 1 of 3 environmental conditions (same as above) in a dish along with E3 media. Total of 30 dishes, with 10 dishes per condition housing 20 eggs each and incubated at 28.5 degrees C for 6 days and surviving fry were counted.

Results/Discussion Points

*Effect of Enrichment on Egg Production: Spawning and Egg Counting*

* Total of number of eggs counted per spawning event were higher in grass enriched environment (p<0.05)
* Rate of successful spawning events was 58.6% across all conditions
* Number of 6dpf fry per spawning event in each condition was not statistically significant
* Interaction of environment type and age of spawning pair was noted.

o   Specifically fish in the grass environment produced more fry when the breeders were 110 and 160 *dpf*. (p<0.05)

o   Fry counts in leaf environment were highest at 173 and 180 dpf

*Effect of Enrichment on Survivability of Zebrafish Fry*

* Enrichment type did not influence fry survivability.

QUESTIONS

1. What time of day to zebrafish typically spawn?

2. T/F. Rainbow trout (*Oncorhynchus mykiss*) are a secondary species per the ACLAM species categorization.

3. T/F. Zebrafish can become aggressive only at low density.

ANSWERS

1. Dawn

2. False. All fish other than Danio rerio are tertiary species.

3. True

***Management***

**Rex et al. Effects of Repeated Anesthesia Containing Urethane on Tumor Formation and Health Scores in Male C57BL/6J Mice, pp. 295-299**

Domain 3: Research

Primary Species: Mouse (Mus musculus)

SUMMARY: Urethane (ethyl carbamate) is an injectable anesthetic that is carcinogenic in susceptible strains of mice.  Urethane is used commonly in electro physiologic recordings of the brain or retina of rodents.  Urethane injected mice maintain a sufficient depth of anesthesia, while avoiding confounding influences on electrical signals produced by other anesthetics.  Typically, injections are performed once, just prior to euthanasia.  The hypothesis of the current study was that repeated injection of an anesthetic mixture containing 560 mg/kg urethane, 28 mg/kg ketamine, and 5.6 mg/kg xylazine does not decrease overall physical health according to 2 scoring systems or induce tumors in C57BL/6 mice.

QUESTIONS

1. In a urethane induced tumor formation model, what is thought to promote tumor formation in C57BL/6 mice?

2. T/F:  The 560 mg/kg dose of urethane was below the threshold dose to induce tumor formation in the current study.

3. Name a human safety concern associated with the use of urethane.

4.  What effects of the ket-xyl-urethane mixture were found on body weight and BCS in the current study?

ANSWERS

1. The partial lack of a tumor suppressor gene, p53.  p53+/- mice on a C57BL/6 background are commonly used.

2. True

3. Urethane is considered a Group 2 A carcinogen, and is probably carcinogenic to humans.

4.  Body weight and condition increased over time, and no tumors or other pathologies were detected in the 4-month time period of the study.

**Seymour et al. Postoperative Analgesia Due to Sustained-Release Buprenorphine, Sustained-Release Meloxicam, and Carprofen Gel in a Model of Incisional Pain in Rats (*Rattus norvegicus*), pp. 300-305**

Domain 1

Primary Species: Rat (Rattus norvegicus)

SUMMARY: The investigators tested the analgesic properties of sustained release buprenorphine, sustained release meloxicam and oral carprofen gel using a model of plantar incisional pain and behavior testing (thermal and mechanical stimulation/withdraw) in rats.  In addition they determined plasma concentration for each of the drugs following treatment.  Rats were assigned to 1 of 5 treatment groups for analgesia at the time of surgical procedure and recovery. The groups included saline, BID injectable buprenorphine given SC for 3 days, SR-buprenorphine given SC one time, SR- Meloxicam given SC one time, and carprofen gel administered in the diet for 4 days.  Results indicated that buprenorphine administered by either dose/route effectively attenuated mechanical and thermal hypersensitivity and maintained a constant plasma level.  Meloxicam-SR or Carporfen Gel both attenuated mechanical hypersensitivity but not thermal.  Meloxicam-SR showed rapid decline in plasma concentration over 24 hours and subsequently, but the definitive concentration to correlate with pain management for Meloxicam is not known.  The carprofen plasma levels remained high as long as the drug was being provided to the animals.  The investigators recommend in their discussion that buprenorphine, by either route is an option for single-agent analgesia in this pain model. They suggest meloxicam SR or carprofen gel not be used as single-agent analgesia and further investigation be performed on the use of these drugs in a multi-modal analgesic plan.

QUESTIONS

1.  T or F. Meloxicam and Carprofen are both NSAIDs that preferentially inhibit cyclooxygenase 2.

2.  Buprenorphine is classified as which of the following:

a. Partial-opioid receptor antagonist

b.  Complete -opioid receptor agonist

c.   Partial -opioid receptor agonist

d.  Complete -opioid receptor agonist

3.  Which of the following is a common tool used to measure mechanical hypersensitivity in laboratory rodents?

a.  Grip strength wires

b.  Von Frey filaments

c. Tail-flick hot plates

d.  Rotarod apparatus

ANSWERS

1.  True

2. c

3.   b

**Johnson. Voluntary Running-Wheel Activity, Arterial Blood Gases, and Thermal Antinociception in Rats after 3 Buprenorphine Formulations, pp. 306-311**

Domain 2

Primary Species: Rat (Rattus norvegicus)

SUMMARY: In this study, 8 adult rats were injected subcutaneously with either BUP, BUP SR, BUP ER, or saline, after which voluntary running-wheel activity, arterial blood gases, and thermal withdrawal latency were assessed.  Buprenorphine HCl (BUP) is a μ-opioid agonist used in laboratory rodents. New formulations of buprenorphine (*i.e.* sustained-released buprenorphine [BUP SR], extended-release buprenorphine [BUP ER]) have been developed to extend the analgesic duration without the need for repeated injections. BUP administration appears to have a “ceiling” effect on ventilation, where a maximum effect is seen despite increases in dose.

Rats were randomly assigned to receive either:  BUP 0.05 mg/kg SC; BUP SR 1.2 mg/kg SC; BUP ER 0.65 mg/kg SC; or 0.9% NaCl as a negative control in a nonblinded, crossover design. Injections were made in the morning (between 0600 hrs and 0700 hrs), immediately following the rats’ dark cycle. To determine the effects of different buprenorphine preparations on voluntary running-wheel activity, rats were single-housed with continual access to voluntary running wheels with magnetic revolution counters. Thermal sensitivity as an indicator of pain threshold was measured by using the latency of hind limb withdrawal from a radiant heat stimulus. The maximal time of heat exposure for all measurements was limited to 20 seconds to prevent thermal burns. Each rat was tested 3 times with at least 5 minutes between trials, and the mean latency response was calculated.

Wheel running was decreased at 24 hours compared with baseline in all treatment groups but returned to baseline by 48 hours. Arterial pH, HCO3–, and CO2 were not changed between groups or over time. However, arterial oxygen was lower than baseline in the BUP, BUP SR, and BUP ER groups compared with saline controls. The BUP ER group showed the greatest decrease when all time points were combined. BUP increased the withdrawal latency at 1 hour; whereas BUP ER increased latencies at 4, 8, 12, and 48 hours and BUP SR prolonged latencies at 24, 48, and 72 hours.

The duration of thermal analgesia varied between buprenorphine formulations, but all 3 formulations reduced voluntary-running activity at 24 hours after injection and may cause hypoxemia in normal adult rats.

QUESTIONS

1.  Buprenorphine (BUP) acts on which receptors?

2.   Did BUP increase or decrease latency response in this study?

ANSWERS

1.  μ receptors

2.  Increased

**Fox et al. Comparison of Dexmedetomidine-Ketamine with Isoflurane for Anesthesia of Chinchillas (*Chinchilla lanigera*), pp. 312-316**

Domain 2: Management of pain and distress)

Tertiary Species: Other Rodent

SUMMARY: This study compared the use of isoflurane (iso) for anesthesia in chinchillas to the injectable combination of dexmedetomidine–ketamine (DK). A previous study had found significant effects on several echocardiographic parameters associated with the use of isoflurane. In addition, isoflurane is normally delivered via facemask so there is some risk of exposure to staff. The need for an alternative to limit the issues associated with isoflurane anesthesia prompted the group to investigate the dexmedetomidine-ketamine combo delivered IM. In addition to determining the physiologic effects of the two different anesthetic protocols the group also assessed the effect on recovery of food intake and fecal output.

Time to loss of evaluated reflexes did not differ between protocols however recovery times were slightly longer with the DK protocol. The heart rate did not differ between protocols. SpO2 was higher in the iso group most likely due to the fact this protocol provides 100% O2 delivery to the animal. Rectal temperature was decreased at the 45 minute mark for the DK protocol. Food intake was significantly different between protocols for 3 days following anesthesia. The greatest decrease in food intake occurred during the first 24h for the DK protocol. For 2 days the fecal output was decreased for the DK group. No significant differences in body weight were found within or between anesthetic protocols. The group concluded that both evaluated anesthetic protocols resulted in safe and effective anesthesia; however, iso was determined to be safer because it resulted in fewer perianesthetic physiologic changes, more rapid recovery times, and fewer postanesthetic side effects.

QUESTIONS

1.  What effects can hypothermia have in the anesthetized animal?

2. What effects are seen across species when using α2-Adrenergic receptor agonists i.e. medetomidine, dexmedetomidine, etc.?

ANSWERS

1.   Delayed drug metabolism and excretion of anesthetic and analgesic drugs, hypotension, and delayed recovery.

2.  Stimulation of peripheral α2 adrenergic receptors in the arterioles, leading to vasoconstriction and increased peripheral vascular resistance. This in turn increases afterload and decreases heart rate and cardiac output.

**Re et al. Effect of Lidocaine-Ketamine Infusions Combined with Morphine or Fentanyl in Sevoflurane-Anesthetized Pigs, pp. 317-320**

Domain 2: Management of Pain and Distress; Task 3 – Administration of Anesthesia

Primary Species: Pig (*Sus scrofa*)

SUMMARY:  A multimodal approach to analgesia has been promoted for more complete analgesia, lower risk of side effects from any one drug, and an overall reduction in the amount of anesthesia needed to complete procedures. Previous studies in dogs and horses have shown a dramatic decrease in the Minimum Alveolar Concentration (MAC) of inhalant anesthetic required when combined with a constant-rate infusion (CRI) of morphine-lidocaine-ketamine (MLK) or fentanyl-lidocaine-ketamine (FLK). In this study, 8 large white female pigs (age 3-4 months) were enrolled in a prospective, randomized, crossover study to measure their sevoflurane MAC while receiving a CRI of MLK, FLK, or Lactated Ringers Solution (LRS, control). Each pig was anesthetized three times and received one CRI per anesthetic event in random order. MAC was calculated by reaction to a standard noxious stimulus (hemostats clamped on dewclaw). Drug doses used were from a similar experiment in dogs. The study confirmed the reduced efficacy of opioids in swine and wide variation in drug responses between species. No statistically significant difference was measured for sevoflurane MAC (among many other physiologic parameters) when exposed to MLK or FLK compared to an LRS CRI.

QUESTIONS

1.   Which of the following is not a physiologic effect of opioids?

a.  Bradycardia

b.  Histamine release

c. Hypotension

d. Respiratory depression

e.  Diarrhea

2.   What drugs have been used in pigs to block or prevent shivering?

3.  T/F.  Pigs require a higher opioid dose to achieve a similar analgesic effect to other species (dog).

ANSWERS

1.  e

2.  Pethidine, ketamine

3.  T

***Experimental Use***

**Seymour and Nagamine. Evaluation of Isoflurane Overdose for Euthanasia of Neonatal Mice, pp.**

**321-323**

Domain 2: Management of Pain and Distress

Primary Species: Mouse (*Mus musculus*)

SUMMARY: Neonatal mice (<6 days old) must be exposed to CO2 for 50 minutes to achieve euthanasia. In the AVMA Euthanasia Guidelines, isoflurane overdose is considered "acceptable with conditions" as a way to euthanize neonatal mice. In this study, neonatal mice (n=76, 1-2d old) were exposed to isoflurane saturated air for 30 minutes then observed for signs of revival for 120 minutes. After 2 minutes, pups were non-responsive-- no righting reflex or withdrawals. After 30 minutes of exposure, all pups were cyanotic and showed no signs of life (absence of respiration, righting reflex and withdrawals). However, between 30 and 120 minutes after removal from isoflurane, 23.7% of the pups revived. Therefore, 30 minutes of isoflurane exposure is not an acceptable method of euthanasia for neonatal mice without a secondary method such as decapitation.

QUESTIONS

1. What other method of euthanasia is acceptable (without conditions) for neonatal mice?

a. Other inhalant anesthetics (sevoflurane, halothane, desflurane)

b. Cooling/hypothermia

c. Decapitation

d. Cervical dislocation

e. Injectable barbiturates

2. How long of CO2 exposure is required to euthanize neonatal mice per the AVMA guidelines?

a. 30 minutes

b. 40 minutes

c. 50 minutes

d. 1 hour

e. 45 minutes

ANSWERS

1. e
2. c

**Garofalo et al. Laparotomic Approach for Collecting Serial Hepatic Biopsies in Rats (*Rattus norvegicus*) and Mice (*Mus musculus*), pp. 324-330**

Domain 1. K2. Surgical techniques associated with diagnostic surgery (e.g., exploratory; biopsy)

Primary Species:  Mouse (Mus musculus)

SUMMARY: Veterinary report on the use of an open midline laparotomic approach to hepatic biopsies in rats using a disposable punch biopsy. Authors hypothesized that survival of subjects undergoing multiple survival procedures would be independent of weight loss or gain sustained throughout the study. Additionally, a pilot study in mice yielded equivalent results. Authors concluded that survival of rodents that underwent multiple laparotomies and liver biopsies was independent of the weight gain or loss throughout the study.

Key points:

* Iron stores are commonly assessed by liver and bone marrow biopsies
* Iron overload can be induced in rodents through their diet to study iron metabolism
* The classic and most common iron overload syndrome is haemochromatosis, an autosomal recessive disorder leading to toxic accumulation of iron in vital organs.
* See <http://www.sciencedirect.com/science/article/pii/S0021997512001570> for a great review of animal models of haemochromatosis.

QUESTIONS

1.  What is Prussian blue used for?

2.  What breed of cattle develops haemochromatosis similar to type 1 in humans?

ANSWERS

1. In histology, stains iron blue. As a pigment, used in painting as seen in van Gogh’s Starry Night (as well as Cerulean blue pigment).



2.  Salers cattles; Early onset, widespread iron accumulation, hepatocellular necrosis and mild cirrhosis, mild myocardial necrosis and osteopenia.

**Maxwell et al. Comparison of Digital Rectal and Microchip Transponder Thermometry in Ferrets (*Mustela putorius furo*), pp. 331-335**

Secondary Species: Ferrets (*Mustela putorius furo*)

SUMMARY: Body temperature is a common physiologic parameter measured in both clinical and research settings, with rectal thermometry being implied as the 'gold standard.' However, the authors here argue that rectal thermometry usually requires physical or chemical restraint, potentially causing falsely elevated readings due to animal stress. Authors compared 2 types of digital rectal thermometers: (1) a calibrated digital thermometer [Welch Allyn Sure Temp Plus 690V and model 15-737, MABIS Healthcare] and (2) a common digital thermometer-with an implantable subcutaneous transponder microchip [IPTT-300 Microchip, Bio Medic Data Systems]. Microchips were implanted subcutaneously between the shoulder blades of 16 ferrets (8 male, 8 female), and temperatures were measured twice from the microchip reader and once from each of the rectal thermometers. Results demonstrated the microchip temperature readings had very good to good correlation and agreement to those from both of the rectal thermometers. This study indicates that implantable temperature-sensing microchips are a reliable alternative to rectal thermometry for monitoring body temperature in ferrets.

QUESTIONS

1. List 3 advantages of using implantable temperature-sensing microchips compared to rectal thermometry in ferrets.

2. What is the normal body core temperature for a ferret (*Mustela putorius furo*)?

ANSWERS

1. Temperature recording time is considerably faster with microchips than with rectal thermometers, the need for marked physical restraint is significantly reduced with microchips vs thermometers, and the implantable microchips also provide a very practical method for ferret identification.

2. 99.5°F -103°F

**Engelke et al. Radiographic Morphometry of the Lumbar Spine in Munich Miniature Pigs, pp. 336-345**

Domain 3: Research

Primary Species: Pig (Sus scrofus)

SUMMARY: Human spinal column disease incidence remains high and animal models are still important for research.  Due to their similar size to humans, pigs remain an important spine model.  The purpose of this study was to radiographically record and evaluate morphometric data of the lumbar spine of Munich miniature pigs and compare it with recorded human data.  Notable differences observed were: Munich minipigs had 5 or 6 lumbar vertebrae; the minipig lumbar vertebral bodies were remarkably larger in the craniocaudal direction and considerably smaller in the dorsoventral and laterolateral directions; the porcine lumbar vertebral canal was smaller; the porcine spinal cord extended into the caudal part of the lumbar vertebral canal; and the lumbar intervertebral spaces of the pig were narrower in craniocaudal direction.  These differences need to be considered when planning surgical actions, not only for the welfare of the animals, but also for accurate scientific results.

QUESTIONS

1. When does sexual maturity occur for all porcine breeds?

a. Between 1 and 3 months of age

b. Between 2 and 4 months of age

c. Between 4 and 6 months of age

d. Between 6 and 8 months of age

2. Which of the following IS TRUE?

a. Wild boars consistently have 5 lumbar vertebrae

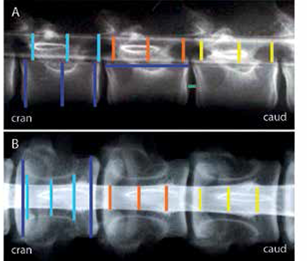
b. Modern breeds of domestic pigs have between 5 and 7 lumbar vertebrae

c. Humans have 5 vertebrae

d. All of the above are true

e. All of the above are false

3. Which of the following imaging modalities was used to produce the image below?



a. Radiography

b. Positron emission tomography

c. Magnetic resonance imaging

d. Computed tomography

ANSWERS

1. c

2. d

3. a

**Clemmons et al. Accuracy of Human and Veterinary Point-of-Care Glucometers for Use in Rhesus Macaques (*Macaca mulatta*), Sooty Mangabeys (*Cercocebus atys*), and Chimpanzees (*Pan troglodytes*), pp. 346-353**

Primary Species: Macaques (Macaca spp.)

Tertiary Species: Other Nonhuman Primates

Domain 1: Management of Spontaneous and Experimentally Induced Diseases and Conditions

T3. Diagnose disease or condition as appropriate; K1. Diagnostic procedures

SUMMARY

Background: There are several indications in NHP medicine for using handheld, point-of-care glucose meters (glucometers), which rapidly and easily measure blood glucose (BG). For example, naturally occurring type 2 diabetes has been reported in more than 40 NHP species, including the 3 evaluated in the current study—rhesus macaques, sooty mangabeys, and chimpanzees. In addition, because glucometers require very small volumes of blood, they are useful in small-bodied NHP that have increased susceptibility to hypoglycemia, such as neonates and many New World species. Furthermore, glucometers are commonly used in NHP biomedical research related to obesity and diabetes. Human glucometers as well as veterinary glucometers intended for use with small companion animals are commercially available; however, the literature contains no information regarding the accuracy of these glucometers in NHP.

Glucometer performance has previously been assessed in dogs, cats, horses, birds, deer, sheep, cattle, alpacas, ferrets, and rabbits. Results from these studies show that glucometers intended for humans have decreased accuracy when used in animal species, suggesting that similar findings might be observed in NHP species. Veterinary-specific glucometers were recently developed for companion animals, but how well these glucometers perform in NHP is unknown.

Glucose levels differ between collection sites, with arterial blood having the highest glucose level. Arterial blood is delivered to capillaries, where glucose is absorbed by tissues as an energy source, thus resulting in the lowest glucose level in venous circulation. Capillary and venous glucose levels have been reported to correlate well in human studies, but it is important to understand the differences between these sampling methods when interpreting glucometer readings. The primary aims of the current study were to: 1) compare the accuracy of 2 veterinary and 2 human glucometers in 3 NHP species with inherently different Hct ranges; 2) determine the accuracy of 2 human glucometers during hypoglycemia and hyperglycemia in rhesus macaques and sooty mangabeys; and 3) determine whether glucometer performance differs between capillary and venous sampling sites. The authors hypothesized that, due to interspecies differences in cell and plasma glucose distribution, human glucometers would report NHP glucose levels more accurately than would veterinary-specific glucometers. Furthermore, sooty mangabeys have a naturally higher HCT range and potentially higher cell: plasma glucose ratio than those of Asian monkeys and African apes; therefore, the authors hypothesized that human glucometers would be less accurate in sooty mangabeys than in rhesus macaques and chimpanzees.

Results:  The veterinary glucometers overestimated blood glucose (BG) values in all species by 26 to 75 mg/dL. The mean difference between the human glucometers and the laboratory analyzer was 7 mg/dL or less in all species. The human glucometers overestimated BG in hypoglycemic mangabeys by 4 mg/dL and underestimated BG in hyperglycemic mangabeys by 11 mg/dL; similar patterns occurred in rhesus macaques. Hct did not affect glucometer accuracy, but all samples were within the range at which glucometers generally are accurate in humans. BG values were significantly lower in venous than capillary samples.

See Table 1. Comparison of human and veterinary glucometers across 3 NHP species

Conclusion: The current study shows that veterinary glucometers intended for companion-animal species are inappropriate for use in the studied NHP species, whereas the human glucometers showed clinically acceptable accuracy in all 3 species. Finally, potential differences between venous and capillary BG values should be considered when comparing and evaluating results.

QUESTION

1. Glucose levels differ between collection sites chose the correct answer.

a.   Arterial blood has lowest glucose levels

b.  Venous blood has the highest glucose levels

c.  Arterial blood glucose and venous blood glucose have similar levels

d.  Arterial blood has the highest glucose levels

ANSWER

1.  Arterial blood has the highest glucose levels