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Capture-related Hypoglycemia and Recovery in Free-ranging Black Rhinoceroses (*Diceros bicornis bicornis*)

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ABSTRACT: Hypoglycemia (glucose <65 mg/dl) was detected in 21 of 28 immobilized free-ranging black rhinoceroses (*Diceros bicornis*). At repeat sampling 25 min later, only 6 of 28 were hypoglycemic ($P<0.05$). Lactate was significantly higher ($P<0.0001$) early in immobilization. Hypoglycemia and elevated lactate may increase risk of anesthetic complications and postrecovery problems.

Exertional trauma, hyperthermia, myopathy, and metabolic changes (lactic acidosis, hypoglycemia, and dehydration) are potential complications in the anesthesia of free-ranging wildlife (Spraker, 1993). These risks are greater in large ungulates that have undergone exertion before capture (Radcliffe and Morkel, 2007). Exercise-related hypoglycemia has been documented in human and animal athletes (Brun et al., 2001). Hypoglycemia can result in impaired thermoregulation and may predispose muscles and tendons to traumatic injury. In addition, the effect of potent narcotics and recumbency can exacerbate these problems by cardiorespiratory changes resulting in hypoxemia, hypercapnia, and inadequate tissue perfusion (Bush et al., 2004). Identifying serial changes in blood chemistry and electrolytes might determine potential interventions that can minimize complications. In this study, changes in blood chemistry values were compared at the time of immobilization and after black rhinoceroses were under anesthesia for a period of time to determine effects of capture and recumbency on selected parameters.

During February and March 2010 and March 2011, 28 black rhinoceroses (*Diceros bicornis bicornis*) were captured for routine identification and biologic data gathering in Etosha National Park, Namibia (latitude 19°0′S, longitude 16°0′E), permitting collection of additional research samples. The research protocol was approved by Cornell University's Institutional Animal Care and Use Committee (Protocol 2006-0170), and by the Namibian Ministry of Environment and Tourism. Animals were immobilized using etorphine HCl (M99; Novartis, Kempton Park, South Africa; total dose 3.5–5.5 mg intramuscular [IM]), azaperone (Stressnil; Janssen Pharmaceutical Ltd., Halfway House, South Africa; total dose 60–80 mg IM), and hyaluronidase (Hyalase; Kyron Laboratories, Benrose, South Africa; total dose 1,750–2,500 IU IM) delivered by 3-ml stainless steel darts (Joubert Capture Equipment, Kimberley, South Africa) from a helicopter. Most procedures were carried out during morning hours.

Blood was collected in heparinized syringes from the auricular artery for biochemical analyses from 28 rhinoceroses. Samples were collected twice during anesthesia; the first sample (S1) was collected at a mean time of 17.04±9.56 min (range, 2–47 min) after darting; the second sample (S2) was collected at 41.93± 16.48 min (range, 16–98 min) after darting. The mean time difference between samples was 24.9±12.5 min. Heparinized whole arterial blood was used to determine blood gas values using the CG4+ iStat cartridge (iSTAT CG4+ cartridges; Heska Corporation, Loveland, Colorado, USA) in an iSTAT1 handheld analyzer (iSTAT®1

Handheld Clinical Analyzer; Heska Corporation) at the time of collection. Heparinized plasma was used for chemistry panel analyses within 4 hr of collection with the ABAXIS VetScan2 chemistry analyzer (ABAXIS Inc., Union City, California, USA) using an Equine chemistry rotor (Equine profile, ABAXIS). The distribution of each parameter was assessed for normality using a histogram with a density line and more robustly using the Shapiro-Wilk test for normality. Depending on the distribution of the data, the paired *t*-test and Wilcoxon signed-rank test were used to compare mean and median values, respectively, between S1 and S2 in individual rhinoceroses. A statistically significant difference was noted at $P<0.05$.

Mean biochemical parameters (±SD) at each sampling time were calculated for lactate, sodium, potassium, creatinine phosphokinase (CPK), glucose, calcium, blood urea nitrogen, creatinine, aspartate aminotransferase (AST), gamma glutamyl transferase (GGT), and total protein. Of the measured values, only lactate and glucose were significantly different between the two sampling time points. The mean glucose value of rhinoceroses sampled at S1 was 60.4±26.9 mg/dl. Mean glucose increased ($P=0.0001$) on average by 25.9 mg/dl at S2 (mean of 86.32± 28.8 mg/dl). There was a significant decrease in lactate (median difference of 2.01 mmol/l, $P<0.0001$) between S1 and S2. Median lactate was 5.41 mmol/l at S1 and decreased ($P<0.0001$) to a median of 3.4 mmol/l at S2. Changes in other parameters related to exertion, capture, and anesthesia, such as potassium, CPK, and AST, did not differ significantly between sampling time points.

Hypoglycemia can lead to clinical signs of weakness, incoordination, nonresponsiveness to stimuli, seizures, and in severe cases, death from an inadequate supply of glucose to vital organs such as the brain and heart (Merck & Co., 2011). Hypoglycemia in rhinoceroses of this study was hypothesized to be due to exertion associated with initial capture (hypoglycemia defined as serum glucose <65 mg/dl based on comparisons to mean reference values of captive animals; ISIS, 2002). Although a quantitative measure of exertion in captured rhinoceroses was unavailable, the changes in glucose and lactate between the initial and second samples were consistent with exertion (Morkel et al., 2010). Of the 28 rhinoceroses tested, 21 had samples with glucose values <65 mg/dl at S1, with a range of 14–151 mg/dl. Most individual rhinoceroses (22 of 28) had glucose values >65 mg/dl at S2 (range of 14–168 mg/dl). In other species, hypoglycemia is partially mediated by the autonomic neuroendocrine system (McGregor et al., 2002). For example, in Standardbred horses exercised on a treadmill, cortisol concentrations increased along with glucose within 5 min postexercise (Valberg et al., 1989). On the basis of their particular physiologic status, individual animals during capture might be at risk of developing hypoglycemia secondary to exertion during the lag period before compensatory systems become activated.

Low initial glucose values postcapture could lead to increased morbidity and mortality in rhinoceroses, especially during anesthesia and recovery. Although glucose levels rebounded within approximately 30 min in the majority of animals, three were still at risk of complications associated with hypoglycemia based on glucose values <65 mg/dl at S2. Hypoglycemia has been shown to decrease cognitive and physical performance in humans and could predispose rhinoceroses to predation, trauma, or inability to adapt to new situations such as boma confinement or translocation (Mendez-Villanueva et al., 2007). Therefore, interventions such as administration of intravenous glucose at induction to minimize hypoglycemia could be useful to improve the safety of capture and immobilization in this endangered species.

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