Journal of the American Association for Laboratory Animal Science
Copyright 2015
by the American Association for Laboratory Animal Science

Vol 54, No 1
January 2015
Pages 86–98

Abstracts of Scientific Papers

2014 Association of Primate Veterinarians Workshop

Cobalamin (Vitamin B12) Deficiency in Rhesus and Pigtailed Macaques with Chronic Diarrhea

J Izzi*, E Hutchinson, K Metcalf Pate

Johns Hopkins University School of Medicine, Baltimore, MD

Chronic diarrhea is the most frequently encountered clinical problem in nonhuman primates and is responsible for high levels of morbidity and mortality within captive macaque colonies. In a large proportion of cats, dogs, and humans affected by chronic gastrointestinal disease, a deficiency in cobalamin (vitamin B12) has been demonstrated and identified as a risk factor for negative outcomes. In addition, supplementation with cobalamin has been shown to improve clinical outcomes in these species. However, no research has been conducted to identify the presence of a cobalamin deficiency in macaques with chronic diarrhea. We hypothesized that macaques with chronic diarrhea would have significantly lower serum cobalamin levels than healthy controls. We measured serum cobalamin levels in rhesus and pigtailed macaques with chronic diarrhea and compared them to those of healthy controls. Additional data obtained at the time of sample collection included age, weight, body condition score, complete blood count, serum chemistry, and fecal culture. Our results show that there is no difference in serum cobalamin levels in either rhesus or pigtailed macaques with chronic diarrhea as compared to healthy controls. Initial inclusion criteria for both diarrhea and control groups included a negative fecal culture; however, results show no difference in serum cobalamin levels in culture positive animals as compared to culture negative animals. In both rhesus and pigtailed macaques, animals with diarrhea had significantly higher platelet counts as compared to normal animals ($p < 0.01$ and $p < 0.001$, respectively). This study is the first to our knowledge to examine cobalamin levels in macaques with chronic diarrhea. Based on the clinical implications of such a deficiency and its use as a diagnostic and therapeutic tool in other species, it is critical to determine whether or not this is a problem that exists in macaques as well. The negative results that we have obtained address this question, and indicate that serum cobalamin level is not a useful component to the clinical workup and treatment of macaques with chronic diarrhea.

An Unusual Presentation of Gluten Sensitivity Enteropathy in a Rhesus Macaque (*Macaca mulatta*)

FD Duke*, MH Nowland, CM Bell, IL Bergin

University of Michigan, Unit for Laboratory Animal Medicine, Ann Arbor, MI

A 20-y-old male rhesus macaque presented with marked loss of body condition (1/5) and severe alopecia (70.7%) at semiannual exam. The animal had a chronic indwelling catheter (left brachial vein) for self-administration studies. The animal's clinical history included chronic intermittent anorexia chronic mild lymphopenia, and severe, progressive dental disease despite regular prophylaxis. The lab declined diagnostic evaluation and elected euthanasia; the gross necropsy was unremarkable save for the clinically recognized alopecia and enamel defects. Histologically there was intraepithelial lymphocytosis and severe, diffuse lymphoplasmacytic infiltration of the lamina propria from the pylorus through the rectum, with the jejunum being most severely affected. The inflammatory population varied segmentally from predominantly lymphocytic to plasmacytic with monotypic foci and a prominent secondary population of eosinophils throughout. The infiltrate was accompanied by severe villus blunting, fusion, and atrophy. The histopathologic lesions are consistent with those of spontaneous gluten sensitivity enteropathy (GSE) in rhesus macaques, a condition similar to celiac disease (CD) in humans. GSE is associated with diarrhea and steatorrhea in nonhuman primates, however humans with CD report a broad range of clinical complaints including weight loss, abdominal distension, malaise, and anemia; these signs may or may not be accompanied by diarrhea. Furthermore, there is strong evidence for an association between CD and dental pathology, and emerging evidence for an association between CD and alopecia areata in humans. Enamel defects and alopecia were prominent and rapidly progressing concurrent conditions in this animal. The histopathologic diagnosis of GSE in a nondiarrheic monkey has not been reported, nor in association with oral disease or alopecia.

Jejunal Ileus and Stenosis Associated with Intestinal Lymphangiectasia in a Rhesus Macaque (*Macaca mulatta*)

AP Crusan*, EH Kriel, TM Nolan, CG McLeod, LJ DeTolla

University of Maryland School of Medicine, Program of Comparative Medicine, Baltimore, MD

A 7-y-old male rhesus macaque (*Macaca mulatta*) presented with inappetence over 24 h and scant watery stool. On physical examination (PE), the animal weighed 18.8 kg with pendulous abdomen and decreased borborygmi bilaterally on abdominal auscultation. A body score of 6.5/9 was determined. Hypoproteinemia, lymphopenia, and hyposthenuria were detected. Initial treatment include enrofloxacin (5 mg/kg SID), famotidine (0.25 mg/kg BID), loperamide (0.1 mg/kg BID), and oral electrolyte solution by water bottle were provided with standard food and water. Appetite and amount of defecation waxed and waned over the next day. A barium series was performed and found increased transit time through the duodenum and proximal half of the jejunum. At mid to distal jejunum, the barium column began to narrow to half of the prior diameter. There was also a moderate deceleration of the movement of the barium sulfate in this region of the jejunum between the 2 h and 3 h radiographs. A review of radiographs did not discern

any overt foreign body, intussusception, or obstruction. The animal weighed 18.35 kg on the day exploratory surgery was performed for evaluation and collection of tissue samples. The only gross abnormality found was a narrowed section in the region of the mid-jejunum correlating with the narrowing of the barium column on the radiograph. The section appeared grossly hyperemic and hypomotile compared to the surrounding tissue. The lack of peristalsis with manual stimulation (gentle pinch across wall of segment) was suggestive of a localized ileus. Full thickness biopsies were taken from this section as well as the stomach, duodenum, normal appearing jejunum, mesenteric lymph nodes, cecum, kidney, and liver. The abdomen was closed in 3 layers and animal recovered uneventfully with the treatments continued post-operatively with addition of analgesics. Histopathological analysis of the hyperemic section of jejunum showed segments of the serosa affected by mucinosis and lymphangiectasia. Several villi have mild lymphangiectasia. A section of the normal appearing jejunum and ileum have morphologic changes similar to the affected jejunum. Stomach is affected by diffuse mucosal inflammation which is mostly lymphoplasmacytic. Several mucosal lymphoid nodules are identified indicating chronicity of these changes. These findings seem to correlate with the hypoproteinemia and lymphopenia initially detected in the animal. The mesenteric lymph nodes show reactive changes with scattered macrophages and histiocytes. Kidney sections have scattered granular and eosinophilic casts with a few small foci of interstitial inflammation, which are mostly lymphocytic. This may be the cause of the chronic hyposthenuria. Due to overall findings, the animal was assigned to an acute study that allowed its use prior to euthanasia, given that long-term prognosis of recovery was poor.

Enterobius Outbreak in a Macaque Facility: Update and Lessons Learned

JM Bruneau, C Janssen*, RS Errahimi, AC Fisher, T Zullo

University of Pittsburgh, Pittsburgh, PA

In 2009 and again in 2012, adult worms of the genus Enterobius were detected at necropsy in the cecum of two cynomologus macaques within an ABSL3 facility. Antemortem testing of all animal in the ABSL3 in 2009 failed to detect any additional cases, nor were additional cases found postmortem in the intervening 3 y. After the 2012 detection, a survey of all animals in the ABSL3 and the associated ABSL2 areas indicated a problem within both areas the facility, but with some clear links between affected groups of animals. A first attempt at facility wide eradication using 3 single doses of pyrantel at 2 wk intervals, coordinated with cage change and room sanitization 2 d after treatment was unsuccessful. A second and third attempt using 3 d of treatment, repeated at 2 wk intervals, and coordinated with a cage change 2 d after treatment was also unsuccessful. Collection of feces for parasite identification indicates that adult worms, containing presumptively viable eggs, continue to be shed in feces for up to 3 d after athelminthic treatment, suggesting that both of the above regimens would be expected to fail in animals confined to close quarters. Current treatment is 5 d of anthelminthic, coordinated with cage change and room sanitization on day three of treatment, repeated at 2 wk intervals. Program changes resulting from this outbreak include perianal cellophane tape testing for all animals upon entry to quarantine and at routine TB testing thereafter, and specific examination of cecum for pinworms at necropsy. Given the difficulty of eradication in a confined, indoor, easily sanitized ABSL2/3 facility, and that this parasite passed through quarantine undetected and despite prophylactic anthelminthic treatment, it is suggested that other programs should survey their colonies if they are not already doing so.

Isolation of Trueperella pyogenes in a Case of Thoracic and Abdominal Abscess in a Galago (*Otolemur garnettii*)

KJ Salleng, B Burton*, T Apple, S Sanchez

Vanderbilt University, Nashville, TN

A 9-y-old male galago (*Otolemur garnettii*) presented with fight wounds, lethargy, and weight loss following pairing for breeding. Physical examination revealed lesions consistent with bite wounds on the right carpus, face, and chest. The wounds were cleaned and flushed with povidone-iodine solution and dilute chlorhexidine solution. Ceftiofur sodium was administered for 5 d, after which the animal was re-evaluated. Due to continued evidence of infection, the wounds were cultured, flushed, and cleaned. The antibiotic was changed to cefpodoxime proxetil for 7 d. Clinical resolution preceded culture results. The facial wound cultures revealed growth of a pleomorphic beaded gram positive bacilli, presumably identified as Arcanobacterium species, resistant to ceftiofur sodium. Culture results of the carpal wound revealed *Corynebacterium* species and unidentified mixed gram-negative and gram-positive bacilli. Forty–six days later, the animal presented acutely with lethargy and additional weight loss. CBC/serum chemistry panel showed an elevated WBC with monocytosis, eosinophilia, lymphopenia, elevated hematocrit, and markedly increased ALT and AST. Supportive care and antibiotic therapy of enrofloxacin and penicillin G were initiated. Differential diagnoses included hepatitis or neoplasia. The animal died 3 d later and was submitted for necropsy (62 d after initial presentation). Necropsy and histopathology revealed a fistulous tract (exiting from the original site of the bite wound on the chest) which communicated with an abscess in both the abdominal and thoracic cavities. The abdominal abscess also encompassed a portion of the liver. Cultures taken of the abscess found heavy growth of *Arcanobacterium* species, most closely identified as *Arcanobacterium hippocolae*. Due to an unusual β-hemolysis pattern and CAMP test 16S RNA sequencing identified the organisms as as *Trueperella pyogenes.* To our knowledge this is the first case of a traumatic abscessation associated with *Trueperella pyogenes* in galagos.

When Pale Becomes Problematic: A Case Report on Anemia in a Juvenile Rhesus Macaque (*Macaca mulatta*)

JM Taylor,* M Gilbert,

Tulane National Primate Research Center, Covington, LA

Spontaneous hemolytic anemia is a condition which is rarely reported in nonhuman primates. Causes of hemolytic anemia are varied and may include: drug administration (cephalosporins, dapsone, phenazopyridine, etc.), envenomation (spider, snake), infectious disease (*Babesia* spp., *Bartonella bacilliformis*, *Plasmodium* spp., etc.), toxin exposure (zinc, lead, copper), hypersplenism, valvular heart disorders, vascular disorders, or hereditary defects in erythrocyte production resulting in

membrane defects or abnormalities in erythrocyte glucose metabolism. The following report describes a suspected case of immune-mediated hemolytic anemia in a female juvenile rhesus macaque (*Macaca mulatta*). JK83, a 3-y-old Indian origin female rhesus macaque with a history of diarrhea, presented to the breeding colony hospital for evaluation of weakness. On physical examination, the following abnormalities were noted: pale pink to white mucous membranes, a 5 cm circular patch of alopecia with central exfoliative dermatitis on the craniodorsal midline, and a Grade I apical systolic heart murmur on auscultation. Complete blood count revealed a marked macrocytic normochromic anemia (PCV=8%, HCV =89.1 FL, MCHC 31.7 g/dL) with reticulocytosis and numerous nucleated red blood cells. Serum chemistry revealed a hyperbilirubinemia, hyperphosphatemia, and increased ALT, AST, and LDH with a concomitant decrease in serum cholesterol. Urinalysis revealed a marked hemoglobinuria with the presence of cellular casts noted. Abdominal radiographs revealed a generalized loss of serosal detail in the abdomen and a mild bronchial pattern in the cranial lung lobes bilaterally. Due to the presence of anemia and appearance of the abdominal radiographs in the absence of available CBC/Chem/UA data, an abdominal exploratory was performed to determine the cause of suspected blood loss, however the procedure was unremarkable. All internal organs appeared grossly normal. A bone marrow biopsy was taken from the right femur, and the animal was recovered. A blood transfusion was performed immediately post-op wherein the animal received 83 mL of fresh whole blood from an in-hospital donor, at which time the PCV rose to 18%. The bone marrow biopsy revealed a severe erythroid hyperplasia (M:E approx 1:8) which is consistent with the regenerative response observed in the CBC. The animal was administered buprenorphine and immunosuppressive doses of dexamethasone and is currently responding very well to this treatment. Further diagnostics to determine the full etiology of this anemic episode are pending.

Pharmacokinetics of Ceftiofur Crystalline Free Acid (CCFA) in Rhesus Macaques (*Macaca mulatta*) after Subcutaneous Administration

GW Salyards*, HK Knych, AE Hill, KR Kelly, KL Christe

Department of Primate Medicine, California National Primate Research Center, University of California, Davis

Rhesus macaques (*Macaca mulatta*) live in social groups with a strict behavioral code of conduct and social hierarchy to ensure stability. Trauma is a common sequela to maintaining order, often necessitating antibiotic therapy. First-generation cephalosporins are commonly used twice daily minimally for 5 d. This routine may have both animal welfare implications (increased stress, distress, and time away from the social group) and management implications (increased time, supplies, and occupational risk). Ceftiofur crystalline free acid (CCFA) is a long-acting, single-dose, injectable third-generation cephalosporin that delivers ≥7 d of therapeutic plasma concentrations in swine (*Sus scrofa domesticus*). We hypothesized CCFA would provide ≥7 d of therapeutic plasma concentrations in rhesus macaques as compared to swine. Thus, we sought to describe the pharmacokinetic profile of CCFA in healthy, adult male rhesus macaques (n = 6) in this 2-period, 2-treatment crossover study at 5 and 20 mg/kg SC administered once. Plasma ceftiofur metabolite concentrations were determined by tandem liquid chromatography-mass spectrometry prior to drug administration and for up to 21 d post. Noncompartmental pharmacokinetic analysis was performed. For each dose (5 and 20 mg/kg, respectively), maximum plasma concentration was 2.24 ± 0.525 and 9.18 ± 4.90 µg/mL, occurring at 2.59 ± 1.63 and 1.82 ± 1.29 h. The area under the curve was 46.9 ± 17.6 and 331.2 ± 84.4 h/µg/mL and the terminal elimination half-life was 56.5 ± 21.7 and 69.7 ± 8.86 h. No adverse effects were noted after drug administration at either dose. Results suggest that for macaque bacterial isolates with mean inhibitory concentrations ≤0.2 µg/mL, a single injection of CCFA at 5 and 20 mg/kg SC provides therapeutic plasma concentrations similar to swine for at least 3 and 9 d, respectively, and can significantly reduce stress and risk to personnel and animals as well as time and financial costs.

Chronic Anemia in a Rhesus Macaque (*Macaca mulatta*)

M Dickerson*, K Barnhart

University of Texas Health Science Center at Houston, Houston, TX

An adult rhesus macaque developed chronic, intermittent anemia after transfer from a south Texas facility. The macaque is generally asymptomatic, although mild fever is occasionally appreciated on physical exam. Complete blood counts have demonstrated a macrocytic, hyperchromic anemia. Abnormal red blood cell morphology was noted on peripheral blood smears prompting further evaluation. Review of thin peripheral blood smears revealed small intraerythrocytic inclusions. Whole blood was submitted for polymerase chain reaction (pending). Several parasites have been reported to infect the red blood cells of nonhuman primates, including *Plasmodium* and *Babesia* spp. Hemoplasma and *Babesia* are of main concern based on history and geographic location.

Abnormal Gait in a Rhesus

A Funk*, L Janke

St. Jude Children's Research Hospital, Memphis, TN

A 6-y-old male rhesus monkey presented with an abnormal gait which consisted of a scooting-like quality of the hindlimbs. This animal was a recipient of an adjuvant and then later an adeno-associated viral vector as part of a hemophilia gene-transfer model. Clinical signs developed 3 y following experimental manipulation and included enlarged lymph nodes and bilaterally abnormal stifel joints.

Oddities and Rarities: What's Your Diagnosis?

S Naraina-Poulle*

Bioculture (Mauritius) Ltd, Riviere des Anguilles, Mauritius

We house more than 16,000 cynomolgus monkeys. While this may look like a big challenge for the veterinary staff, it does have the advantage of, once in a while, exposing us to some very rare and odd pathological cases. In this presentation we will browse through a few of these oddities and rarities.

Effect of Major Histocompatability Complex Haplotype on T-Lymphocyte Population Characteristics and SIV Viral Load in a Colony of Sooty Mangabeys (*Cercocebus atys*)

GR Smith*, RW Wiseman, LP Daley-Bauer, J K Cohen, G Silvestri, ZP Johnson

Yerkes National Primate Research Center, Atlanta, GA

Genetic variation in the major histocompatibility complex (MHC) of nonhuman primates negatively affects interpretation of immunologic data from infectious disease and transplant medicine studies. The ability to select individual animals with known MHC haplotypes for inclusion in studies reduces data variability, allows for more targeted study design, and permits identification of more subtle differences between experimental groups. Immunogenetic management software (IMS) was developed to manage MHC haplotype, MHC expression, and pedigree data in large nonhuman primate (NHP) colonies being used in infectious disease and transplant medicine studies and to facilitate targeted subject selection. Here, we used IMS to investigate the relationship between MHC haplotype, T-lymphocyte population characteristics, and viral load in a large colony of sooty mangabeys that included both naïve and naturally simian immunodeficiency virus (SIV)-infected individuals. Sooty mangabeys and other African NHPs are natural hosts for SIV, the ancestral virus of human immunodeficiency virus (HIV). Unlike SIV-infected Asian NHPs and HIV-infected humans, sooty mangabeys infected with SIV do not display clinical signs of acquired immunodeficiency syndrome despite high viral replication levels. Blood collected at semiannual health monitoring surveys was used for DNA extraction to determine MHC haplotypes, flow cytometry to quantify T-lymphocyte subpopulations, and quantitative RT-PCR to determine viral loads. Within the 144 animals included in this study, we identified 74 unique MHC haplotypes. No significant differences were observed in T-lymphocyte population characteristics among identified MHC haplotypes. Among naturally SIV-infected individuals, no MHC haplotype was associated with different viral load levels. Our data suggest that unlike in HIV-infected humans and in SIV-infected Asian NHPs, specific MHC haplotypes do not result in different T-lymphocyte characteristics or viral loads following SIV infection in sooty mangabeys.

Spontaneous Aortic Aneurysm in Sooty Mangabeys (*Cercocebus atys*)

J Wood, G Daggett, Jr*, S Jean, J Scott, D Kempf, P Sharma, S Gumber, E Strobert

Yerkes National Primate Research Center, Atlanta, GA

Thoracic aortic aneurysm occurs frequently in humans and is associated with genetic diseases of connective tissue, high blood pressure, elevated cholesterol, and atherosclerosis. Naturally occurring aortic aneurysm has been described in mustached tamarins, owl monkeys, and one case of a mangabey with ruptured mycotic aneurysm. Here we present 3 cases of spontaneous thoracic aortic aneurysm in cage-housed, aged sooty mangabeys. Case 1 was a 19-y-old, SIV negative, male mangabey that presented with weight loss and diarrhea. Physical examination revealed no cardiac abnormalities. Laboratory diagnostics on blood, feces, and urine were unremarkable. Thoracic radiographs revealed a widened mediastinal silhouette with an enlargement of the proximal aorta. The animal was euthanized due to progressive weight loss. Postmortem examination revealed a focal dilatation of the ascending aorta and multifocal yellow plaques on the intimal surface of the aorta and iliac arteries. Histopathologic evaluation revealed moderate multifocal atherosclerosis of the aorta and iliac arteries and minimal cardiac fibrosis. Case 2 was a 22-y-old, naturally-infected SIV positive, male mangabey that died acutely with no preceding clinical signs. The animal showed no clinical signs of AIDS, however he had been receiving antiretroviral medications as part of an approved research protocol. A physical examination performed 9 d prior to his death was unremarkable, however a complete blood count collected at that time showed mild polycythemia (hemoglobin of 16.7 g/dL). Postmortem examination revealed an ascending aortic aneurysm, severe hypertrophic cardiomyopathy, left ventricle myocardial infarct and rare aortic intimal atherosclerosis. Histopathologic evaluation revealed severe myocyte disarray, cardiac interstitial fibrosis, and multifocal adventitial hemorrhage at the aortic aneurysm site. Case 3 was a 22-y-old, naturally infected SIV positive, diabetic female mangabey that presented for weight loss. Physical examination revealed no cardiac abnormalities, but thoracic radiographs revealed a widened mediastinal silhouette with increased opacity cranial to the heart. A complete blood count revealed polycythemia (hemoglobin of 22.1 g/dL). The animal was euthanized due to progressive diabetes mellitus. The aortic arch was markedly dilated with multifocal intimal atherosclerosis noted at postmortem examination. Atherosclerosis is a leading cause of aortic aneurysm in humans and has been reported to occur naturally in several nonhuman primate species, including squirrel monkeys and cynomolgus macaques. It is unclear if the same risk factors for humans also contribute to thoracic aortic aneurysm development in mangabeys. Further investigation into the pathogenesis of this condition is planned, but aortic aneurysm should be considered as a differential diagnosis in mangabeys with non-specific clinical signs.

The Use of Integrative Therapy to Treat an Ocular Lesion in a Chimpanzee

SJ Buchl*, E Magden

UT MD Anderson Cancer Center, Bastrop, TX

Integrated medicine combines alternative medicine with western evidence-based medicine. This whole animal approach focuses on overall health rather than just treating the disease. By integrating medicine, one is combining Eastern with Western medicine. A 52-y-old female chimpanzee sustained injuries in a social group altercation that needed medical attention. On examination, there were multiple lacerations but the most severe were the ocular lesions of lacerations to the commissures of the left eyelid and a corneal scratch. Addressed is the selection of the acupuncture points along with western medical techniques in the treatment of the chimpanzee's ocular lesions.

Bilateral Paralumbar Abdominal Wall Hernias in an Adult Female African Green Monkey Following Mating

E Romero*, D Hasselschwert

University of Louisiana-Lafayette New Iberia Research Center, New Iberia, LA

A 17-y-old female African green monkey presented with bilateral swellings just cranial to the pelvis on either side of the abdomen. The swellings were identified as hernias of the abdominal wall, with one side reducible and one side nonreducible. Abdominal palpation was normal at that time, and the animal appeared otherwise healthy. The animal was diagnosed with bilateral paralumbar abdominal wall hernias, which appeared to be analagous to "handlebar hernias" in humans. Handlebar hernias are abdominal wall hernias resulting from direct trauma to the anterior abdominal wall, usually at weak anatomic locations. The animal was taken to surgery to repair the hernias, which were both found to be ~ 1.5 cm diameter. The insertion of the abdominal muscles appeared to have been partially avulsed from the iliac crest. Surgical repair of the hernias was accomplished by debridement of the tissue edges and primary closure with stainless steel suture in the muscle fascia and periosteum of the ilium. Approximately 6 wk following initial presentation the animal presented for a routine physical and was discovered to be approximately 8 wk pregnant. It was concluded that the hernias were likely the result of rough treatment by the male during breeding.

A Comparison of Ketamine-Dexmedetomidine in Combination to Single Agent Ketamine for Short Term Anesthesia and Recovery in Galagos (*Otolemur garnettii*)

T Apple*, B Burton

Vanderbilt University, Nashville, TN

Little published information exists regarding the use and effects of anesthetic agents in galagos. Our annual galago physical examination and tuberculosis testing are routinely performed under ketamine anesthesia. Our objective in this study was to refine injectable anesthesia by reducing anesthetic and recovery times during the annual health assessment. We evaluated anesthetics including a combination of ketamine (a dissociative agent) and dexmedetomidine (an alpha2- adrenergic agonist) with the reversal agent atipamezole (an alpha2- adrenergic antagonist) compared to ketamine alone. In total, 50 galagos were given health assessments and TB tests while under anesthesia. Thirty-nine galagos (17 males, 22 females) were anesthetized with ketamine (2.5 mg/kg IM) plus dexmedetomidine (25 µg/kg IM) and received atipamezole (250 µg /kg IM) at completion of medical procedures. Eleven galagos (7 males, 4 females) were anesthetized with ketamine (20mg/kg IM) alone. Longer average induction times were observed with the ketamine-dexmedetomidine (3:57 min) versus ketamine injection (3:00 min). The combination drug protocol reduced the average time from anesthesia to recovery from 37 to 13 min. Heart rates of those animals under the dual agent were roughly half those of the ketamine group (158 versus 333 beats per min). Based upon clinical assessment, galagos under ketamine-dexmedetomidine anesthesia were judged to have greater muscle relaxation, greater loss of reflexes, and a smoother recovery with less salivation when compared to the ketamine group. The greater muscle rigidity detected in the ketamine group hindered palpation and range of motion assessments. Single agent ketamine did not uniformly eliminate palpebral movement. Eyelid movement is a disadvantage as the superior lid is the preferred location for intradermal skin testing. Based upon our initial experience, ketamine-dexmedetomidine-atipamezole used in combination offers significant advantages over single agent ketamine in galagos.

A Comparison of Propofol Versus Hyperventilation for Induction of Apnea in Lung Function Testing of Infant Olive Baboons (*Papio anubis*)

VA Ivanov*, JF Papin, RF Wolf, SN Moore, MP Anderson, CL Hill, RC Welliver, Sr

University of Oklahoma Health Sciences Center, Oklahoma City, OK

Olive baboons (OB) are attractive animals to model pulmonary diseases of humans. For complete quantitative evaluation of lung function, sedation and induction of apnea are required. The consistent induction of apnea with the standard method of hyperventilation is not always possible in subjects with severe lung disease and high level of spontaneous ventilation. We investigated if using propofol to induce apnea in infant OB influences pulmonary function measures in comparison with data gained in the same animals with hyperventilation-induced apnea. Nine healthy 4-5 wk old OB were sedated with continuous infusion of ketamine, intubated and placed on an Avea ventilator equipped with a hot wire pneumotachometer. Initially the OB were allowed to breathe spontaneously with zero end-expiratory pressure and no support for spontaneous breaths. Then the animals were mildly hyperventilated with a mandatory respiratory rate 60 breaths per minute, inhalation time of 0.5 s and tidal volume 8 ml/kg until cessation of spontaneous breaths, when pulmonary function parameters were measured, calculated, and recorded with the ventilator. Next, the animals were allowed to return to spontaneous breathing, after which apnea was induced by IV administration of propofol (~10 mg/kg). Apneic OB were ventilated with the same parameters and the same measurements were done. Values obtained using propofol and hyperventilation, respectively, were: static compliance 0.897±0.09 vs. 0.899±0.17 ml/cm H2O/kg, dynamic compliance 1.08±0.19 vs 1.07±0.22 ml/cm H_2O/kg, work of breathing 0.46±0.09 vs 0.47±0.12 J/L, peak expiratory flow rate 2.6±0.60 vs 2.7±0.64 L/min, resistance at peak pressure 49±7.4 vs. 46±10 cm H_2O/L/sec, compliance ratio (C20/C) 2.20±0.24 vs 2.23±0.20 (mean ± S.D.). All the differences were not statistically significant in paired two-tailed Student t-test. Results of lung function tests in OB were similar whether apnea was induced by hyperventilation or by IV propofol. However, measurements obtained under propofol showed a trend to lesser variability than those obtained during hyperventilation. This enables use of propofol for apnea induction in animals with high background ventilation without loss of data quality. The reduced variance in data obtained with propofol may allow a more accurate evaluation for differences in lung function measures.

Appropriate Anesthesia Techniques for Diagnostic Procedures

A Kamholz*

Covance Laboratories, Inc., Madison, WI

In the research environment, anesthesia can involve much more than simple surgical plane and appropriate analgesia management as most veterinary practitioners are well trained to perform. At our laboraboratory, I have developed specialized protocols for anesthesia in macaques that address specific concerns for some common diagnostic procedures. I will present an anesthetic protocol we use to prevent drift of the optic disc

during ocular topography. I will present the ideal anesthetic dosage of ketamine and timing of collection to allow for collection of the most desirable ECG tracing. I will share other protocols of anesthesia that we use commonly for diagnostic procedures. Additionally, I will share the multi-modal analgesic plans that we commonly use and are most effective at our facility.

Blood Volume Measurement in Rhesus Macaques: Is the "10%:10% Rule" Accurate?

T Hobbs*, S Blue, F Pau
Oregon National Primate Research Center, Beaverton, OR

The use of mathematical formulas to regulate blood volume withdrawal in nonhuman primates (NHPs) is ubiquitous among research organizations using NHP models. Blood draw limits are typically expressed as an allowable percentage of total blood volume (TBV) taken over a given time period. TBV, the basis for these calculations, is often estimated by applying a fixed ratio of blood volume (ml) to body weight (kg) without consideration of body condition, a primary predictor of blood volume in humans. Because of increases in the use of NHP models for obesity research, accurate estimation of TBV in this population has become more relevant. A study was conducted to determine the influence of body composition on TBV. The weight, crown-to-rump length, and body composition by dual-energy x-ray absorptiometry (DEXA) were measured in each of 20 adult rhesus macaques (10M:10F). A body condition score was determined for each subject which ranged from 2.0 to 4.5 within the study group. The TBV for each subject was calculated from plasma volume and hematocrit. Plasma volumes were determined by measuring the degree of dilution of two different tracer substances simultaneously injected into the circulatory compartment of each anesthetized subject. This enabled a side-by-side comparison of 125I-labeled rhesus monkey serum albumin (125I-RSA) and fluorescent-labeled hydroxyethyl starch (FITC-HES) tracers for determining TBV, a secondary aim of the study. Our results demonstrated that the commonly used "10%:10% rule" clearly over-estimated the TBV of all subjects. Moreover, subject body composition, specifically body fat percentage had a significant effect (p-value<0.0001) on TBV not captured by the fixed ratio of blood volume per kg body weight formulas currently in use. Additionally, TBVs calculated using the FITC-HES technique were generally lower than those calculated using the 125I-RSA technique.

The Use of Oxytocin to Facilitate Female-Infant Interactions in Macaques

P Otovic*, E Hutchinson

Johns Hopkins University, Baltimore, MD

Infant macaques are abandoned by their mothers in every primate colony. In captive environments this often requires the infants to be reared using a variety of artificial strategies, including peer and surrogate-peer rearing, in order to promote healthy neonatal physical and psychological development. While these rearing techniques are less damaging than rearing in isolation, evidence has revealed long-term, irreversible adverse changes in both physical and psychological health in infants reared away from their mothers. Ideally, all infants would be raised by their mothers or foster mothers. Oxytocin is a hormone that is released during mother-infant bonding and pair-bond formation; levels of cerebrospinal oxytocin have been reported to be positively correlated with maternal behavior in rhesus macaques. Administration of oxytocin increases a variety of social behaviors and mitigates HPA axis activity in monkeys, both of which are important influences to maternal acceptance of her infant. Two pilot studies were conducted which examined the effects of intranasal oxytocin administration on social behavior between adults during pairing and between a mother and her previously abandoned infant. After giving oxytocin to the adult female pigtailed macaques, the females were successfully pair housed without aggression and have continued to be pair housed for the past eight months. After failing to reunite a female rhesus with her infant, the mother accepted the infant after oxytocin administration. Our follow-up to these initial studies has used a within- subjects design to compare the amount of visual attention and prosocial behavior that unrelated adult female pigtailed macaques directed towards infants as a function of whether they had been treated with oxytocin. We predicted that the influence of oxytocin would cause increases in looking time and prosocial behavior directed from adult females towards infants. Further, we predicted that infants would be more likely to be accepted by adult females under the influence of oxytocin. Preliminary results suggest an increase in affiliative behavior, attention paid to, and tolerance of infant pigtailed macaques by adult females under the influence of oxytocin. We conclude that oxytocin administration increases the chances that an infant is raised by a female macaque and that oxytocin therapy should be considered prior to artificial rearing.

Example of a Wellbeing Score Card in a Large Cyno Breeding Facility: A Tool that Maximizes Available Resources

S Lefin-Desvaux de Marigny*

Noveprim Lt, Vieux Grand Port, Mauritius

As primate veterinarians we are responsible for ensuring and promoting the wellbeing of the primates under our care and responsibility. Our cyno breeding facility in Mauritius houses more than 10,000 animals in more than 700 social groups. And even if several methods for assessing animal wellbeing have been described and published, those methods remain poorly adapted to our conditions. Measuring the wellbeing of group housed cynos in a large breeding facility is rather challenging, but absolutely necessary to maintain a high level of welfare for each animal housed. We propose to share an example of an animal welfare score card we developed and how it is routinely used to assess and manage our breeding colony. The scoring system is a tool which allows all our animal welfare technicians to screen the animals on a monthly basis. The system gives our technicians a practical and user friendly tool to identify groups requiring further investigation. It also offers a grading of wellbeing which then allows us to efficiently use our resources by focusing the attention of our veterinary and animal behavior staff where they are most needed and to adapt strategies to the problems diagnosed. We will give practical examples of cases identified and managed using this score card.

Neurological Induced Self Injurious Behavior in a Rhesus Macaque (*Macaca mulatta*)

B Hibl*, W Rinaldi, K Schmidt

AlphaGenesis, Yemassee, SC

Self-injurious behavior (SIB) is a significant problem both in human and animal health. There is no apparent singular factor that causes the disease, and no clear reason for the varying severity of the disease. A 10-y-old male vasectomized Rhesus macaque (*Macaca mulatta*) presented to clinic with a 5-y history of intermittent bouts of SIB related mostly to times when capture for routine health processing was imminent. He also had a 6-y history of hand-eye incoordination, and slow, but deliberate movements. The monkey's SIB and motor skill abnormalities were unresponsive to SSRIs (selective serotonin re-uptake inhibitors) and various sedative agents. Due to the decline in his condition as exhibited by more frequent occurrence and severity of SIB, euthanasia was elected. Necropsy revealed a large (5cm × 2.5cm × est. 3cm) fluid-filled cyst occupying the left caudal aspect of the brain and a small (1cm diameter) cyst noted to the right mid brain. Histologically the cysts represented dilated lateral ventricles causing compression and distortion of the temporal lobe. Chronic internal hydrocephalus was also seen. It is suspected these brain lesions were at least partially, if not wholly, responsible for the disease severity. Studies have shown that in captive rhesus monkeys, SIBs can be related to malfunctions in the basal ganglia, which may be caused by chronic hydrocephalus, but no reports have been found describing large cranial lesions like the one seen in this case.

Assessing Cardiac Arrhythmias in a Chimpanzee Using an Implantable Loop Recorder, Acupuncture, and Laser Therapy

E Magden*, R Jones, M Sleeper, S Buchl, G Wilkerson

UT MD Anderson Cancer Center, Bastrop, TX

A 37-y-old male chimpanzee, during routine physical and echocardiogram examination, was observed on ECG to have severe cardiac arrhythmias in February 2012. While under sedation, the cardiac arrhythmias were identified and characterized as ventricular premature contractions (VPCs), multifocal, and presented as both singlets and couplets. In order to monitor the arrhythmias over a prolonged period of time, and also to assess the nature of the arrhythmias while the animal was not under sedation, an implantable loop recorder was subcutaneously placed over the dorsal thorax. Using this device we routinely acquire 7.5 minute ECG recordings as the animal voluntarily presents his back for data retrieval, allowing us to monitor the frequency of VPCs during normal daily activity. Furthermore, we are able to monitor for VPCs and other cardiac arrhythmic episodes that occur throughout the day. The loop recorder is programmed to automatically record episodes of asystole, bradycardia, ventricular tachycardia, and atrial fibrillation. Following the initial diagnosis, the animal was started on the anti-arrhythmic medication amiodarone to treat the arrhythmias, however he developed thrombocytopenia before the dose could be titrated upwards to an effective level. The medication was discontinued, and in the absence of a good pharmacological treatment option, we elected to attempt treatment of the arrhythmias with acupuncture and laser therapy. This decision was based on evidence in the human literature which shows some support for the use of acupuncture to decrease cardiac arrhythmias. The presence of the loop recorder which records the arrhythmic episodes eliminates the bias and placebo effect so often present in studies evaluating complementary therapies. Our findings using acupuncture and laser to treat cardiac arrhythmias will be discussed in this case presentation.

High Ventricular Septal Defect in a Juvenile Rhesus Macaque

J Smith*, D Hasselschwert

University of Louisiana-Lafayette New Iberia Research Center, New Iberia, LA

A 3-y-old male rhesus macaque presented with grade IV/VI heart murmur at physical examination. The macaque was kept on clinical observation for 1 mo and remained clinically normal otherwise, and was returned to group housing. Electrocardiography was performed in September 2013 following semiannual physical and showed depressed s-waves and elevated t-waves. The animal's condition began to decline in April 2014, as several episodes of intermittent nonspecific enteritis developed. EKG results again looked similar, but animal did not respond to treatment for enteritis; the animal was euthanized. Necropsy revealed cardiomegaly with right ventricular hypertrophy. A 0.5 cm ventricular septal defect was found near the heart base just distal to the pulmonic valve.

Myocardial Fibrosis and Arteriosclerosis in an African Green Monkey (*Chlorocebus aethiops sabaeus*) with a Unilateral Pheochromocytoma

F. Castillo-Alcala[1], A. Beierschmitt[1*], J. Beeler-Marfisi[1], J. DeLay[2]

[1]Department of Biomedical Sciences, Ross University School of Veterinary Medicine, St. Kitts, West Indies; [2]Animal Health Laboratory, University of Guelph, Ontario, Canada

An aged, female African green monkey (*Chlorocebus aethiops sabaeus*) presented with a clinical history of a fast-growing facial mass. A diagnosis of cutaneous melanoma was made on cytology and the monkey was euthanized. On post-mortem examination, the facial mass was located in the cutaneous tissue over the zygomatic bone and extended over the lateral aspect of the frontal bone. On internal examination, the heart was slightly enlarged, with dilated ventricles and apparently thinned ventricular walls. The left adrenal gland was markedly enlarged. No other gross lesions were noted. Microscopic examination of the facial mass confirmed a diagnosis of melanoma. Immunohistochemistry demonstrated positive reaction for Melan-A and PNL2 indicating melanocytic differentiation. Cytoplasmic staining for S100 protein was evident in the majority of neoplastic cells. Examination of the enlarged left adrenal gland revealed an expansile, well-demarcated mass within the medulla that compressed the adjacent adrenal cortical tissue. The mass was highly cellular and composed of a homogeneous population of polygonal cells with granular cytoplasm arranged in nests and packets. Immunohistochemistry of the adrenal mass confirmed a diagnosis of a pheochromocytoma. Virtually all neoplastic cells demonstrated intense immunostaining for chromogranin A, and variably intense staining for synaptophysin and S100 protein. Neoplastic cells did not stain with antibodies to Melan-A or PNL2. No metastases were observed from the tumors. Myocardial fibrosis and arteriosclerosis, lesions known to be associated with a functional pheochromocytoma, were also present in this monkey.

Comparison of Pair and Single-housed *Macaca mulatta* on Biodosimetry and Stress-Related Biomarkers in Total-body Irradiation Model

J Gulani[2,3], MG Chappell[2]*, KP Hieber[1,3], P Ney[1,3], NI Ossetrova[1]

Uniformed Services University (USU), Armed Forces Radiobiology Research Institute (AFRRI), [1]Scientific Research Department and [2]Veterinary Science Department, Bethesda, Maryland; [3]The Henry M. Jackson Foundation, Bethesda, MD

The aim of this ongoing study is to compare biodosimetry and stress-related, hematological and blood chemistry biomarkers between pair and single-housed nonhuman primates (*Macaca mulatta*) before and after total-body irradiation (TBI) to 1 Gy with 60Co g-rays at dose rate of 0.6 Gy/min. TBI causes bone marrow suppression thereby destroying the progenitors of white blood cells, red blood cells, and platelets, as well as multi-organ failure resulting in changes in blood chemistry parameters. The radiation-responsive biomarkers are used to determine the level of radiation exposure so that the patient can be quickly evaluated to receive appropriate treatment. Nonhuman primates, in general, are not socially housed post-TBI because exposure leads to immunosuppression and predisposes them to extensive bleeding and infection in the event of a secondary injury. Our study includes 4 groups with 2 animals in each group: (1) – single-housed sham-irradiated, (2) – single-housed irradiated to 1Gy, (3) – pair-housed sham-irradiated and (4) – pair-housed irradiated to 1 Gy. We did not see any detrimental effect (infection or uncontrolled bleeding) in pair housed animals post-irradiation. We are evaluating multiple biomarkers (i.e., absolute neutrophil count (ANC), absolute lymphocyte count (ALC), ratio of ANC to ALC, platelets (PLT), red blood cells (RBC), hematocrit (HCT), amylase, lipase, albumin, total protein, lactate dehydrogenase (LDH), alkaline phosphatase (ALKP), creatine kinase (CK), alanine aminotransferase (ALT) and aspartate aminotransferase (AST)) in pair and single-housed nonhuman primates over the 60 d monitoring period followed by TBI. Results from this study suggest that nonhuman primates may be pair-housed in biodosimetry research. However, more studies are needed to evaluate the effects of higher doses of radiation. The research was supported by Inter-Agency Agreement (IAA) AFR.10.064 between AFRRI and the Biomedical Advanced Research and Development Authority (BARDA) (awarded to Dr. Natalia Ossetrova). Material presented is sole opinion of the authors. No endorsement of results is implied or given by the U.S. Department of Defense. The views expressed are those of the author and do not necessarily represent those of the Department of Defense or the Uniformed Services University of the Health Sciences.

Different Post-Vasectomy Complications in Rhesus and Cynomolgus Macaques

J Chevrette*, JC Gourdon, S Nuara, G Berube

McGill University

Social housing of macaques is an important component of an environmental enrichment and wellbeing program. However it can be challenging when it comes to finding compatible cagemates for sexually mature males. Vasectomy and castration can be used to increase the possibility of social housing by allowing pairing or grouping sexually mature males and females, while controlling the reproduction. Vasectomy has the advantage over castration of not affecting the hormonal status. We performed vasectomies on 15 sexually mature macaques (6 rhesus and 9 cynomolgus). Complications such as sperm granulomas, fistulas, and chronic congestive epididymitis were seen in 6 cynomolgus, but none were observed in the rhesus macaques. This differential response should be taken into account when considering vasectomy as a tool in managing a social housing program for cynomolgus macaques.

Colonization of the Vaginal Environment of Cynomolgus Macaques with Lactobacillus rhamnosus Gr-1

F Connor-Stroud*, C Zhao, P Oviedo-Moreno, MH Sung, CJ Kim

Yerkes National Primate Research Center, Atlanta, GA

We are evaluating the cynomolgus macaque (CM) as a model of vaginal microbicide mediated protection from mucosal acquisition of simian/human immunodeficiency virus (SHIV) and herpes simplex (HSV-2). CMs were chosen due to their continuous reproductive cycle which is similar to humans, as opposed to rhesus macaques that have a seasonal reproductive cycle. To validate the CM model of SHIV transmission, we first characterized the vaginal environment over various phases of the reproductive cycle. Similar to rhesus macaques, the vaginal environment of CMs exhibits little or no constitutive lactobacilli and high Nugent scores, comparable to women with bacterial vaginosis (BV), which is associated with an increased susceptibility to HIV in women. BV in women is a condition that involves a decrease in protective vaginal *Lactobacillus* spp (LAB), the resident population of bacteria responsible for the acidic environment, and an overgrowth of anaerobic bacteria. Recombinant LABs in addition to their intrinsic mucosal protective effect are also easily engineered to express foreign proteins including compounds with antiviral activity. Thus, to establish proof of concept that lactic acid and hydrogen peroxide-producing LAB can colonize the CM vaginal tract and successfully outcompete other gram-negative anaerobes, such as G*ardarella vaginalis*, five sexually cycling female CMs were repeatedly administered 1010 *Lactobacillus rhamnosus* intravaginally and monitored weekly for dominant microbiota. They were first administered LAB alone vaginally (×4), then LAB preceded by a vaginal wash with 10 ml lactic acid pH3.5 (×4) and finally LAB preceded by a lactic wash and intravaginal topical treatment with erythromycin, delivered 1 d before LAB administration (1-2×). Although inoculation of the vagina with LAB alone or following the administration of lactic acid altered the pH and Nugent scores, LAB while detectable using culture isolation, remained a minor population by Nugent scoring one week after each administration. Erythromycin pretreatment, for which Lactobacillus rhamnosus expressed a resistance factor, resulted in a LAB dominated vaginal environment for several weeks. This proof of concept not only provides a model with which to test the vaginal delivery of protective LAB in macaque monkeys and the protective role of such colonization against exposure to SHIV and HSV-2, but may also open novel treatment strategies for human BV.

Facial Adenocarcinoma in a Cynomologus Macaque (*Macaca fascicularis*)

KE Breyer, E Mendoza, M Cottingham*, J Bernal, M Novilla

SNBL USA SRC, Alice, TX

An 8-y-old intact female cynomologus macaque (*Macaca fascicularis*) presented for bilateral conjunctivitis and was treated with a systemic antihistamine and topical antibiotics. Despite treatment, the condition progressed within several weeks to severe swelling across the bridge of the nose and lateral deviation of the left eye. Skull radiographs showed moderate to severe lysis at the bridge of the nose. Surgical exploration of the swollen area revealed a large hollowed area in the sinonasal cavity, at least 5 cm deep, surrounded by abnormal proliferative tissue. The animal was euthanized due to the severity and invasiveness of the lesion. On necropsy, the periorbital area contained a large, irregularly shaped, soft, friable, proliferative mass with indistinct margins, encompassing the nasal and sinus cavities, extending into the calvarium, and obliterating the left medial ocular orbit. Histologically, the mass was comprised of large papillary tubular outgrowths, arranged in lobules and separated by fibrovascular stroma, some with necrotic centers. The mass was compatible with a diagnosis of nasal papillary tubular adenocarcinoma. Sinonasal malignant neoplasms are rare in humans and domestic mammals, with clinical signs identical to those caused by inflammatory disease. To the authors' knowledge, this is only the second reported case of nasal adenocarcinoma in a macaque.

Validation of a Dry Whole Blood Spot Sample Collection Method for Routine Serosurveillance of Cynomolgus and Rhesus Macaque Colonies

RK Dhawan*, ML Wunderlich, D Cohen, A Shaikh, M Dodge

Charles River Laboratories, Wilmington, MA

This method utilizes a dried whole blood spot sample collection technique instead of serum for routine serology. Immune and nonimmune serum sample pairs from macaques were tested by using routine simian multiplexed fluorometric immunoassay (MFIATM) bead panels. The immune (known-positive) samples were prepared from naturally or experimentally infected cynomolgus or rhesus macaques with one or more pathogens including simian retrovirus (SRV), simian immunodeficiency virus (SIV), simian T-lymphotropic virus (STLV), and herpes B-virus. The nonimmune (known-negative) samples were derived from historically known negative specific pathogen free cynomolgus or rhesus macaque colonies for the above mentioned agents. Eight positive and 8 negative macaque whole blood samples were spotted on the cards and equivalent serum samples from the same animals were prepared. Elution of serum IgG's from the cards was performed on three separate occasions and 3 different MFIATM runs were performed on serum paired samples. Dry whole blood spot sample collection MFIATM data from triplicate runs was compared to the serum data to evaluate diagnostic sensitivity and specificity, reproducibility and ruggedness. A total of 624 assays were performed and analytical performance of the dry whole blood spot sample collection MFIATM assay including selectivity and limit of detection was found to be comparable to those obtained by serum MFIATM. The diagnostic specificity of both dry whole blood spot sample collection and serum simian assays was found to be 100%. The diagnostic sensitivity of individual infectious agents was 98% in all MFIATM runs. The validation study shows good correlation between dry whole blood spot sample collection and corresponding serum samples data. It also proves that the dry whole blood spot sample collection MFIATM results are analytically and diagnostically equivalent to those with serum indicating that the dry whole blood spot sample collection is a suitable alternative to serum for routine serologic testing of macaque colonies.

A Mobile Tablet Application for Collection of Behavioral Assessment

M Fahey*, V Herring, L Lynch, K Stonemetz, J Schimmel, S Whiting

New England Primate Research Center, Southborough, MA

Behavioral assessments are a key component of a comprehensive program for nonhuman primate health care. We developed a mobile tablet application for collection and recording of behavioral assessment data in order to streamline the behavioral assessment process at. The application populates the current demographic information for each animal from the medical records database. Tabs divide the assessment into main sections for easy navigation. The presence or absence of abnormal behaviors, temperament assessment, and environmental enrichment present at the time of assessment are documented. Additional fields capture key information pertinent to behavioral management including environmental enrichment, social housing, and positive reinforcement training. Alopecia score and self-injurious behavior score, if applicable, are also recorded. Comment fields throughout enable additional information to be captured. The assessment concludes with overall evaluation, recommendations, and monitoring level. Upon completion of all required fields, the assessment uploads automatically into the computerized medical record. By eliminating the steps between collecting behavioral data and entering into the medical record, this point of care application has improved ease of recordkeeping, reduced the potential for data errors, and increased staff efficiency.

Solitary Plasmacytoma of Bone in a Rhesus Macaque (*Macaca mulatta)*

LM Garzel*, ER Wisner, A Spinner, P F Moore, CN Alarcon, P Ross

California National Primate Resesarch Center, Davis, CA

A 9-y-old female, captive-born, Rhesus macaque (*Macaca mulatta*) housed in an outdoor breeding group presented for a 2.5 × 2.5 × 2.5 cm raised, sessile, broad-based soft tissue mass on the right rostrolateral face overlying the maxilla. Right maxillary first molar had significant mobility, and abnormally short roots were noted upon extraction. Dental radiographs showed periapical bony lysis of maxillary premolar 4 and the alveolar bone in the region of the extracted molar. Computed tomography of the head identified an expansile mass with associated osteolysis of the immediately adjacent zygomatic arch, maxilla, and nasal turbinates. Complete blood count, serum chemistry

panel, and urinalysis were unremarkable. Cytologic examination of the mass revealed a mixture of well-differentiated plasma cells and small mature lymphocytes. A punch biopsy of the mass was consistent with a round cell tumor of sheets of large cells with distinct cell borders, moderate basophilic cytoplasm, large round to oval vesicular nuclei having central to eccentric nucleoli, and occasional perinuclear clearing. Bone marrow biopsy was considered normal. Although there was a slight increase in the total plasma cell numbers, their total proportion was less than 10% of the marrow constituents. Immunohistochemical staining with multiple myeloma oncogene 1 (MUM1) had strong, specific nuclear staining of at least half of the tumor cells. Electron microscopy confirmed that the cell morphology and ultrastructure was consistent with plasma cells, as evidenced by eccentric round nuclei having multifocal clumped chromatin adjacent to the nuclear envelope and a central round nucleolus. Cytoplasm of the cells contains closely apposed dilated rough endoplasmic reticulum, with the cisternae containing a homogeneous material. Based on these findings, the mass is consistent with a solitary plasmacytoma of maxillary bone. Plasmacytomas and multiple myeloma are rarely reported in nonhuman primates. To the authors' knowledge, this is the first described case of a solitary plasmacytoma of bone in a macaque.

Effect of Adult Male Canine Tooth Modification on Group Welfare in Rhesus Macaques

D Hannibal*, B Beisner, S Cital, A Maness, N Kashyap, B McCowan, R Sammak

University of California Davis, Davis, CA

Social housing is one of the most important strategies to ensure good welfare in rhesus macaques. Unfortunately, social housing also comes with the risk of conspecific trauma, and when trauma is severe or recurring, the injured animals and/or aggressors are often removed from the group. Adult male rhesus macaques have large canine teeth adapted for social aggression and capable of inflicting serious injury, but with no important dietary role for large canine size. Historically canine crown reduction (canine cutting or vital pulpotomy) was performed to reduce the risk of trauma from adult males. Canine crown reduction can result in chronic oral pain, leading the USDA to consider the management practice unacceptable. Canine tooth blunting, without penetrating the pulp cavity, is considered an acceptable alternative in some situations. However, the efficacy of any method of canine tooth modification in reducing trauma has not previously been demonstrated. To obtain a more complete view of the welfare effects of canine tooth modifications, 9 groups of rhesus macaques (1072 total) were studied. The groups consisted of multi-male/multi-female family lines in half acre corrals. Adult males (n = 38) from three corrals were assigned to each condition: maxillary canine crown reduction (n = 12), canine tooth blunting (n = 12), or no manipulation (n = 14) of the canine teeth. Trauma in all occupants of these cages was scored and aggressive interactions were sampled twice weekly during the following breeding season. Ordinal mixed-model regression analyses show that the severity of laceration and puncture trauma increased with the rate of contact aggression by adult males, but was lower for animals in the blunt (treatment × male aggression: beta=-3.33, se=1.51; p=0.03) and cut conditions (treatment × male aggression: beta=-1.71, se=1.20, p=.16). These preliminary results indicate that both canine crown reduction and blunting reduced the severity of trauma, contributing to improved welfare for the group. Further analysis is planned to evaluate the number of animals removed from social housing due to such trauma. Longitudinal monitoring of dental pathology is ongoing for adult males in all groups to directly compare the rate of complications for canine crown reduction and blunting.

Automatic Cognitive Testing in Social Groups in Macaques

C Jouy, N Souedet, D Thenadey, P Hantraye, RA Badin, JM Helies*

Molecular Imaging Research Center, CEA, Fontenay-aux-Roses, France

Primate cognitive behavior in the laboratory has often been evaluated by housing subjects individually or isolating them and by imposing fluid or dietary restrictions to increase the subject's motivation to work. Advances in animal welfare have significantly changed the way in which research institutions house primates in terms of space and numbers, accompanied by enrichment programs with novel objects and food that break with traditional feeding habits. Although some could potentially see these changes as a bias to previously published data, others have already proved that it is possible to obtain remarkable scientific results while offering primates a highly enriched environment. Inspired by recent publications on automated cognitive testing in social groups, our laboratory developed a special application on tactile screens, AUTOBUNTO, by which each primate learnt its own pin code to launch a single trial of its own behavioral test. This system allows testing animals on different cognitive tests while preserving social groups in their home cages. Two tactile screens can be installed at 2 ends of the gang cage to avoid dominance issues over screen availability. Results suggest that gang-training to touch tactile screens is quick and that completion of different cognitive tests, including visual discrimination tasks and working memory, can be acquired in a few weeks. More importantly, primates are free to work whenever they desire it instead of being imposed with a rigid testing schedule. Isolation or dietary restrictions seem unnecessary for healthy primates to perform cognitive tests on tactile screens.

Establishing Vertebral Heart Score (VHS) Norms in the Rhesus Macaque (*Macaca mulatta*)

R Herbert*, RA Woodward

National Institute of Allergy and Infectious Diseases, Dickerson, MD

A vertebral heart score (VHS) is utilized in veterinary medicine to radiographically evaluate the heart and provide the clinician with an objective assessment of true cardiac enlargement. There is a strong correlation between vertebral body length and heart size which carries across dog breeds. VHS utilizes this correlation to determine cardiac enlargement by measuring the long and short axes of the heart and scaling these measurements against the length of the vertebral bodies starting at the fourth thoracic vertebrae. The sum of the vertebrae incorporated into these measurements results in the

VHS. Standard ranges for the VHS are well established in small animal veterinary medicine, allowing the clinician to differentiate cardiac disease from other conditions such as respiratory disease. Rhesus macaques are the most widely used nonhuman primate in the research setting and experience cardiovascular abnormalities similar to humans. Thus, establishing a set of normative values that could be applied in laboratory animal medicine would benefit research outcomes and animal care. To this end, approximately 100 lateral radiographs are being evaluated and scored from both clinically healthy animals and those presented to the veterinary staff for non-cardiac health concerns. This noninvasive radiographic technique will provide the nonhuman primate clinician with a useful method to identify cardiac disease and monitor its progression over time.

Blood Biochemistry and Haematological Reference Values of Juvenile (24-36 mo) Mauritian Long-Tailed Macaques (*Macaca fascicularis fascicularis*)

S Naiken, MA Griffiths, JR Hurdial, S Narainapoulle, P Honess*

Bioculture (Mauritius) Ltd, Riviere des Anguilles, Mauritius

The Mauritian long-tailed macaque (*Macaca fascicularis fascicularis*) is widely used in biomedical research, and determining reference intervals for its biochemical and hematological parameters provides an important tool for clinical diagnosis and preclinical research. Blood samples from 736 purpose-bred, SPF Mauritian long-tailed macaques (335 females and 401 males) were analyzed to determine normal reference intervals for 13 biochemical and 10 hematological parameters. The need for partitioning of the reference intervals by sex was also determined, and effect of age, sex, and weight on variation in the assessed parameters was analyzed. Analyses indicated that partitioning of reference intervals is recommended for levels of albumin, alkaline phosphatase, granulocytes, and mean corpuscular hemoglobin levels. Sex had significant interaction on levels of alanine aminotransferase, gamma glutamyltransferase, glucose, total cholesterol, alpha-amylase, granulocytes, lymphocytes, and mean corpuscular hemoglobin. Age had significant effect on levels of albumin, total protein, mean corpuscular hemoglobin, and white blood cell. Both age and weight significantly affected the levels of alkaline phosphatase, aspartate aminotransferase, calcium, gamma glutamyltransferase, glucose, total cholesterol, triglyceride, alpha-amylase, hematocrit, hemoglobin, mean corpuscular volume, monocytes, platelets, and red blood cells. The findings presented in this poster provide an important reference for research involving Mauritian long-tailed macaques.

Clinical Presentation of a Cutaneous Actinomycete Infection in a Rhesus Macaque

A Jay*

TNPRC, Covington, LA

A 6-y-old, 7.39 kg, female Indian-origin rhesus macaque (*Macaca mulatta*) housed in an outdoor SPF breeding colony presented, along with her healthy 3-mo-old infant, for an inflamed finger. Abnormalities revealed upon physical examination included severe inflammation of the left proximal phalanx of D4 without external indications of trauma. Radiographs were taken, on which a homogenous soft tissue opacity surrounding the digit was seen. Lancing produced 3 to 6 mm white-tan opaque, firm nodules, which were sent for biopsy and hemorrhagic fluid. No significant abnormalities were noted on CBC or serum chemistry. The animal was placed on procaine penicillin-G, buprenorphine, and carprofen and a bacterial culture of the lesion was submitted. After 7 d, the culture grew a non-acid fast, aerobic Actinomycete. The pathogen was not demonstrated on histopathology. Another course of penicillin was instituted 4 wk after presentation to treat the remaining nodules found at recheck. Radiographs taken 7 wk after presentation showed osteomyelitis of P2 of D4 of the affected manus. The osteomyelitis resolved after a 21 d course of clindamycin and the animal was returned to the outdoor SPF breeding colony shortly thereafter.

Cercopithecine herpesvirus 9 (Simian Varicella Virus) Infection in Rhesus Macaques (*Macaca mulatta*)

L Millen*, L Tomanek, S Gonzalez-Arroyo, CL Zao

Covance Research Products, Alice, TX

Twelve animals (out of a total of 165) were noted to have a rash over the face, body, and limbs consistent with a hemorrhagic cutaneous exanthema in our CDC quarantine facility 6 d after arrival from China. This type of rash in macaques is difficult to differentiate between simian varicella virus (SVV) or measles infection. One animal was moribund and was euthanized. Necropsy results showed intranuclear inclusion bodies in the spleen, stomach, and tongue consistent with herpesvirus infection. Vasculitis was present in the liver, mesenteric lymph nodes, and stomach. To help determine the etiology, serial serum samples were collected from each affected animal at 7, 19, and 33 d post-arrival. All 12 animals were anti-B virus IgG negative. Measles serologic tests showed that all 12 animals were anti-measles IgM negative and anti-measles IgG positive, which reflect previous vaccination for measles. SVV ELISA results showed that 5 animals were anti-SVV IgM weakly positive at the first time point and became negative at the following two time points; all other 7 animals were anti-SVV IgM negative at all three time points. However, anti-SVV IgG titers increased from either negative or weak positive to strong positive in a month for 11 of the 12 animals. These SVV serologic results indicated that animals were newly infected with SVV, and were either in the late acute infection stage or had just passed the acute infection stage. SVV infection was further confirmed by PCR samples collected 1 mo post arrival. The same 11 anti-SVV IgG positive animals were also SVV PCR positive. Since there were some latent SVV infected animals with strong anti-SVV IgG titers within the cohort, the source of SVV in newly infected animals could be transmitted from SVV reactivated animals during the shipment.

Frequency of ABO Blood Group Alleles in a Baboon Research Resource Colony

JF Papin*, AF Gillaspy, GL White, RF Wolf

University of Oklahoma Health Sciences Center, Oklahoma City, OK

Papio anubis baboons are increasingly being used as medical research models including infectious disease models, vaccine development, and xenotransplantation. The ABO blood

group antigens are of significance especially in models of transplantation. To this end we have decided to characterize the blood type of our colony using molecular analysis of the ABO blood group alleles. The blood group alleles for Papio anubis baboons have been previously described. The different blood group antigen alleles can be distinguished by 7 single nucleotide polymorphisms found in exon 7 of the coding sequence of the glycosyltransferase that determines the ABO carbohydrate antigen. Four of these distinguish the O allele and the remaining 3 distinguish A and B alleles. Using primers established by Diamond et al, we amplified and sequenced this region from 300 baboons in our colony using standard PCR techniques and the ABI 3730 DNA analyzer. Sequence was analyzed using software created by Biomatters Previous reports demonstrate that type B blood is the most common found in *anubis* baboons and that type O is exceedingly rare. This is in direct contract to humans where type O is the most prevalent. Our baboons are no exception with 57% of the 300 baboon analyzed exhibiting a type B blood group based upon the alleles detected and 33% exhibiting type AB. Only 9% and 1% were type A and O respectively. Interestingly, while type O only represented 1% of the population tested, compared to the 9%that were type A, the frequency of each allele in the population (A-22% and O-16%) was much more similar. Our baboons are primarily of blood type B based upon molecular analysis. However, there are a tiny percentage of type O baboons present in the colony, a significant benefit for xenotransplant studies, though numbers are too small to support a significant amount of research in the field. It is of interest to note that while A and O alleles are present in similar percentages in the colony, baboons homozygous for A alleles are twice as abundant as those that are heterozygous for O alleles. Further analysis including the evaluation of more baboons as well as reverse typing to confirm results is necessary.

Successful Social Housing of Mature Male Cynomolgus Macaques in Mixed-Sex Rooms

D Abney, K McGrew, J Toscano, E Moreau, H Moomaw, D Reim*, C Winnicker

Charles River Preclinical Services, Reno, NV

We are committed to ensuring all our animals have the highest level of care and welfare. To this end, our social housing program includes placing all animals in pairs or groups. We have a rate of almost 100% success social housing juvenile and sub-adult animals as well as adult females. Social housing of sexually mature males can be a challenge. Some publications suggest that it is not advisable to attempt adult male introductions in mixed-sex rooms of rhesus macaques (*Macaca mulatta*). However, separating animals into single-sex rooms introduces a potential scientific confound as well as operational inefficiencies, and to our knowledge this data has not been published for cynomolgus macaques (*Macaca fascicularis*). Data was collected from two sites that are actively social housing mature males. For the purposes of data collection, sexually mature males were defined as 5 y of age and 5 kg or greater. As is common in toxicology research, all animals had a narrowly defined weight range. A pair/group was considered successful if they had maintained compatibility for a minimum of 2 wk. All social housing attempts were made in rooms with females present and visible to the males. A total of 21 rooms were analyzed, and 81% of the rooms surveyed had success in pairing the majority of males in the room. Fifteen rooms had a success rate of 75% to 100% (median 92%) with over 280 male animals being socially housed. This data shows that mature males can be successfully socially housed in rooms with females. The ability to compatibly socially house mature males in mix sex rooms does not compromise welfare and allows for greater flexibility of vivarium space usage.

Leuprolide Therapy in the Treatment of Endometriosis and Uterine Enlargement in a Rhesus Macaque

KA Rice*, RL Herbert, JA Mattison

National Institutes of Health, Dickerson, MD

A 23-y-old female rhesus macaque (*Macaca mulatta*) with a 2-y history of uterine enlargement and cystic abdominal mass, diagnosed as endometriosis and presumptive uterine leiomyoma, presented with metrorrhagia despite on-going treatment with medroxyprogesterone. No other clinical signs were noted. Abdominal x-rays were consistent with uterine enlargement; however, the second abdominal mass was not clearly identifiable. Ultrasound confirmed progressive enlargement of the uterus and cystic abdominal mass. Abnormal bleeding was persistent and treatment with leuprolide was initiated to alleviate clinical signs and facilitate hysterectomy. Leuprolide acetate is a synthetic gonadotropin-releasing hormone (GnRH) agonist that disrupts the pulsatile stimulation of the pituitary leading to a down-regulation of gonadotropin (luteinizing hormone, follicle stimulating hormone) secretions and ultimately a state of hypoestrogenism. The drug is commonly used pre-surgically in women to reduce the size of large leiomyomas and to halt leiomyoma associated uterine bleeding, In this case, leuprolide treatment was administered as depot injections every 4 wk for 3 mo (0.3mg/kg IM). Because of the mechanism of leuprolide, an initial increase in estrogen, so called "flare" effect, is expected within the first 10 d of treatment. Recurrence of heavy uterine bleeding was observed in this animal at day 7 thru 10 post-treatment. No other post-treatment recurrence of uterine bleeding has been noted. Uterine size was monitored by ultrasound and decreased over time: 5.3cm × 3.7cm (day 0), 3.8cm × 2.61cm (day 28), 3.4cm × 2.5cm (day 56). The animal is scheduled for ultrasound evaluation and hysterectomy at day 84. Extended treatment with leuprolide is not recommended in women due to the side effects associated with prolonged hypoestrogenism. Treatment of uterine leiomyomas with leuprolide should not be initiated unless in conjunction with surgical excision as these tumors have been shown to rapidly recur following treatment. The clinical outcome as well as discussion on mechanism and applications of leuprolide therapy in rhesus macaques will be presented.

Atypical Presentation of Gluten Sensitivity in a Rhesus Macaque (*Macaca mulatta*)

M Stovall*, DC Owens

Yerkes National Primate Research Center, Lawrenceville, GA

At annual physical exam, a 7-mo-old female rhesus was noted to be underweight for age with a thin body condition (BCS: 2/5), pale mucous membranes, and a sparse haircoat. Hematology, serum chemistry panels, and a rectal culture were collected.

Hematology revealed a moderate microcytic, hypochromic anemia. Serum chemistry revealed a mild hypoproteinemia and hypokalemia, but was otherwise within normal limits for age. Rectal bacteriology culture revealed a *Campylobacter jejuni* ssp. infection. The animal was treated with hematinics and antibiotics for noted iron-deficiency anemia and infectious enteritis. The anemia initially responded to clinical therapy, but relapsed shortly after iron-replacement therapy was discontinued. Serum immunologic testing revealed antigliadin antibodies consistent with gluten sensitivity or celiac disease. While celiac disease in humans is typically associated with diarrhea and failure to thrive, there are also atypical symptoms of the disease that can occur in the absence of gastrointestinal symptoms. Atypical symptoms include anemia with iron deficiency and a low stature. This case represents the first known example of an atypical form of gluten sensitivity in a rhesus macaque.

Urinary Bladder Diverticula in a Rhesus Macaque (*Macaca mulatta*)

T Tanaka*, T Huynh

New England Primate Research Center, Southborough, MA

On semiannual preventive health care exam, a 15-y-old female rhesus macaque presented with polycystic urinary bladder on abdominal ultrasound. The animal was hospitalized for further work up including complete blood count (CBC), blood biochemistry, urinalysis, urine culture, contrast radiography, and cytology. CBC, chemistry, and urinalysis results were unremarkable. Cystogram clearly demonstrated multiple diverticula of the urinary bladder. A cytology sample was collected via urinary catheter by debriding the bladder mucosa with gentle suction under ultrasound guidance. A large amount of normal epithelial cells were observed, but no neoplastic or inflammatory cells detected. Bladder diverticula consist of an outpouching in the bladder wall that can be congenital or acquired.

Overview of Viral Antibody Diagnostic Positive Rates in Non-Human Primates from 2007 to 2013

C Zao*, Y Yang, A Cooke, R Berger

VRL, San Antonio, TX

Limited information on virus prevalence in nonhuman primates is available. To provide simian health care decision makers a reference on viral antibody detection positive rates, serologic screening results from testing Old World monkeys, new world monkeys, and apes were compiled from a data mine collected from 2007 to 2013. Data presented here were obtained from either ELISA or dot immunoassay screening tests. Confirmation test results were not included, therefore potential false positives and the lack of detailed background information, such as origin, age, sex and health status may restrict the diagnostic interpretations of these results. However, these data give a snapshot of each viral antibody testing positive rate in specific monkey species and may provide serologic surveillance for virus infection in simians.